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Master Thesis

The Copernicus program, a tool for Security and Autonomy of the European Union ?

Supervised by Pr. F. Longo and Pr. Q. Michel

Gilles Olivier
Academic Year 2022/2023

Firstly, I would like to thank Prof. Michel who allowed me to spend this year in Catania, giving me a great deal of freedom and trust, and without whom this dissertation would not exist.

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Introduction

Since the birth of the Humanity, men and women never stopped exploring and observing their environment. Since the first man-made object sent to space, its exploration helped the world to further away the limit of our knowledge and comprehension of Earth. Over the years, space programs have evolved, from military to civil oriented missions, but the competitive collaboration always staid. In this context, the European Union took an active part in the Earth Observation from space and developed an important tool : Copernicus.

This paper will be focused on answering the following question : "Is Copernicus a tool for the Security and the strategic Autonomy of the European Union ?". To answer this question, we will address different key chapters. First of all, we will define the concept of Strategic Autonomy and the concept of Security. We will then continue with the History of the space programs and the space exploration. In this chapter, we will discuss the competition between the USA and the USSR, where Europe was at the time and the history of space exploration. The third chapter will be composed of the European Union in space and will be followed by a detailed chapter about Copernicus. The fifth chapter will be interrogating the reason for the EU to feel the need to have some autonomy. This will lead to the last part of this paper, discussing the different components of the Copernicus program and their implication on the strategic autonomy and security of the EU.

Methodology

This research was conducted following a qualitative approach. Given the field of research, we feel that this is more appropriate than quantitative methods.

The first phase of the data collection is a general literature review on three subjects : the security, the strategic autonomy and Copernicus. This literature review allowed the preparation for the second phase of this research, composed of the interviews.

The second phase is thus the interview of some experts in the field. The first person to be interviewed was Dr. P. Messina. He is the Head of the Council and Subordinated Bodies Support section at the European Space Agency. His interview was pertinent due to the relation between the EU and ESA in the Copernicus program, in addition to the multiple articles written on the strategic autonomy in space. The second interview was with C. Grudler, Member of the European Parliament. His interview was pertinent due to his place in the "Sky and Space Intergroup", Industry-Research-Energy committee and the Security and Defence one. The third interview was with a counsellor on space in the Permanent

Representation of Belgium to the EU, J. Béclard. Our fourth interview took place with the president of the representative of interest of the space industry in Europe, ASD-Eurospace, O. Lemaitre. The final interview took place with an expert who asked to remain anonymous. He is an expert in security, being assistant professor at the VUB and researcher at multiple institutes and foundations. All of this allowed us to follow with the third phase of this paper.

The third phase of this research was the analysis of the interviews. This part was realised in parallel with a second data search based on the interviews and their analysis. This leads to the last part, the redaction of the following paper.

Theoretical Framework

The theoretical framework of this paper will be the strategic autonomy linked to the concept of security developed by Buzan. We think that the concept of strategic autonomy goes perfectly in the framework of the security studies for multiples reasons. The first reason is the close link between the early concept of strategic autonomy and the military culture of the security studies field. The other reason on why Buzan is important, it's because he questions the traditional concept of security with a broader view, as the EU does with the strategic autonomy concept up to this day. In this chapter, we will first describe the Buzan concept of security and then, we will try to define the concept of strategic autonomy for the European Union.

The concept of security

The traditional concept of security has always had the state at its core, and the realists view the security as a derivate of Power (Buzan, 1991). Buzan, however, stated in his book "People, states and Fear" that this concept of security was not broad enough and thus, offers a new framework incorporating new concepts that were not traditionally included. The first novelty is the new level of analysis : as said before, the traditional concept of security is clearly state centred, however, Buzan analyses the security from the international level to the individual. The second innovation is the concept of Security Complex, the third is the five sectors of security, and the last one is the concept of securisation.

The levels of analysis can be defined as the spatial scale, from large to small. It is composed of three main levels and two sublevels. The smallest level is the Individual one, the smallest analysis level possible in the social sciences field. The middle level is the Units. This level is composed of actors that are sufficiently coherent and autonomous to be seen as different from other groups. The Units are composed of different subgroups, these same subgroups can be studied as sublevel and thus called sub-Units if they have enough power to affect the behaviour of the unit above-mentioned. The highest level is the International level, composed today of the entire planet. This level can be decomposed into different International subsystems, these subsystems can be differentiated from the International system by their nature of the intensity of interaction (Buzan et al., 1998).

The second concept, the Security Complex, was defined by Buzan in “Security, a new Framework for analysis” as a security interdependence that is strong enough to mark them as subsystem themselves. The classical, and thus, the one mainly focused on the military aspect of security, can be described in four characteristics : There are at least two states; with a coherent geographical grouping; the relation between the two states is clearly marked by security interdependence, positive or negative, and this relation is significantly stronger toward the inside than the outside; the security interdependence needs to be deep and durable. To go past the military centrist view, two ways are proposed to open the security complex to other sectors. The first one is called the Homogenous Complex, that retains the classical assumption that security complex are centred around specific sectors, with specific forms of interactions and thus similar types of units. The second one is the Heterogeneous Complex, that abandons the idea of locked security complexes into specific sectors and assumes that, at a regional level, different types of actors can interact across different sectors(Buzan et al., 1998).

The security sectors come from the assumption that the security is broader than just the offensive and defensive aspects of it. There are five security sectors that have been cited by Buzan. The first one is the most common one, the military security. This security, in addition to the defensive and offensive capabilities, is also composed of the perception of the other intentions. The main threats linked to the military security are the other states, but also other political entities, as military in case of a coup. The second sector is the political one. This security sector regards the organisational stability, the system of government and the ideologies that provide legitimacy. The main threats to this sector are traditionally seen as everything touching to the sovereignty, the legitimacy or the recognition. For example, the European Union can be threatened by the disruption of the integration process. The three last security issues are not into the regalia power list, but are so important for the general security. The third sector is the economic security, that is defined as the access to the resources, finances, markets that are necessary to be sustainable as a state and maintain a certain welfare. The threats in this area are mainly due to the private sectors, as the bankruptcy or the delocalisation of the productions and demands. The societal security is the fourth sector. It’s the maintenance of the traditions, languages, cultures, religions and national identity of the state. The last security sector is the environmental one. It is the preservation of the regional and global biosphere as the fundamental foundation upon which all other human endeavours rely. The threats in this category include man-made and natural environmental catastrophes as earthquakes or spill over (Buzan et al., 1998).

The last innovation is the securisation process. It can be defined as the last step of the politicisation process, or also the political process that puts an issue on the agenda. The issues can be non-politicised, when the state does not deal with the issue. The issue can be politicised, when it is part of the public policy and the issue can be securitised, when it is presented as an existential threat requiring emergency measure(Buzan et al., 1998).

The definition of the Strategic Autonomy

Now that the security concept has been defined, we can put our focus on the strategic autonomy concept. We will start with the history of it, then the contemporary vision, and finally, we will make the definition that will be used for this paper.

In the European Union, the concept of strategic autonomy is a relatively new concept. The first occurrence of the term in this context was in 1998, with the Declaration of Saint-Malo between France and the United Kingdom. The declaration stated that the Europe should have "Capacity for autonomous action, backed up by credible military forces, the means to decide to use them, and a readiness to do so" (Järvenpää et al., 2019). This declaration led to the creation of the European Security and Defence Policy, later renamed the Common Security and Defence Policy. At the same moment, the EU worked with NATO on cooperation, these talks led, in 2003, to the arrangement "Berlin Plus" that gave the EU the collectives assets of NATO for EU-led operations. The reasoning behind these framing was the end of the Balkans wars and the need to have crisis management capabilities. As described previously, the concept of strategic autonomy was tight firmly to the security of the EU, and more precisely, the military aspect of it. We can argue that this vision of the strategic autonomy is inherently intergovernmental and thus, was more the strategic autonomy of the states, within the EU framework.

To see the reappearance of the term "Strategic Autonomy" in the EU framework, we needed to wait until 2016 and the publication of the Global Strategy for the European Union's Foreign and Security Policy. This publication has a broader and less focused on the military than the first occurrence. This paper puts more the emphasis on the stability and peace through the rule based international order and the multilateralism, while also keeping a deterrent force and industrial capacity. Some sources of what is defined as the strategic autonomy of the EU can be found in two EU communications from 2016 and 2023. In 2016 (*COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Space Strategy for Europe*, 2016), four general goals are listed and detailed : Maximising the benefits for the society and the economy; Fostering the competition on an international level and innovation in EU space sector; Reinforcing the autonomy in the accession and the utilisation of the space; and finally, strengthening the role of EU as a Global actor. In the 2023's communication, the accent is put on the security and defence principles. The goals listed are the technological sovereignty of the EU, the development of capacities, the support of the EU security and defence capabilities and creating international partnership (*JOINT COMMUNICATION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL European Union Space Strategy for Security and Defence*, 2023).

Jan Wouters and Rik Hansen propose to define the concept of independence as the opposition of dependence. That means that independence is the action of not being conditioned by another, not relying on another support and not being subjected to another jurisdiction. It is also described that there are different independence in existence. The political one, ranging between Autonomy and submission, and the Economic one, going from autarky to a negative trade balance. Of course, the two are on a scale and not in an on and off situation. The strategic autonomy is then described as a two criteria concept, the formal, the entitlement to make decisions, and the De Facto one, the ability to put into act the decisions. (Wouters & Hansen, 2015)

Now that we have all the official information, we can start the definition process. The simplest definition given can be found in the policy paper of Lippert (Lippert et al., 2019), and states that the strategic autonomy is the ability to set its own priorities and make its own decisions in matters of foreign policy and security, together with the institutional, political and material means to carry these, with or without cooperation. Having a strong autonomy means being able to set, modify and enforce international rules. The opposite of being strategically autonomous is being a rule-taker subject and, thus, being dependent on strategic decisions made by others. Other definition come from different interviews (Anonymous, personal communication, 2 May 2023; J. Béclard, personal communication, 14 April 2023; P. Messina, personal communication, 29 November 2022). The 2002 EU decision No 1513/2002/EC and Mr. Béclard explain that in the space sector, being autonomous means being able to manufacture, launch and control whatever we want, in other terms, that the EU space programs must be built entirely from EU components, developed and controlled by EU countries or the EU institutions. On a broader scale, Mr. Messina explains that the independence is also the capacity to think independently, to have some capacity for action and thinking (Al-Ekabi & Mastorakis, 2015). The Many Facets of European Autonomy, The ESPI conference on European Autonomy in Space, held on 17th and 18th of January 2011, under the leadership of former ESPI Director, Prof. Kai-Uwe Schrogl, provided an insightful evaluation of autonomy as one of the key drivers leading to the development of Europe's current space capabilities. Defining autonomy in Europe was the first step, wherein speakers distinguished the term from other forms of self-sufficiency, such as autarky, non-dependence, and the like. With the issue defined, the policy areas and the elements of autonomy and dependence were discussed, covering European pursuits in a broad range of topics including energy, culture, science, and security. With those elements identified, the key issue areas addressed access to space, space applications, human spaceflight, security and space situational awareness, and strategies that could be followed (Al-Ekabi & Mastorakis, 2015).

As a conclusion to this chapter, this paper will be mainly focused on the capacity to act more than the institutional ability to make decisions. The strategic autonomy in this paper will be defined as *the capacity to take strategic decision allowing the maintenance of strategic assets of the security of the European Union*. This emphasises the promotion of stability, peace, and a rule-based international order through multilateralism, while also maintaining a deterrent force and industrial capability. It encompasses diverse dimensions such as maximising societal and economic benefits, fostering international competition and innovation, reinforcing autonomy in space activities, and enhancing the EU's global role. Strategic autonomy necessitates the ability to set, adapt, and enforce international norms, safeguarding the entity from being a passive recipient of others' strategic decisions.

Conclusion

As a general conclusion of this chapter, we will be explicit the general definition that will be used in this paper :

The strategic autonomy in the European Union can be defined as the means for the EU and its member states to maintain the five securities, respectively the Military, Political, Environmental, Economic and Societal security, and that, without relying on external means.

History of space programs and exploration

Before heading to the main subject of this paper, we should first understand the world context of the space exploration and the history behind it. We will firstly shortly discuss the two hegemonic powers of the time, that were also the leaders of the space exploration, the United States of America and the Union of Soviet Socialist Republics. We will then talk about the European space programs. We will finally talk specifically about the Earth Observation history.

USA and USSR Hegemony

First, we will talk about the USAian space program. This program can be sequenced into multiple time periods: Before NASA, The Space Race, The Space Shuttle, International Cooperation, New Space. The program begun just after the second World War, with the operation paperclip and the construction of first copies of the V2 missile and then, the creation of the Redstone and Jupiter rockets. The development of these rockets, as well as the first satellite (Explorer 1) were under the direct supervision of the Ministry of Defence of the US. Soon after the launch of Explorer 1, the NASA (National Aeronautics and Space Administration) was created (1958), taking the competencies of the NACA (National Advisory Committee for Aeronautics) and adding the aerospace to it. The reasoning behind the fusion and the civilian lead was the multiplication of military agencies, like the Jet Propulsion Laboratory, the Army Ballistic Agency or Naval Research Laboratory, and thus increasing the cost without a real advantage. The space race began in 1957 with the first manned fly into space and, thus, just before the creation of NASA. This race was an inhibitor for more fund and also more civil focused missions with the well-known missions : Pioneer (Solar System Exploration), Viking (Martian Mission) or Surveyor (Moon Landing demonstrator). With NASA and the space race also came the manned missions Mercury, Gemini and Apollo, with respective goals of sending a man in space via ballistic mean, to orbit and to the moon. Followed by the Skylab and the sign that the space race was finished : Apollo-Soyuz in 1975. In the seventies, the USAian government wanted a more cost-efficient way to go to space than the traditional space capsule. This gave birth to the Space Shuttle, a reusable vessel that can take both passengers and a payload into space. This program was in place for twenty-nine years (1982-2011) and hit by two deadly accidents in 1986 (Challenger) and the final nail in the coffin, Columbia, in 2003. The final flights were to build the biggest USAian program, and maybe the world's most expensive structure : the International Space Station, built in collaboration with Russia, ESA, Canada and Japan. This overview of the main NASA programs cannot blur the military programs of the USA. The most well-known is the GNSS constellation “Global Positioning System”, and now used both by civilian and military customers.

The Soviet, conversely to the USA, has always had its space program under the military administration. Directly after the second World War, the USSR recovered some V2 and technical details. These German research papers were the basis for the soviet ballistic missile program. These missiles were also the basis for the Soviet space program. The first artificial satellite (Sputnik-1) was launched on the 4th of October 1957, followed soon after by the first living animal (Laïka on Sputnik-2) in space on the 3rd of November 1957. These events have launched the race to space with the USA. During this race, the USSR was the winner of most of the achievement as : 1st satellite, 1st man in orbit, 1st woman in orbit, 1st spacewalk, etc. The USSR also had a manned moon program but failed due to problem with the N-1 rocket. However, they created the Lunokhod remote rover. One of the greatest achievements of the USSR program is the space stations. The Salyut family of stations was the first station and lead to the precursor of the ISS : Mir. Mir was the station composed of multiple sections, assembled in space by multiple launches. At the end of the Cold War, the Mir station became the first International Space Station in cooperation with the USA. As said at the beginning of this paragraph, the Soviet Union space program was never civilian and thus, all the missions were military, even the scientific ones. After the fall of the Soviet Union, the Russian space program was brought under a civil agency called Roscosmos.

Even if the two main actors of the time were the USA and the USSR, the rest of the world was not a passive spectator. On the Asian stage, Japan was the first Asian country, and the fourth globally, to become a space nation in 1970 with the Oshumi satellite. Moreover, Japan also possesses a strong launcher industry. Since 2003, the Japanese space programs are concentrated under JAXA. For a long time, Japan only had a civil space program and created a military one only in 1998. The fifth space nation is China. Even during the height of the Cultural Revolution, China had a space program, mostly based on the Soviet ballistic missile one. Like the Soviet space program, the Chinese one is mostly military and state controlled. The last one that we will talk about is the Indian one. The Indian space program was launched in 1960, with the help of France. But these nations are not the main focus of this paper.

Europe as Individual Actors

Now, we can talk about the space programs in Europe. We cannot talk about Europe without talking about the different countries and their diverse programs. As a matter of fact, Europe was, and still is in a certain level, fragmented. The first country in Europe to have a space program was the United Kingdom, started as early as October 1945. An agreement was made with Australia to use some parts area of Western Australia as a launching base and test centre. The first rockets were suborbital launchers, we can mention the Skylark one, used between 1957 and 2005. The UK program was also heavily supported by the USA. The UK had an Intercontinental Ballistic Missile project called “Blue Streak” that had a range of 2 500km, but that military project was later cancelled. The civil program was also heavily helped by the USA, the first satellites were launched by NASA in the sixties, following the proposition of the former to launch scientific probes from foreign countries (Al-Ekabi & Mastorakis, 2015).

The second European country in Europe is France. France also started quickly after the end of WW2, some German scientists were brought into France and created the sounding rocket family called “Veronique” based on the V-2 research. The first launch was in 1954 in the French Algeria. The French space program took a boost after the “election” of Charles de Gaulle in 1958. His will to have an independent Nuclear program and mean to deliver it, in complement with the shock of Sputnik-1 made possible the creation of Diamant family of rocket. These efforts allowed France to put into orbit “Asterix” in 1965, followed by the first scientific satellite soon after, but this one was transported by a USAian Scout launcher. All this work was done under the newly created “Centre National d’Études

Spatiales" (1961). After the independence of Algeria, the launch base was transferred from Hammaguir, French Sahara to Kourou, French Guyana (Al-Ekabi & Mastorakis, 2015).

The third European nation to have a space program is Italy. After the war, under the impulsion of the military, Hermann Oberth was invited to work at the arsenal of La Spezia. This program took had for primary objectives the creation of ICBM for a hypothetical military nuclear program but was ultimately abandoned after the ratification of the Nuclear Proliferation Treaty. The program turns in 1959 with the alliance of the Aeronautica Militare and the different scientific research institute, especially the Centro di Recherche Aerospaziali of Sapienza University. The common program started under the direction of Colonel Broglio and used the Salto di Quira experimental military base, officially called "*Poligono Sperimentale e di Addestramento Interforze Salto di Quirra"* (PSIQ) in Sardinia. In 1962, a collaboration with NASA was proposed and accepted. This collaboration was called "San Marco" Program and used Scout rocket to launch Italian Scientific satellites in space. At first, launched at PISQ, the launch was transferred to the San Marco platform, in the Indian Ocean on the coast of Kenya, in 1967. The platform was operated by Italian from La Sapienza (Al-Ekabi & Mastorakis, 2015).

The last big country in Europe to have a space program is Germany. Germany started its program late because of multiple causes. The first cause is the fact that it was not a country with its own government until 1949 and was banned from having an army until 1955. With the army, rockets were also banned until 1955, and after their legalisation, were kept under 70 km of distance. Due to these limitations, the program was, a contrario of the other countries, mainly civil and scientifically oriented. But these restrictions, indeed, limited the faculty of Germany to develop knowledge and competencies in the space fields and thus, was lagging everyone else. Because of this, Germany proposed a collaborative European Space program initiative to enter the field by the backdoor without breaching the different treaties (Al-Ekabi & Mastorakis, 2015).

In conclusion, the European States had, at first, a mostly military program that went quickly under civil administration. It is also important to acknowledge the dispersion of resources that a program by country represents. These challenges prompted the need for a more international space program that led to the creation of ESA.

Europe as an Agency

Before ESA, was ELDO and ESRO. The reason behind the creation of an or multiple agencies are diverse. The first one is the fact that smaller countries can't compete with the virtually unlimited funds that both the USSR and USA gave to their space program. Indeed, these two superpowers were motivated by strong political, military and ideological interests. The second reason stems from the previous one, sharing the cost and the knowledge between the leading companies in Europe in the aircraft and missiles area could lead to the development of aerospace activities in Western Europe. The last reason was the belief that civilian application was a highly probable usage, for example, the meteorologic or communication usage. These elements led to the creation of two organisations : "European Launcher Development Organisation" and "European Space Research Organisation".

The European Space Research Organisation was established by the ESRO convention, signed in Paris. The creation of ESRO was seen as a way to promote cooperation and coordination in space research among ten European countries (Belgium, Denmark, France, Germany, Italy, Netherlands, Spain, Sweden, Switzerland and the UK). ESRO also provided the framework to create joint programs by pooling resources and expertise. By pooling all these resources, the countries can develop more ambitious programs. The creation of an agency also demonstrates the technological and scientific capabilities of the continent. The most significant achievement was the launch of ESRO 1, a satellite studying the Arora Borealis, soon followed by the missions ESRO 2B, ESRO 4, etc. In contrast to the Soviet and USAian space agency, the European one is purely civil and is banned from any military use of its resources, this field staying in the scope of the state (Krige et al., 2000).

The other space agency created in the year 1964 is the European Launcher Development Organisation. It was also created by the signature in Paris of a convention, the ELDO convention. The organisation was created by the same countries as the ESRO with the notable exception of Denmark, Spain, Sweden and Switzerland due to some difference of views on the independence and launch capacity needed by the Europe and the addition of Australia as an associate member. The goal of the organisation was the creation of a European Launcher, cost-effective and versatile enough to be able to launch scientific and commercial payloads. The launcher developed was based on the British ICBM called "Blue Streak". The rocket was called "Europa" with a clear repartition of competence : the UK, with the help of Belgium and the Netherlands, worked on the Blue Streak stage, the first one ; The French built the second stage, called Coralie ; and the German worked on the third stage, called Astris ; Australia, on its part, provided access to the military base of Woomera as a launching site. Unfortunately, all the launches of Europa were failures, the reason was a lack of communication between the different states and ultimately led to the end of ELDO(Krige et al., 2000).

In 1975, after eleven years, ELDO and ESRO were merged into a brand-new agency called the European Space Agency, usually referred to as ESA. But even if the two organisations didn't let the biggest mark on the mind of the general public, they both shaped the future structure still in place up to this day. The European space organisation is still strongly anchored on the intergovernmental approach and focused on the peaceful application of space. This first point can look anachronism when you look at the other international organisations created at the same time : European Community of

Coal and Steel, Euratom, European Economic Community. We can deduce that the space domain is strongly seen by the countries as a key area for their sovereignty and international prestige ('"United Space in Europe"? The European Space Agency and the EU Space Programme', n.d.).

Now that we have discussed the history that lead to the creation of the ESA, we need to talk about the ESA and how it is organised, the accomplishment and the history of the successor of Europa : the Ariane Family, and all that came after.

First of all, we need to discuss how the ESA was established. After multiple meetings and discussion, a merge of ELDO and ESRO missions was approved and signed on the 30th of May 1975, and thus, ESA started to exist de facto on the 31st of May, but was the jure established in 1980 with the final ratification of the treaty. It is, as its predecessor, an intergovernmental organisation with a peaceful purpose (ESA Convention and Council Rules of Procedure, 1975). We will come back to this claim later, but the meaning of "peaceful" has changed a lot since the creation of the ESRO and ELDO. The missions dedicated to the ESA, as described by its convention, are the design, development, construction, launch and control of satellites and space transport system.

The member states of ESA changed a lot since 1975. Originally, eleven countries were members of the ESA. Today, the number as double to arrive at 22, without counting the associated and cooperation members. To finance the Agency, each member state should participate in the ESA budget, as it will. But to incentive the states, the ESA invented something called "geographical return". The geographical return, to put it simply, is the redistribution of the ESA budget into contract proportionally the contribution made by the country (ESA Convention and Council Rules of Procedure, 1975).

Even if ESA tries to be as independent as possible, it doesn't mean that there is no cooperation with other agencies. ESA had common missions with the Russian Roscosmos before the 24th of February 2022, and still has common missions plan with the Japanese JAXA[1] and the USAian NASA[2].

One of the biggest realisations of the ESA in terms of autonomy is the Ariane launcher family. To understand why Europe has an independent launcher, we need to go back to 1972, and the failure of Europa II and the departure of Germany and the United Kingdom of the Europa program from ELDO. Shortly after the end of the Europa program, two telecommunication satellites needed to be launched, the "symphonie". The USA accepted to launch them with the conditions that they will only be used with scientific finality and not commercial one, the goal was to keep a monopoly on the

[1] Rosetta is a prime example.
[2] The James Webb telescope, or even more recently, the Artemis Missions to the Moon.

telecommunication market. France tried to launch the satellites via the USSR, but they ultimately refused in order to not upset the USA. The satellites were ultimately launched, but this episode acted as a “wake-up call” to all the European Countries, they were reminded that the USA can be an allied, but they were also a Hegemon that wanted to keep its advantages (Al-Ekabi & Mastorakis, 2015; Doboš, 2019).

After this diplomatic incident, France offered to rebuild a European launcher, and this time, taking the majority of the risks and all the over cost. This proposition was accepted and the program “L3S” was launched. Time after time, the launcher took form and the name was changed to Ariane, and Ariane 1 made its maiden fly the 24th of December 1979. But the innovation of Ariane didn’t stop there, in 1980, a company was created : “Arianespace”. This company had for goal to commercialise the launcher, and this is the first commercial company for space transportation. ESA didn’t stop at this moment and the family is still up today, with the retirement of Ariane V and the development of Ariane VI, and the creation of a little sister, the Vega family.

History of Earth Observation

Now that the general history of the European Space program and organisation is known, we must focus on the history of Earth Observation. The observation of our environment started since the creation of the eye, and never ceased to evolve since. First, the use of three, hill, mountain to observe. Then came the creation of maps to keep the knowledge intact, one of the oldest known represents the sky (16 500 BCE, Lascaux) then maps of the ground, like the Bedolina map. The technics never ended improving, to be more precise, refining, representing larger area, different subject, but stayed based on ground observation. One of the biggest technology improvements came from the creation of Montgolfier, followed soon after by the Zeppelin and planes. These technologies allowed the humans for the first time to see the world from above, without behind restricted by the heights of towers and threes. The next step was space.

The first image of the earth from space was taken by a V2 rocket launched by the USA between 1946 and 1948. These suborbital launches, followed by dedicated satellites. The first one was a meteorological satellite, called TIROS-1 and soon followed by the CORONA program, a military scouting mission relying on photographic film and recovery mission by parachute. We needed to wait to 1972 and ERTS-1 to have the first true mapping satellite, better known as Landsat-1. This satellite was the first of a family still in activity today with Landsat 7, 8 and 9 (Jutz & Milagro-Pérez, 2020; Wouters & Hansen, 2015).

On the European continent, the first EO satellites were built by the CNES in 1977, called Meteosat and had a meteorological purpose. Thanks to the success of this program, the organisation

EuMetSat was created in 1986. The first Landsat compatible satellite in Europe was called SPOT and was built by France with a participation of Belgium and Sweden. These satellites led to the creation of the corporation “Spot Image”, in collaboration with multiple private and public actors, as CNES, MATRA, Geological institutes, … “Spot Image” that was ultimately brought into the Airbus umbrella under the name Airbus DS Geo. Another big player in the space observation business is Astrium, later called EADS Astrium to ultimately be called Airbus Defence after it merged with other subsidiaries of Airbus. In 2007 and 2010, Germany launched two satellites in a PPP EADS Astrium, called TanDEM-X and TerraSAR-X. Italy also has a small observation satellites fleet with the COSMO-SkyMed (in collaboration with France, Argentina and Sweden) and PRISMA. A constellation worth mentioning is the Pléiades one, built by the CNES in an international collaboration and co-exploited by EADS Astrium, later merged into Airbus Defence and Space. This constellation had a resolution of 70 cm in 2011 and was a dual use civil and military. The successor is called Pléiades Neo, developed on self-funding by Airbus will have a 20 cm resolution (Jutz & Milagro-Pérez, 2020; Wouters & Hansen, 2015).

Outside national programs, ESA also has an earth observation program. It can be traced back to 1981 with the decision to build the European Remote Sensing, that was ultimately launched in 1991 and 1995. They were the most advance system of Earth Observation manufactured or launched in Europe. To replace it, ESA launched an Eight metric tonnes satellite in 2002. Unfortunately, due to a loss of contact, it became inoperable in 2012. Another program called PROBA, focusing on CubeSat and less expensive solutions, has an EO segment (Jutz & Milagro-Pérez, 2020; Wouters & Hansen, 2015).

The EU history in Space

When we speak about the European Union in space, we need to understand that the competency is quite recent. Indeed, this one appeared in 2007 in the Treaty of Lisbon, at the article 189 of the TFEU. That makes it a shared competency but with a specific distinction, when compared to other shared competencies, although the EU can have a space program, it’s specifically stated that it can’t harmonise the member state programs. But how did the EU before that? The EU had some view on the space sector before 2007 and thus, came with different strategies to overcome the lack of competency. The main one was using some catch-all clause of the treaty, especially the one under the “Research and Technology development”. (Decision No 1513/2002/EC of the European Parliament and of the Council of 27 June 2002 Concerning the Sixth Framework Programme of the European Community for Research, Technological Development and Demonstration Activities, Contributing to the Creation of the European Research Area and to Innovation (2002 to 2006), 2002; Decision No 1982/2006/EC of the European Parliament and of the Council of 18 December 2006 Concerning the

Seventh Framework Programme of the European Community for Research, Technological Development and Demonstration Activities (2007-2013)#Statements by the Commission, 2006)

But what is the EU, and what is the EU space program? The space program is composed of multiple components. The most famous ones are Copernicus and Galileo, but the program also has a space awareness component and recently, a new component arrived at the table : IRIS², a telecommunication constellation. In this paper, we will only discuss the Galileo and Copernicus history.

Galileo

The first program to be born was Galileo. The GALILEO program is originated in a speech given in 1998 by the European Commissioner for Transport, Sir Neil Kinnock. In this speech, the emphasis is on Europe's need for autonomy in having its own GNSS system. It was only in April 2001 that the Council, pushed by the Commission, approved the plan for a civil GNSS which was to be carried out in three phases, respectively development, deployment and operation. The last phase was initially scheduled to end in 2008. According to the original plans, the first so-called development phase was to be financed entirely by ESA and EU public funds, followed by in-orbit testing and validation in 2005, and ending with full deployment in 2008 with a public-private partnership, also known as a PPP, for the operation and deployment phase (Aliberti & Lahcen, 2015).

This public-private partnership, which was supposed to reduce costs for the taxpayer, was fashionable at the time. For the implementation of this PPP, it was planned to set up the GJU, the Galileo Joint Undertaking. The GJU was therefore created in 2002 with the role of carrying out the development of the Galileo programme during its development. In addition, it should ensure the management of important demonstration projects. The founding members were the EU, represented by the Commission, and ESA. Additional members were the European Investment Bank and the companies that had won the tender. It is precisely with the latest that problems will arise. The choice that followed the call for tender was very complicated because of a difference of opinion between the Commission and ESA. Indeed, while the Commission was looking for the best value for money, ESA was basing itself on the principle of geographical return. Following lengthy negotiations, in May 2004, the EU-ESA framework agreement excluded geographical distribution systems, of which the fair return system was a part, but this did not prevent some from reintroducing it de facto (Aliberti & Lahcen, 2015; Telò, 2005).

For various reasons, the two PPP-consortium merged. Finally, in 2006, the negotiations between the GJU and the consortium ended, thereby ending the GJU's mission and even leading to its dissolution on 31 December 2006. The companies argued that they did not have enough guarantees of clear returns on investment while taking the majority of the financial risks. Following this, the consortium was given an ultimatum to create a company to manage Galileo, but this did not succeed.

Despite these various failures to negotiate with private companies, Galileo nevertheless managed to receive the support of the majority of Member States and the Parliament to make it an entirely public system, whose budget would come directly from the Union. As a reminder, in 2007, no satellite had yet been launched despite initial plans for full deployment in 2008. With this new situation came new rules, reducing the weight of the European GNSS agency, called GSA until 2010, and increasing the Commission's management control (Aliberti & Lahcen, 2015; Telò, 2005).

As a result of this reorganisation, secure program funding and strong institutional support, the first qualification satellites could be launched in 2011 and 2012. Then, in the EU's 2014-2020 multiannual budgetary exercise, the rules were changed again, giving the GSA renewed importance. The rules were changed for the last time in 2021 with the disappearance of the GSA and the creation of the European Union Space Agency, the EUSPA.

Governance of the EU Space Program

Copernicus being part of the general European Union Space program, the governance of the latest is important to comprehend the general framework. In order to ensure an effective coordination, efficiency and the adherence to the established goals, the EU Space Program is guided by several principles (Règlement (UE) 2021/696 du Parlement européen et du Conseil du 28 avril 2021 établissant le programme spatial de l'Union et l'Agence de l'Union européenne pour le programme spatial et abrogeant les règlements (UE) no 912/2010, (UE) no 1285/2013 et (UE) no 377/2014 et la décision no 541/2014/UE, 2021).

Firstly, there is a clear division of tasks and responsibilities between the various bodies involved in implementing the program. The Member States, the Commission, the Agency, ESA and EUMETSAT are assigned specific roles according to their respective competences. This approach makes it possible to capitalise on the knowledge and expertise of each stakeholder, while avoiding unnecessary overlap.

Next, the relevance of the governance structure is considered for each program component and measure. This adaptation enables the specific needs of each aspect of the program to be met, by providing an appropriate decision-making structure. In this way, decisions can be taken in a targeted manner, according to the requirements of each component.

Rigorous control is also essential to ensure that costs, deadlines and performance are met. Each entity involved in the program must exercise meticulous control within the scope of its specific responsibilities, in accordance with the regulations in force. This approach guarantees transparency and accountability in the management of resources.

Transparent and cost-effective management is a priority. Transparency builds public confidence and enables stakeholders to understand and engage with the program's activities. By ensuring efficient use of resources, the program aims to maximise benefits while minimising costs.

Continuity of service and protection of necessary infrastructure are also key aspects. The program is committed to ensuring continuity of service by providing data, information and services on an uninterrupted basis. This requires adequate protection against potential threats, thus guaranteeing the availability of the infrastructures needed to implement the program.

In addition, the needs of the users of the data, information and services provided by the program's components are systematically taken into account. The program endeavours to keep in step with relevant scientific and technological developments, to meet users' expectations proactively.

Finally, the program implements ongoing risk management. Efforts are made to identify, assess and reduce risks throughout the program's lifecycle. This proactive approach makes it possible to anticipate and deal with potential threats, thereby ensuring the stability of the program.

In order to achieve the program, as previously planned, and to respect the different principles, the four main actors received specific responsibilities from a legal point of view. The four entities are : the member states; the European Commission; the European Space Agency; and the European Union Agency for the Space Program (Règlement (UE) 2021/696 du Parlement européen et du Conseil du 28 avril 2021 établissant le programme spatial de l’Union et l’Agence de l’Union européenne pour le programme spatial et abrogeant les règlements (UE) no 912/2010, (UE) no 1285/2013 et (UE) no 377/2014 et la décision no 541/2014/UE, 2021).

Firstly, Member States play a vital role in the implementation of the program. They contribute their technical competence, know-how, and assistance, particularly in safety and security matters. Member States may also make available data, information, services, and infrastructure in their possession or located on their territory to support the program. Cooperation between Member States and the Commission is crucial to widen the uptake of data, information, and services provided by the program's components.

The Commission has overall responsibility for implementing the EU Space Program. It determines priorities, supervises implementation, and ensures coordination among the entities involved. The Commission also safeguards the Union's interests, monitors adherence to financial regulations, and fosters the uptake of data and services by promoting their use in the public and private sectors. Additionally, the Commission ensures coherence between the program and other Union actions and programs, as well as cooperation with the Agency and ESA.

ESA has significant responsibilities within the EU Space Program. It coordinates the space component of Copernicus, designs, develops, and constructs the Copernicus space infrastructure, and may provide access to third-party data. The construction was a particularly hard part, legally speaking. Indeed, the European Union is tied with the best component per the money invested, for its part, the ESA is tied to the Geographical Return explained before. In order to join the two approaches, the ESA is buying two of satellites at the same time. A financial support permits to acquire the first one entirely, but the second (which is necessarily low cost since it has already been developed once) is acquired and paid for by the European Union (O. Lemaire, personal communication, 27 April 2023). ESA also contributes to the evolution of Galileo and EGNOS and engages in upstream research and development activities within its expertise. The Commission and the Agency collaborate closely, and ESA may provide technical expertise upon request.

The EUSPA performs various tasks related to the EU Space Program. These include security accreditation of the program's components, coordination of user-related aspects of GOVSATCOM, communication and promotion activities related to Galileo, EGNOS, and Copernicus services, and provision of specialised training in the field of space. The Agency cooperates closely with the Commission, Member States, ESA, and other relevant stakeholders.

Copernicus

The history of the program

The second project in the EU space program is the Earth Observation satellites constellation. It was formerly known as GMES for "Global Monitoring for Environment and Security" and even earlier "Global Monitoring for Environmental Security", but for ease of reading, it will be referred to as "Copernicus" for the rest of this paper.

Copernicus, or more exactly, the concept of the European Union Earth Observation program, was born in 1997 with the Manifesto of Baveno. The goal was to monitor the progress of the member states following the adoption of the Kyoto Protocol. The participants of this meeting leading to the manifesto were the Director General of the Joint Research Centre of the European Commission, also functioning as the coordinator for space matters within the European Commission, and other high-level representatives from ESA, EUMETSAT, national space agencies, and the European space industry. In 1999, in coordination with the ESA, the EU Commission presented a working document that emphasised Earth observation's strategic value as a crucial component of implementing the EU's "post-

Kyoto strategy" and its potential to support other policy areas. The working document emphasised that it was in Europe's best interest to ensure that there were multiple sources of information derived from space-based observation, as the USA was putting itself in position to monopolise the EO field and other countries that owned EO satellites were unlikely to challenge that initiative. The project's initial phase started a few months later, on 11 November 2001, with ESA allocating €83 million to it. Later, through its 6th Framework Program for Research and Technological Development, the European Union offered comparable funding. By the end of the first phase, it was clear that the information provided by the GMES program would not only help Europe meet its environmental obligations but, would also support sustainable development in areas like regional development, development aid, agriculture and fisheries, transportation, and other policy areas. Additionally, the program should contribute to civil security as well as the goals of the Common Foreign and Security Policy (CFSP). Thanks to the Galileo experience, the program was made fully public and European from the beginning to avoid the same problem as Galileo : PPP and Bei-Du failure. But being European and public doesn’t mean that it can’t be made in partnership. During the 2004-08 period, it was therefore decided that the space component would be composed by the Sentinels’ constellation and “contributing missions”. Thus, the Sentinels will neither replace nor duplicate other European Earth Observation missions, but instead, they will complement each other(Al-Ekabi, 2015).

But everything was made under the Maastricht framework. With the passage of the Lisbon Treaty, the European Union gained the authority to create a European Space Policy by encouraging collaborative efforts, fostering technological advancement, and organising the activities required for space exploration and exploitation. Instead of advancing our understanding of the universe, the flagship programs of the European Space Policy (Copernicus and the Galileo system) serve the exploitation of space with a focus on Earth. These programs are used to meet the demands of a society that depends increasingly on information about the Earth. But unfortunately for the program, in parallel to the Lisbon treaty, another world-changing event occurred : the subprime crisis, soon followed by the euro crisis. Before the 2014 budget, and in order to save the program and in order to secure more financing for the EU, the Commission at the time proposed to transform Copernicus into an intergovernmental project. This project was vehemently rejected by the member states, the European Parliament, the European council and the council of the European Union. Copernicus was, thus, ultimately reintroduced into the EU budget, even if it was with a shorter budget than previously expected (O. Lemaire, personal communication, 27 April 2023). The last budget appears in 2021, at the same time as the creation of the EUSPA. The budget allowed to Copernicus during the 2021-2027 period will be €5,421 billion.

Now that the history of the program is explained, we will see the different components of the Copernicus program. There are six services in total : Atmosphere, Marine, Land, Security, Emergency and Climate Change.

[Fig 1 : The logo of the six Copernicus Services. Source : https://www.cophub-ac.eu/twg/]

The first component is the Climate Change Service. The mission is to support society by providing information on the past, present and future climate in the world. There is a wide variety of users, we can take into example the brewery Heineken, the Costa Rica, etc (*Climate Change | Copernicus*, n.d.).

The second component is the Marine Service, from its full name Copernicus Marine Environment Monitoring Service. This service is the one monitoring the ocean on three levels : Blue, the physical water; White, the sea ice; and the Green, the biogeochemical state (*Marine | Copernicus*, n.d.).

The third component is the Atmospheric one. The Copernicus Atmosphere Monitoring Service offers the ability to continuously monitor both the global and regional atmospheric composition. This service capability includes the ability to describe the current situation, forecast the situation for the next few days, and provide consistent retrospective data records for recent years (re-analysis). The service produces geophysical products that call for additional technical processing and a variety of high-level data to assist decision-makers. It is mainly composed of : Air quality and atmospheric composition; Ozone Layer and ultraviolet radiation; Emissions and surface fluxes; solar radiation and climate forcing (European Commission, 2017a).

The Copernicus Land Monitoring Service is the fourth component. This service provides geographical information. The CLMS is divided into 5 categories : Biophysical monitoring; Lang cover and use mapping; Thematic hotspot; Reference data; Ground motion service (European Commission, 2017b).

The fifth component is the Emergency Management Service. The CEMS distributes flood and forest fire warnings and risk assessments, as well as geospatial data derived from satellite images on the effects of natural and man-made disasters worldwide. By means of these, it aids crisis managers, civil protection, hydro-meteorological, and humanitarian aid organisations that deal with natural disasters, man-made emergencies, and humanitarian crises, as well as those engaged in recovery, disaster risk reduction, and preparedness activities. The EMS's top priority as an EU service is attending to EU needs and interests, both inside and outside the EU. To authorised users, the Emergency Management Service is offered without charge. Early Warning and Mapping are the two primary components of the service (*Copernicus Emergency Management Service*, n.d.).

The sixth and latest component is the Copernicus Security Service. The aims are to support European Union policies by providing information when a security challenge appears. The key areas are the support of the EU External Actions; Maritime Surveillance and Border Surveillance (European Commission, 2017c).

Official justification and reasons

To know why the EU wants an Earth Observation Program, we need to look at the different regulations, communication and white paper.

The official justification for the European Union Space Program evolved at the same pace as the society and technologies, and, at the same time, stayed coherent between the different official publications. In this subchapter, we will see the evolution of the justification and the missions of the EU space program, from the year 2000 until today.

In 2000, a communication listed three main objectives. The first one was the preservation of independent access to space, with the insurance of an industrial base capable of designing, manufacturing and operating satellites. The second one is the enhancement of scientific knowledge from the Earth to the Universe. And finally, the last objective was a mercantile one. The goal was the implementation of a demand-driven approach to exploiting technical capabilities of the space community in order to benefit markets and society. But these objectives were not the only justification. At the time, space was already seen as a strategic component for the future. Communication satellites were already planned, and the positioning system was seen as a strategic asset to have in a world with a GPS monopoly. The observation satellite was planned to be useful in different situations. It is, for example, vital for meteorology and global change studies, identification of environmental problems early warning of crisis, … The services were also seen as having a strategic value in the economic, political and societal area (*Communication from the Commission to the Council and the European Parliament - Europe and Space*, 2000).

The 2003 white paper gave a more detailed area on the benefits foreseen on having a space program. The five first benefits were : an economic growth, with the creation of high added value job creation and the improvement of industrial competitiveness; the enlargement of the EU was also in all the minds at the time and the space program was seen as a mean to make it successful; the sustainable development; a stronger security and defence and finally; fighting poverty and the aid in development. This white paper also put the emphasis on the possibility for the EU to be more politically recognised on the international stage and seen as a respected global partner (*White Paper - Space*, 2003).

Seven years later, after the adoption of the Lisbon Treaty and the article 189 of the TFEU, the EU Regulation 911/2010 was specifically made for the Copernicus program. In this regulation, the legislator explains that the Copernicus should provide better exploitation of the industrial potential of the EU and the development of technologies in the Earth Observation field. But it was also stated that the main objective of the program was the possibility to have reliable information sources for the environment and security field. The first annex also gives us some detailed possible future uses for each component of the program. The emergency service was intended to be put at the disposition of every actor that would need it, in case of emergency, and so, without regard to its geographical situation. It was to be used in case of meteorological, geophysical, man-made and humanitarian catastrophes. The land service was intended to send information on the biodiversity, state of the waters, soils, forest and national resources in addition to the monitoring of national environmental policies, the collection of data on the agriculture, urban environment, infrastructures, etc. The marine component was focused on the physical state of the oceans, principally to be used in the maritime security, the monitoring of resources and meteorological previsions. The atmosphere service is to be used for the monitoring of the air quality and the atmosphere chemistry. As the three previous components, the climate change monitoring service should contribute to the provision of climate variables essential for climate analyses and projections and the provision of services useful for these purposes. The last component is the security one. This one as a very general explanation, explaining that this component should be used to provide useful information to go above the challenges that the EU faces in the security area, including the control of the borders, maritime surveillance and support of the EEAS.

This regulation is also essential to understand the importance of having an independent earth observation constellation. In the preliminary section of the regulation, each component is justified. The emergency service was necessary to coordinate the EU capacities and the one from the MS in order to be better prepared in case of natural or man-made disasters. It is especially important with the climate change and the multiplication of emergencies. Because of the use of these data in a wide range of resources and policies linked to natural resources, the land service was important for the EU to collaborate within and outside of Europe and the UN to provide access to this information. The marine component was deemed necessary to fight the climate change, monitor the marine environment and the transport policy. It's also a key component for the EU in order to fulfil its obligation to the world meteorological organisation. As the marine service, the atmosphere one was also a key component for the WMO obligations. The monitoring of climate change was the combination of the land, atmosphere and marine components. It was a particularly important area of Copernicus in order to analyse climate change and find adaptation and mitigations solutions. The Security services were a really important part of Copernicus, but except what was already said in the previous paragraph, there is not a lot more explained. With all this very vague description and without giving clear justification, we can consider the EU was not in accord with itself on the meaning to give to "Security" and thus, was the most controversial part of the program. This suspicion will only be comforted by replacing regulation, in the next paragraph.

The regulation 377/2014, replacing the previous one, keeps the previous justification and objectives with some differences. The first one is the Security services described as "civil security" and not security on a broader scale, that includes border and maritime surveillance, crisis prevention and preparation. But it's also important to note that this precision on the civil part of the civil security should not stop the SatCen using the Copernicus data, or other CFSP organs. The second change is that the Copernicus should be explicitly used in the "Strategy Europe 2020" framework, and more precisely, the second chapter, for an intelligent growth, sustainable and inclusive (*EUROPE 2020 A Strategy for Smart, Sustainable and Inclusive Growth*, 2010). This chapter gives three main objectives : An economy based on knowledge and innovation; An economy more efficient and sustainable, greener and competitive; an economy with a high level of employment, with an economic, social and territorial cohesion. For the first time, the regulation also states a goal for Copernicus : "The objective of Copernicus should be to provide accurate and reliable information in the fields of environment and security, tailored to the needs of users and to support other EU policies, in particular those related to the internal market, transport, environment, energy, transport and energy efficiency, policies, including those relating to the internal market, transport, the environment, energy, civil protection and civil security civil protection and civil security, cooperation with third countries and humanitarian aid."

The Joint communication on the Space Strategy for security and Defence also states that Earth Observation is a system require supporting security and defence because :"*Space-based Earth Observation supports autonomous assessment and decision–making. It is a key enabler for security and defence. It has proven to be a game-changer for the Ukrainian Armed Forces to resist the Russian attacks."* (*JOINT COMMUNICATION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL European Union Space Strategy for Security and Defence*, 2023)

Regulation (EU) 2021/696

This regulation is the cornerstone of the European Union space program. It is the summary of the space program, why the EU needs a space program and how it should be implemented. It is basically a summary of the previous text, but also clarifies some previously vague terms. It's not only an important piece of information because it's the most recent regulation concerning the EU space program, but it also gives a list of objectives in general and for each program and some indicators.

In the introduction of the regulation, there are different reasons that summarise the previous justifications. We can divide them into three porous categories : the economic and industrial categories, the international and strategic vision, and finally, the scientific and policy reasons. Most of the justifications already existed since 2016 in a communication on the EU space strategy, but it is now official. The first reason given on why the EU needs a space program is the fact that today, the space technologies are indispensable in the day-to-day life and the safeguard of several strategic interests.

The first economical reason behind the space program is the actual competitively of the EU space industry. The space industry within the EU is, today, one of the most competitive in the world, but in order to keep this place of first rank actor, to increase the conception, construction and exploitation capabilities, the EU needs to support the space industry in its competitively and scientific progress. Outside the space industry strictly speaking, the program is composed of dual-use items, but are still very important for the EU economy. A number of strategical economic sectors are using satellite navigation and earth observation systems, as the transport, telecommunications, agriculture and energy sectors, for example. The policy of free, full and open access to the data is also a really important part of the program and the stimulation of downstream uses.

In the security sector, the EU considers that autonomous access to space and the use of it at will in security is an indispensable to achieve a certain liberty of action independence and security. On the international scene, space is seen as an international cooperation area that is essential to promote the EU as a global actor, promoting fair competition and cooperation. The international aspect of the space program is also seen as a way to fight for global challenges, but also a way to exercise a space and economic diplomacy, via the EEAS, or other development cooperation policies.

Concerning the last section, Copernicus should provide information in order to ease and ensure an independent decision-making and action from the EU. The example given were the environment, climate change, marine and maritime affairs, agriculture and rural development, cultural heritage conservation, civil protection, land and infrastructure monitoring, security and the digital economy. Speaking of climate change, Copernicus should be used in order to monitor the respect of the EU International engagement in favour of the climate.

But the regulation is not only composed of the introduction, but also the legal instrument. In this part, we have the article 4 stating the general objectives and the objectives specifically for Copernicus. The general objectives are to give data and services of quality, globally and able to support the EU policies; to maximise the socio-economical advantages; to reinforce the surety and security of the EU and its member states, in addition with a strategic autonomy for the EU, especially in the technological area; and finally, to promote the role of the EU as a space actor on the global scale, reinforcing its space diplomacy. For the Copernicus objectives, they are stated as such : ”Copernicus: to deliver accurate and reliable Earth observation data, information and services integrating other data sources, supplied on a long-term sustainable basis, to support the formulation, implementation and monitoring of the Union and its Member States’ policies and actions based on user requirements”. These objectives are to be linked with the articles 49 and 51, giving respectively application field and the legitimate actions. The application fields were already stated in the introduction and restated in the previous paragraph. The article 51 explains the six components of Copernicus. There is little in comparison to the previous regulation, the main one being the change from “Civil Security” to “Security” in the security component of Copernicus.

To monitor the success of the program, the annexes give us seven key indicators. The indicators for the objectives stated in the article 4 are the number of users, the satisfaction, the number of new products using Copernicus services and data, and the quantity of data generated. The ones stated at the article 102 are the number of EU policies exploiting Copernicus, the downstream usage is calculated by the number of new enterprises, the number of jobs created and their financial results. The space sector results are, in the upstream, calculated by the number of jobs created and their financial result.

The different tasks given to institutions

In order to insure the efficiency of the Copernicus program, each agency, from the EU or independent, has a delegation of tasks from the EU Commission. These entities are : the ESA; EUMETSAT; the European Environmental Agency, known as EEA; the Mercator Ocean International; the European Centre for Medium-Range Weather Forecast, known as ECMWF; Frontex; the EU satellite Centre, known as SatCen; and the EUSPA. (*ANNEX to the Commission Implementing Decision on the Financing of the Union Space Programme and the Adoption of the Work Programmes 2021 (Direct Management) and 2021-2027 (Indirect Management) Copernicus Part of the 2021 (Direct Management) and 2021-2027 (Indirect Management) Work Programmes of the Union Space Programme*, 2010).

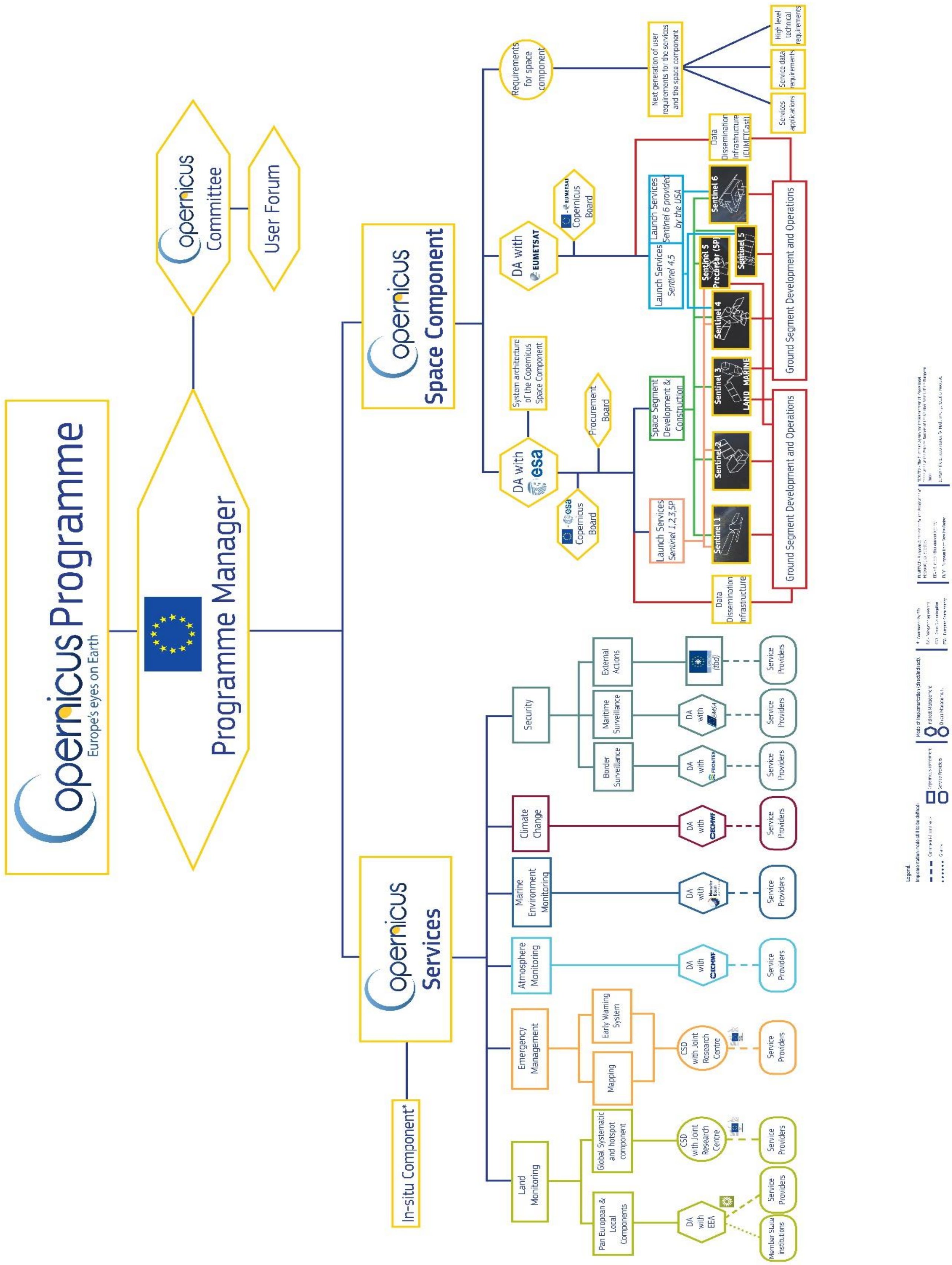
First, starting with the European Space Agency. The tasks include the development, maintenance, and operation of Sentinel missions, as well as the provision of third-party data, data access and distribution, user uptake, market development, and capacity building. The ESA is entrusted with various tasks, including the completion of space segment development, launch services, ground segment development, operations of the Copernicus Space Component, maintenance of data quality, data management, access management, integrated data management, end-of-life/replacement phase, short-term and long-term evolution, and communication, user uptake, market development, and capacity building activities. These tasks aim to support the effective functioning and development of the Copernicus program. In order to achieve these missions, the ESA receives a budget of €4.115B from the 2021-2027 budget.

EUMETSAT is responsible for ensuring the continuity and expansion of the Sentinel missions. This includes the development, maintenance, and operation of new Sentinels to broaden the scope of Copernicus' observations. EUMETSAT also contributes to the infrastructure upgrades of the Copernicus Space Infrastructure, ensuring enhanced continuity and expanding observation capabilities. Additionally, EUMETSAT collaborates with ESA in managing the flight operations and data processing operations of various Sentinel and Copernicus missions. The organisation plays a crucial role in providing data access and distribution services, including the calibration and validation of Sentinel missions. Furthermore, EUMETSAT ensures access to its own mission data and selected third-party missions relevant to Copernicus environmental services, in line with user needs and requirements.

The EUSPA is responsible for the user uptake on the Copernicus program. This entails extending the European GNSS User Consultation Platform to engage end-users and ICT stakeholders, fostering collaboration with entrusted entities, and closely monitoring and analysing data access. Moreover, the EUSPA plays a crucial role in creating a business-friendly ecosystem that promotes entrepreneurship among Other Copernicus Users. It also remains attentive to emerging tasks related to user uptake, adapting to the evolving dynamics of the downstream sector in collaboration with the Commission.

The EEA is the agency responsible for the implementation of the Land Monitoring Service of Copernicus. The Maritime Service is, however, split between two main actors. The first actor is the Mercator Ocean International, an independent organisation. This organisation is responsible for the marine environment monitoring service. For the maritime surveillance, this includes : Fisheries control; Maritime safety and security; Customs; Law enforcement; Maritime pollution monitoring; and International Cooperation, the EU has trusted the European Agency for Maritime Safety, an EU agency. Another independent agency called to be responsible for the Copernicus service is the European Centre for Medium-Range Weather Forecast. This agency is responsible not only for the Atmosphere Monitoring Service but also the Climate Change Monitoring Service. The border surveillance service is delegated to Frontex. The support of the External Action Service is located in the Satellite Centre of the EU.

[Fig 2 : Copernicus Governance Scheme. Source : https://www.copernicus.eu/fr/propos-de-copernicus/copernicus-en-bref] (See annex 1)



The Contributing missions and the different Sentinel variants

As previous said, Copernicus is composed of multiple components, including a space component. The space component is composed of the different Sentinel satellites, from 1 to 6, each with a different mission. But before the birth of the Sentinels, other missions already existed in the Earth Observation area, as stated in the history of the space program. But in order to ensure better data for the Copernicus Services, other operators' satellites can be used by the Copernicus Program. Even if the Sentinel Satellites are all operational, the contributing missions are essential to deliver complementary data. There are currently twenty-two contributing missions or soon to be contributing missions, operated by private or public actors. In this chapter, we will discuss them and explain the six Sentinels missions. The contributing missions can be divided in different ways, but the one that will buses in this chapter first is dividing them between optical and SAR satellites, then between the Very High Resolution 1, the Very High Resolution 2, High Resolution 1 and 2 and Medium Resolution 1. In order to use and publish the data in accordance with the Copernicus principle, freely and openly, the European Commission negotiated with the owners of the satellites' procurement contracts. The cost of the data is thus paid by Copernicus to redistribute it freely (*Contributing Missions*, n.d.; Jutz & Milagro-Pérez, 2018).

The first Sentinel constellation is the Sentinel-1, composed of an A and B satellite, with redundancy in mind. In December 2021, the first satellite of the Constellation stopped emitting, the Sentinel 1B thus became the first Copernicus Satellite to die and will be replaced by a new generation Sentinel 1C (*Mission Ends for Copernicus Sentinel-1B Satellite*, n.d.). Sentinel-1 is SAR based, providing land and maritime imaging capabilities. Sentinel-2 is, however, an optical platform providing high-resolution multispectral imagery of Earth's land and coastal areas. With its multispectral capabilities, Sentinel-2 is instrumental in monitoring vegetation health, land cover changes, and assessing the impact of natural disasters. Sentinel-3 is the first multi-instrument satellite of the Copernicus space component. It is a constellation of satellites dedicated to global ocean and land monitoring, collecting a wide range of data, including sea surface temperature, ocean colour, and land surface temperature. These measurements contribute to understanding climate dynamics, monitoring marine ecosystems, and supporting sustainable management of Earth's resources. Sentinel-4, as Sentinel-5, are instrument linked to other missions. Sentinel-4 is a geostationary imaging spectrometer designed to monitor atmospheric composition that provides continuous and high-resolution measurements of trace gases, aerosols, and clouds in the Earth's atmosphere. Sentinel-5 is focused on monitoring the Earth's atmosphere and providing accurate data on atmospheric composition. Sentinel-5 carries spectrometers to measure various trace gases, aerosols, and cloud properties. Sentinel-5p is a precursor mission for the Sentinel-5 series. Sentinel-5p is dedicated to monitoring atmospheric composition and provides high-resolution measurements of trace gases, aerosols, and clouds. Sentinel-6 carries a radar altimeter to measure global sea-surface height, primarily for operational oceanography and for climate studies.

[Fig. 3 : List of all the Sentinel mission active today and their functions. Source : https://www.euspa.europa.eu/sites/default/files/expo/5._information_about_copernicus.pdf]

In order to maintain and extend the capacity of Copernicus, multiple missions are in preparation for the incoming years. These six missions are CO2M, LSTM, CHIME, ROSE-L, CIMR and CRISTAL. (*Copernicus Sentinel Expansion Missions*, n.d.)

The Copernicus Anthropogenic Carbon Dioxide Monitoring, CO_2M mission aims to monitor and measure anthropogenic CO_2 emissions from human activities. It focuses on quantifying and understanding the sources and sinks of CO_2. CO_2M utilises advanced sensors and technologies to provide accurate and precise measurements of CO_2 concentrations, contributing to a better understanding of the carbon cycle and its impact on the Earth's climate system. The Land Surface Temperature Monitoring, LSTM, focuses on monitoring and analysing land surface temperature variations. It will provide crucial information about the Earth's surface temperature patterns, helping to understand climate dynamics, heatwave detection, and urban heat island effects. The Copernicus Hyperspectral Imaging Mission, CHIME, is designed to capture high-resolution hyperspectral imagery of the Earth's surface. The ROSE-L, Radar Observing System for Europe - L-band, is dedicated to monitoring the Earth's surface using SAR technology. It will monitor land deformation, ice sheet dynamics, forest mapping, and maritime surveillance. The Copernicus Imaging Microwave Radiometer, CIMR's mission is focused on observing the cryosphere, including sea ice, ice sheets, and snow cover, as well as the ocean surface temperature and salinity. And the final project of improvement for the Copernicus program is the Copernicus PolaR Ice and Snow Topography Altimeter, CRISTAL, which mission is dedicated to monitoring ice and snow-covered regions, with a specific focus on polar areas.

The reasons why the EU needs some strategic autonomy

In this chapter, we will discuss the reason of why the EU feels the need to achieve some kind of strategic autonomy. To start, we will talk about the change in the international order since the European Union is called the European Union. Then we will analyse the reliability issue with our international partner, and finally the reason why space is considered as a geostrategic area.

The most visible change since 2000 in the International Order is the return of conventional war in Europe. Combined with the straightening of the illiberalism, the EU is challenged in its ability to promote its vision and interests. The first electroshock for the European Union was the departure from the Union by the United Kingdom in 2016. Since then, the world is more and more multipolar, with some state unilaterally denying the rule - based world order, increasing the instability close to the borders of the European Union. The best example is the full-scale invasion of Ukraine by Russia started the 24th of February 2022, even if the war started in 2014 with the unlawful annexation of Crimea and the invasion of the Luhansk and Donetsk oblast. But the instability is now global going from the Balkans, the unsolved issue between Serbia and Kosovo, the southern neighbourhood with the Libyan and

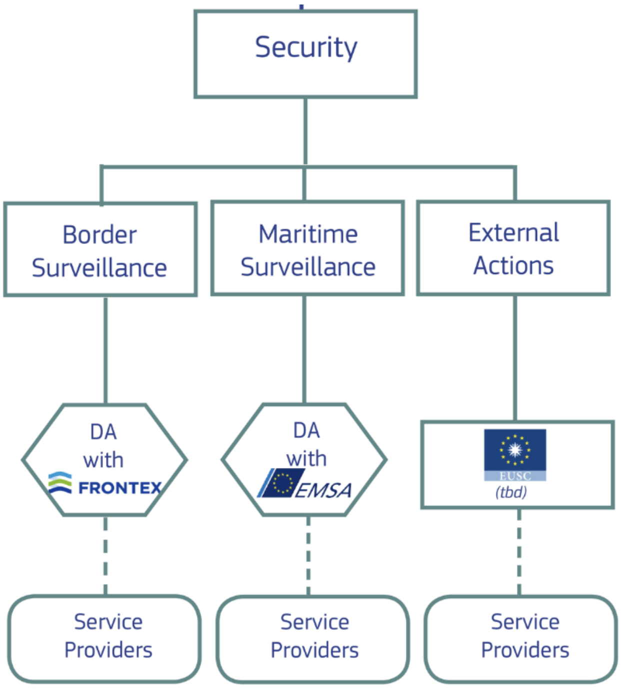
Syrian civil war. On the Eastern front, the Middle East and gulf area are still a hot spot for confrontation, with the Afghanistan and Iran. Indo-Pacific and Asia are areas with more and more tension between the two most populous countries in the world, in addition to the fact that the area is indispensable for the world economy. And finally, Africa, with the resurgence of dictatorship and terrorism in the Sahel, and instability in the great lake area and African horn. The EU, for a long time had been a proud soft power user, but with the recrudescence of the threat, the multiplication of military and civilian missions led by the EU was deemed necessary, and thus hard power came into action, and with it, capacity are needed (Council of the European Union, 2022; European External Action Service, 2016).

Another reason why the EU feels the need for some strategic autonomy is the fact that the international partners were not always as reliable as hoped for. One of the most recent examples can be seen with the Covid-19 and the masks' problem. But the problem is not new, as explained before, the Symphonies satellites were a prime example of non-reliability of a strategic partner. Another example is the Běidǒu sage with Galileo, where the Chinese stole the technologies without doing their part of the partnership. On the reliability issue, the fact that the EU countries can't produce some parts and thus, rely on US manufacturers puts them at risk with the ITAR and EAR norms. These norms allow the USA to receive a lot of information on the foreign market. Indeed, in order to comply with the extraterritoriality of the USA jurisdiction, European companies are required to fully open their books and to grant unlimited access to their facilities to the US authorities. These problems were particularly visible during the shaping of Galileo, or when EU companies try to do business or research with India or China (Al-Ekabi & Mastorakis, 2015; Anonymous, personal communication, 2 May 2023; O. Lemaire, personal communication, 27 April 2023; Tortora, 2015).

As stated in the previous chapters, space has always been an area of confrontation, with strong geopolitical implication. The European Union already stated that space is a strategic area for its interest as stated previously. And thus, having security capacity independent of other powers can be seen as a must-do by the EU.

The Security component

The security component of Copernicus is the closest one to the traditional military understanding of security, and is at the same time quite far from it. The Copernicus Security Service is itself composed of three subcomponents, respectively the Support of the External Action, the Maritime Surveillance and the Border Surveillance (Règlement (UE) 2021/696 du Parlement européen et du Conseil du 28 avril 2021 établissant le programme spatial de l'Union et l'Agence de l'Union européenne pour le programme spatial et abrogeant les règlements (UE) no 912/2010, (UE) no 1285/2013 et (UE) no 377/2014 et la décision no 541/2014/UE, 2021).



[Fig 4 : Security Component. Source : https://www.copernicus.eu/fr/propos-de-copernicus/copernicus-en-bref]

The first institution that comes in mind when we talk about military intelligence in the EU is the Satellite Centre, the SatCen. This one is the geospatial intelligence agency of the European Union. The Geospatial Intelligence principle is to organise and combine all available data around its geographical location on Earth and then exploit it in order to prepare products that can be easily used. While it is true that a range of commercial firms can provide satellite imagery, SatCen is unique in being able to provide institutional and political authorities with sensitive and classified analysis (Fiott, 2020). Since 2010, the share of European imagery used by SatCen increased by 80 percentage points, going from 6% to 86% in 2022. The satellites used by SatCen, although principally European, are also in majority commercial satellites, as the Pleiade Neo, Kompsat 3 or COSMO SkyMed, but the others like LandSat are foreign controlled (European Union Satellite Centre (EU body or agency), 2023a; Haljnalka, 2022).

The support of the external action

The Copernicus Support for External Action, also known as the SAE, is the sub-service of Copernicus aiming to provide rapid and on demand geospatial information. The goal is to provide information to monitor events and activities outside the borders of the European Union that may have implications for the EU and Global security. This mission has been delegated to the Satellite Centre by the EU Commission, and thus, the information transmitted is based on space data (European Commission, 2017c; European Environment Agency (EU body or agency), 2021; European Union Satellite Centre (EU body or agency), 2023b).

As stated before, the SatCen has been chosen to be responsible for the Copernicus SAE, responsible for this segment since 2016 and operational since 2017. During the 2022 year, the SAE was activated 40 times and received more than 80 products. Since the beginning of the service, more than 1 000 products have been delivered to the SAE. The user of this service was mainly the EU commission, followed by the Member States, and then, for 10% shared, the EEAS and International organisation.

(European Union Satellite Centre (EU body or agency), 2023). The products aforementioned can be divided in two categories, the reports and the maps (*Products – Copernicus SEA*, n.d.). These maps and reports can also be categorised by what they are analysing, such as evacuation plan, camp analysis, crisis situation picture, etc.

The first example of products constructed in the SEA service is the analysis of the Infrastructure and the activity of Ounianga Kebir, a lake area in Chad, in 2017 or the monitoring of refugees' camp at the border between Syria and Jordania in 2018. This service is also used for the EU Space diplomacy, as demonstrated by the help given to the USA in the aftermath of the Harvey Hurricane in 2017, or with the intelligence given to Ukraine since the start of the war (Cooperation Arrangement Between The European Commission And The Government Of The United States of America On Cooperation On Earth Observation Data Related To The Copernicus Programme, 2015; 'U.S.-EU Satellite Data Arrangement Aids in Hurricane Harvey and Hurricane Irma Efforts', n.d.; European Union Satellite Centre (EU body or agency), 2023a; P. Messina, personal communication, 29 November 2022).

The thing that can be noted from these different examples is the use of commercial and public satellites, not the EU own constellation.

Maritime Surveillance and Border Surveillance

The Maritime Security sub-service is a service of Copernicus, delegated to the European Maritime Surveillance Agency, known as the EMSA. This sub-service is itself divided into Fisheries Control, Law Enforcement, Marine Pollution, Customs, Maritime Safety and Security, and finally, the Support to International Organisation. The EMSA works in close relation with the European border patrol agency, known as Frontex, and the European Fisheries Control Agency (*TRIPARTITE WORKING ARRANGEMENT between The European Border and Coast Guard Agency (Frontex) And the European Fisheries Control Agency (EFCA) and The European Maritime Safety Agency (EMSA)*, n.d.). These working relations are codified in a tripartite agreement. Frontex also works in close relation with the SatCen for its mission of border surveillance (European Union Satellite Centre (EU body or agency), 2023).

Speaking of Frontex, in 2022, 18,7% of all the analysis from the Centre were destined to Frontex, particularly helped by the launch of the full-scale invasion of Ukraine by Russia in February. SatCen uses its expertise in satellite remote sensing and geospatial analysis to provide Frontex with timely and accurate information about potential migration flows, border surveillance, and the identification of irregular activities. With the use of satellite imagery, it assists Frontex in detecting and monitoring suspicious vessels, identifying potential migration routes, and assessing the situation at various border regions (European Union Satellite Centre (EU body or agency), 2023a). The collaboration between Frontex and the EMSA is best described by the seizure of 40T of hashish by the Spanish coast guards in 2016, with the help of Frontex (*Frontex Helps Seize 40 Tonnes of Hashish in Operation in Spain*, n.d.).

The customs component is a key component of the CMS. Indeed, 90% of the international trade and 40% of the internal trade are done through maritime routes (Review of Maritime Transport, 2022). The goal of the EU is to ensure that customs authorities can monitor the entry and exit of the ships, the harbour and beach or any abnormal behaviour that could lead to the illegal transshipment of goods in order to avoid the duties or the entry into the EU of illegal or forbidden goods (*Infographics - EMSA - European Maritime Safety Agency*, n.d.). One of the examples that can be given is the seizure of the Ali Primera, a Venezuelan ship arrested in 2017 by the Spanish coast guards, in collaboration with the US DEA, the UK national crime agency and with intelligence from the CMS : the ship was intercepted with a 2,4 tonnes shipment of cocaine (*Two Tons of Cocaine Seized from Atlantic Fishing Boat*, 2017).

Fishing in the European Union is a highly regulated area, but it is also a hard zone to monitor due to the remoteness and the extensiveness of the ocean controlled by EU countries. The deployment of coast guards' ships and aerial surveillance is not always the most cost-effective solution, in addition with the lack of capacity to monitor the millions of square kilometres of EEZ. The use of satellites is thus seen as a viable alternative to monitor these areas. These capacities can be used in different case, such as the apprehension of fishing vessels trying to smuggle drugs into the EU, the support by the EFCA of west African countries in order to improve the fishing governance and palliate their lack of infrastructure to target poaching ships or supporting the UN Office on drugs and Crimes in the Ghana to tackles down the piracy in the gulf (*Infographics - EMSA - European Maritime Safety Agency*, n.d.).

The law enforcement is the service targeting coastal state authorities in order to help them to detect and identify illegal activities, as the speed boats delivering drugs. The Marine pollution monitoring targets, as its name suggests, the marine pollution caused by illegal discharged, but also accidental spill-over. In most of the case, a combination of space and earth-based assets are used in order to monitor these pollutions, such as in Greenland. The maritime safety and security service provides means to monitor, follow accidents, track objects at sea and identify vessels. A real life example of the use is the rescue of a drifting vessel at large off the Reunion island in 2017. The last service served by the EMSA in the Copernicus framework is the support to International Organisation, in order to promote the CFSP and other policies. The example of use are numerous, and in addition to the previous example already cited, we can add the support of the African Navy's Exercise for Maritime

Operation, involving the UNODC and the French navy (*Infographics - EMSA - European Maritime Safety Agency*, n.d.).

Summary and use in the context of strategic autonomy and security

In this chapter, we've seen the use of the Copernicus Security Service and its three sub-services. In this section, we will analyse the different usages and functions in the security and strategic autonomy framework. We will firstly analyse the five securities and then, the strategic autonomy.

The first security point of view that will be analysed is the military security. In this sector, we can observe that the Copernicus program in general is used to gather intelligence and thus, allow a better perception of the other intentions. However, the satellite constellation of the EU is not primarily meant to be used to gather military intelligence, the general framework of Copernicus and the use of third-party satellites allows to be used in these circumstances (*JOINT COMMUNICATION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL European Union Space Strategy for Security and Defence*, 2023). For the Political security, the question is a bit harder, but we can see that a space diplomacy is in action though and thus promotes legitimacy on the international stage, as the EU can be seen as a reliable partner when needed. The economic security is not really the most preeminent security concerned by the CSS, but can still be seen as being protected in the fisheries industry and the fight against smuggler of counterfeit goods. In regard to the environmental security, the CMS is a tool in the protection of the maritime resources from the human pollution, wanted or unwanted. The extensive use of Sentinel-1 in this mission can be seen by the report of the CleanSeaNet service of the EMSA (European Maritime Safety Agency (EU body or agency), 2022), where no less than 5 975 detections of pollution were detected by Sentinel-1 satellite, on a list of 3004 pollutions[3]. The last security is the societal security. This one is the hardest to analyse because it depends on the culture and other traditions, but we can say that the CSS is not a tool intended to protect language and culture.

In terms of autonomy, the security service is not revolutionary, but it allows the European Union, its member states and institutions to access information without needing to disclose the reasons or the target. Unfortunately, we can't say that the EU is self-sufficient in this case due to the capacity of the Sentinel satellites that were not meant to be used for military information, and thus, force the use of other satellite constellations, private or public. It should be remarked that the proportion of non-EU imagery as sharply declined during the last decade. Another assumption that can be made is the issue with the EEAS and the intelligence. In a speech to the ambassadors in 2022, Josep Borell explains that he is not made aware of what happens in the world by its ambassadors but rather

[3] One pollutant detection can be detected by multiple satellites.

by the press, and thus that the reaction time should be smaller than what it is now. We can assess that the use of the SEA could be used more extensively than what is already used (Borrell, 2022).

Emergency service

The Copernicus Emergency service is the service of Copernicus, focusing on the challenges addressed by natural disasters and man-made emergencies. It aims to provide an accurate, timely and reliable information for civil risk management and reaction. The service is composed of two sub-services, the mapping component and the early warning component (Règlement (UE) 2021/696 du Parlement européen et du Conseil du 28 avril 2021 établissant le programme spatial de l'Union et l'Agence de l'Union européenne pour le programme spatial et abrogeant les règlements (UE) no 912/2010, (UE) no 1285/2013 et (UE) no 377/2014 et la décision no 541/2014/UE, 2021).

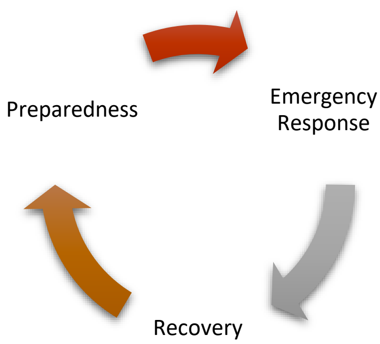
The different sub-services

The first sub-service of the Copernicus Emergency Management Service is the Early Warning System, itself composed of three different systems : The EFAS, European Flood Awareness System, the EFFIS, European Forest Fire Information System and the EDO, European Drought Observatory, complemented by the GDO, Global Drought Observatories (de Boissezon & Eddy, 2020).

The EFAS role is to actively monitor and predict floods across the continent. Its role is to provide flood early warning information up to 10 days in advance. The services given are composed of flood monitoring, probabilistic flood forecasts, flash flood indicators, flood impact assessments, and seasonal flood risk outlooks (*Copernicus Emergency Management Service*, n.d.). Since 2021, this service has been extended to the world through the GloFAS, standing for Global Flood Awareness System (*Global Flood Awareness System*, n.d.). The EFAS exists since 2003 and emerged from the European Scale Flood Forecasting System and joint to the CEMS in 2011, and has been fully operational since 2012 (*European Flood Awareness System – EFAS | Copernicus EMS - European Flood Awareness System*, n.d.). The second system is the EFFIS. EFFI System has been created to acquire information on forest fires and their ecological ramifications, covering today the area of Europe, Middle East and North Africa. It provides near-real-time information services encompassing the current and future fire danger forecasts, active fires, burned areas, and post-fire damage assessments (*Copernicus Emergency Management Service*, n.d.). Created in 1998, it became part of the CEMS in 2015 (*EFFIS - Welcome to EFFIS*, n.d.). At a global level, and in collaboration with the Group on Earth Observation and NASA, the Global Wildfire Information System has been put in place (*GWIS - Welcome to GWIS*, n.d.). The EDO and GDO, European and Global Drought Observatories, are focused on the computing, monitoring, and forecasting of key drought indicators. These indicators represent different aspects of the hydrological cycle and specific impacts associated with droughts. EDO provides maps, spatially explicit data, a map viewer and dynamic reports(*CEMS Flyer Droughts EDO*, 2020).

The other sub-system of the CEMS is the mapping service. This service is composed of two modes for different situation, the rapid mapping and the risk and recovery mapping.

The first mode is the rapid mapping, supporting the emergency response. When a disaster occurs, such as an earthquake, flood, or wildfire, this mode can provide timely and accurate maps to aid in disaster management efforts (*Copernicus Emergency Management Service*, n.d.). In order to respond to every disaster, the service proposes four products, available all days of the year, 24 hours a day. The products are : the reference product, made to assess the territory before the emergency; the first estimate product, the fastest assessment of the affected location; the delineation product, that assesses the impact, the extent and the update the situation; and the last product is the grading products, that provide information about the damage extent, including the grade, the spatial distribution (*CEMS Flyer Rapid Mapping*, 2021). The second mode is the risk and recovery mapping. This mode is used in the recovery and the preparedness phase of the management cycle, it focuses on prevention, disaster risk analysis, and recovery activities. In this mode, the service helps assess the vulnerability and potential risks of specific areas to various hazards. This focus on prevention, disaster risk analysis, and recovery activities. In this mode, the service helps assess the vulnerability and potential risks of specific areas to various hazards (*Copernicus Emergency Management Service*, n.d.). In order to provide information, there are two packages available with different delivery times. The first package is a standard one, with a shorter activation time, but with predefined products. The other package takes more time, around one or two month(s), but has a tailored study for the user (*CEMS Flyer Risk Mapping*, 2021).



[Fig 5 : Emergency Management Circle]

Example of use

Since the creation of the CEMS, it was activated multiple times. We will talk about multiple cases of use. The first example is about the hurricane Irma in the Caribbean Islands products (de Boissezon & Eddy, 2020).

First, in September 2017, the Caribbean experienced a devastating hurricane called Irma, which had a significant impact on various islands, including the French territories of St Martin and St Barthélemy. This hurricane reached a category 5 status, unleashing winds that exceeded 297 km/h. The consequences were subsequential, particularly on the region's infrastructure. The electricity network was down, the water network was rendered inoperable, and the telecommunications system came to a halt, including antennas and submarine cables. Moreover, the roads became inaccessible due to the presence of debris. Unfortunately, the aftermath of the disaster was marred by looting and physical abuse, further intensifying the crisis. It took four days to establish a substantial police presence and address these issues. The storm's impact extended beyond physical damage, severely affecting all aspects of governance, including law and order, essential infrastructure, and information and communications systems. To respond to this dire situation, a relief operation was launched, involving 2,500 policemen and the COGIC, Centre opérationnel de gestion interministérielle des crises. To respond to this crisis, the Copernicus Emergency Rapid Mapping Service and the International Charter Space and Major Disasters were activated by COGIC, enabling the prompt acquisition of satellite imagery. This imagery played a vital role in generating cartographic products to aid relief efforts. Remarkably, the cartographic data was delivered within an exceptionally short 12-hour timeframe, facilitating swift decision-making and response coordination. Furthermore, the CNES contributed to the relief efforts by providing high-precision satellite imagery to Copernicus, surpassing the standard charter agreement between Copernicus and CNES. As a result, a staggering 95% of the information available to COGIC was derived from satellite-based sources. The utilisation of satellite imagery and cartographic products proved instrumental in enhancing situational awareness and guiding relief operations in the hurricane-affected areas. In the aftermath of the hurricane, Copernicus Risk and Recovery mapping was used pretty extensively in order to assess the damages and help the reconstruction. The service was activated in February 2018, enabling regular mapping updates on the status of buildings, storage areas, rubble, shipwrecks, and improvised dumps. Copernicus utilised images from its Third-Party Missions as well as commercial data from partner states to generate accurate mapping products (de Boissezon & Eddy, 2020). The emergency mapping was also used in numerous other cases, as the flood in the Maritime Alps in 2020 (C. Grudler, personal communication, 30 November 2022), or more recently, it has been activated in ten times in May 2023, including activation in Mozambique, Burma and Uganda. To this day (11/06/2023), the rapid mapping was activated more than 600 times (*List of EMS Rapid Mapping Activations*, n.d.). The risk and recovery service, however, received less activation overall, with around 150 activations (*List of EMS Risk and Recovery Mapping Activations*, n.d.).

But as stated before, the mapping is not the only sub-service of CEMS. There is also a flood, fire and drought information service. The most well-known activation of the EFAS in Belgium could be during the summer 2021. At the time, four alerts were given to Belgium by the EFAS mechanism (Belga, 2023) but were, unfortunately, not taken into account properly (Belga, 2023; *Les autorités auraient-elles pu mieux anticiper les inondations de juillet ?*, n.d.; *Les prévisions de l'EFAS n'ont pas été consultées avant les inondations en Wallonie*, n.d.)The EFFIS, for its part, focuses less on the prevision but on the information in general, with reports of what's happened, with the statistics of what was burned (*EFFIS - Statistics Portal*, n.d.; *Incendies en Europe*, n.d.), the monitoring of the weather to prepare the season and the risks of fire (*EFFIS - Long-Term Fire Weather Forecast*, n.d.). The prime example of the use of these means is the fire in Spain (*Espagne*, n.d.). The EDO's mission can be seen with the multiple reminder that Europe lack water ('Europe's next Crisis', 2023), with, at the 15th of June 2023, a quarter of Europe in drought warning condition and already 8% in drought alert (*Parliament to Sound the Alarm about the Water Crisis in Europe | 12-06-2023 | News | European Parliament*, 2023) and does not foresee the end of the drought before November (*Europe Suffering Worst Drought in at Least 500 Years – European Commission*, n.d.).

The strategic autonomy and security

The CEMS has been described, but we need now to analyse what kind of security and autonomy it provides.

We can already tell that this service has no military security, its purpose being clearly in the civil security field. On the political security, we can argue that, even if it is not the primary role of the CEMS, it is a component of the space diplomacy of the EU. By allowing third country to access data and maps from the service on a global scale, it gives more credibility and legitimacy to the EU on the International scene. The most logical security implied by this system is the ecological security, this is particularly true with this system, allowing the states to react to man-made and natural catastrophes. The economic security is a more collateral effect, with the due to the access of resources, especially with the water and the soil dryness. The societal security is always difficult to analyse, we could argue that in order to maintain the society, it's important to protect the citizens, and thus we could argue that the CEMS is a tool for the societal security. About the autonomy, the creation of the Emergency Service allows relying less on external sources to protect its population and citizens from natural disaster, and thus maintain the security of the population by itself, without relying on the third-party country, at least partially, because of the usage of satellites outside the Sentinel Constellation. It is also a great tool that can reduce the dependence, if it's used properly by the states.

Environmental Services

We have discussed the two services, focused primarily on the military and civil security, in the past chapters. In this chapter, we will mainly focus on the four last services, comprised of the Atmosphere Monitoring Service, the Marine Service, the Land Monitoring Service and the Climate Change Service. It has been decided to merge them in one chapter because of the proximity between the four.

Atmosphere

The Copernicus Atmosphere Monitoring Service, the CAMS, is the Copernicus service monitoring, assessing and forecasting the air quality at different scales, from the continental to the local one. The creation of the service was made possible thanks to the sixth and seventh framework programs, and has been operational since 2015. It is managed by the European Centre for Medium-Range Weather Forecast, the ECMWF. One of its prominent features is its capability to monitor and forecast the global atmospheric composition, including greenhouse gases like carbon dioxide and methane, reactive gases such as carbon monoxide and sulphur dioxide, as well as ozone and aerosols. These comprehensive data provide valuable insights into climate change by offering information on emissions, surface fluxes, and climate forcing. Furthermore, CAMS is dedicated to providing near-real-time analysis and 4-day forecasts specifically for European air quality. This functionality ensures a continuous evaluation of the air we breathe, enabling timely interventions to safeguard public health. For instance, the service contributes to public health policies by furnishing information on UV radiation and stratospheric ozone, aiding in the prevention of skin cancer and related health risks. Additionally, CAMS actively contributes to the advancement of renewable energy resources. By supplying accurate information on solar radiation resources at the Earth's surface, the service facilitates the development and utilisation of solar energy. This data is of immense value to organisations involved in solar energy use, supporting their decision-making processes and promoting the growth of sustainable energy production (*Data | Copernicus*, n.d.; Jutz & Milagro-Pérez, 2018, 2020).

The examples of utilisation are numerous. There are two main branches of utilisation at the moment : the first one is the use by the private sector and the second one is the service targeted for policymakers.

The data and tools provided to the private sector can lead to a multitude of different use by a wide variety of actors. Companies like Euronews, CNN, and Windy utilise air quality data to display daily forecasts of European air quality, enabling individuals to make informed decisions about their outdoor activities. Platforms such as BreezoMeter and airTEXT help people reduce their exposure to air pollution by offering personalised recommendations based on real-time air quality data. Additionally, météo Pollen and PASYFO inform users about pollen concentrations, assisting individuals with allergies or respiratory conditions in managing their symptoms effectively. Other platforms, such as ATMOSYS-CAMS, support the implementation of air quality policies and legislation by providing policymakers and government agencies with accurate and comprehensive air quality data. Another application involves Mon Toit Solaire, which simulates and calculates the energy potential of rooftop photovoltaic projects, using sunlight exposure and rooftop characteristics data. This enables individuals and businesses to assess the feasibility and benefits of installing solar panels, thereby promoting renewable energy adoption. In terms of health and safety, SunSmart leverages UV radiation data to provide users with daily alerts and recommendations for sun protection. By raising awareness of UV radiation peaks, individuals can take necessary precautions to prevent sunburn and minimise the risk of skin damage. Additionally, platforms like SafeAdviser and DiscovAir provide travellers with environmental information, including allergen forecasts, to help them plan ahead and ensure a safe and healthy journey. Lastly, in the civil and environmental security, the Upper ASEAN Wildland Fire Special Research Unit aims to reduce the utilisation of fire in land use and land use change through data-driven strategies and tools. By promoting alternative solutions and sustainable practices, this initiative minimises the environmental impact of land management practices (*Air Composition Data for Businesses | Copernicus*, n.d.). What's offered to policymaker through the CAMS is a multitude of services, such as atmospheric forecast, assessments reports, monitoring of the air quality at a European level. These services are used to plan and evaluate policies and strategies. It can also determine the origin of the polluting elements, such as German, English and French origin of the pollution in the Netherlands (*Air Composition Data for Policymakers | Copernicus*, n.d.; *CAMS Policy Tools for Decision Maker*, 2019).

Marine Service

The second service of this chapter is the Copernicus Marine Service, the CMS. It has been operational since 2015 and its responsibility is to provide regular and systematic reference information on the physical and biogeochemical state, variability, and dynamics of the ocean and marine ecosystems. It has coverage of the global oceans, including European seas, and is managed by Mercator Ocean International. The CMS is dedicated to supporting various marine applications, encompassing marine safety, marine resources, coastal and marine environment, weather, seasonal forecasting, and climate. To enhance marine safety, the service provides hydrodynamic forecasts and remote sensing blended products, supplying valuable information on currents, winds, and sea ice. This assists in improving ship routing services, combating oil spills, conducting offshore operations, and facilitating search-and-rescue operations. In terms of marine resources, the service furnishes long-time series of in situ and remote sensing products, along with analysis, reanalysis, and forecasts of hydrodynamic and ecosystem models. These contribute significantly to the protection and sustainable management of living marine resources, particularly benefiting aquaculture, fishery research, and regional fishery organisations. For the marine and coastal environment, the Copernicus marine service supports essential environmental applications like water quality monitoring and pollution control. Additionally, it plays a vital role in assessing coastal erosion by utilising sea-level rise data. Moreover, the service is instrumental in seasonal and weather forecasting through the provision of long-time series of in situ and remote sensing products. These include crucial parameters such as sea-surface temperature, salinity, sea level, currents, wind, and sea ice. By offering reanalysis of physical parameters at various temporal resolutions and scales, the service significantly contributes to weather, climate, and seasonal forecasting efforts (Jutz & Milagro-Pérez, 2018, 2020).

For this service, the examples of utilisation are so numerous that it will be difficult to explain every aspect of the service in this chapter. We can say that there are at least twelves areas of utilisation of the data, respectively : the Polar Environment Monitoring; Climate and Adaptation; Ocean Health; Marine Conservation and Biodiversity; Science and Innovation; Policies, Ocean Governance and Mitigation; Education, Public Health and Recreation; Extremes, hazards and Safety; Marine Food; Coastal Services; Trade and Marine Navigation; and finally, Natural Resources and Energy. These areas can be grouped into three categories : Environment, Society and Economy. One example of each utilisation will be presented shortly.

In the environmental categories, in the monitoring of the polar environment, a study called “Modelled prey fields predict marine predator foraging success” has been held by the Institute for Marine and Antarctic Studies, an Australian institute associated to the university of Tasmania (Green et al., 2023). On the climate and adaptation, a private Dutch company called MARIS created in collaboration with other organisms the Marine Data Viewer. This data viewer allows the user to interact with different variables, such as temperature, oxygen, pH, etc, at different levels, such as geographical, depth, time and date (*Marine Data Viewer*, n.d.). On the Ocean Health, we can talk about the tool Sea Clearly. This initiative allows the monitoring of the microplastic on a global scale (*SEA CLEARLY - A Tool to Assess Ocean Plastic Transport on and by Aquaculture Farms | CMEMS*, n.d.). On the marine conservation and biodiversity area, we can talk about the project led by the Centre for Environmental and Marine Studies of the Aveiro’s University, called "Modelling coastal upwelling off NW Iberian Peninsula: New insights on the fate of phytoplankton blooms" (Picado et al., 2023). In the society focused area, the GeoEnrich is the first project we will talk about. This tool is a part of the science and innovation sector and provides a useful tool for the scientists in the species occurrence

(Morand & Poulain, 2023). On the ocean governance, policies and mitigation sector, we can talk about the Utrecht University project called TOPIOS, and tracking the plastic litter polluting the oceans (van der Mheen et al., 2020). For the public health and education, the wildlife tracker powered by the GIS4 Wildlife Movement Analytics has for goal to monitor the marine megafauna and other bio-physical variables (*Real-Time Assessment of MPAs with Marine Megafauna Movements and Bio-Physical Ocean Variables | CMEMS*, n.d.). And finally, for the society, for the extremes, hazards and safety sector, we can put the spotlight on the SPOT tool, created by the Spanish National Research Council and in collaboration with Digital Earth Solutions, to provide a fast, reliable solution to any oil spill (*SPOT – User-Friendly Oil Spill Model | CMEMS*, n.d.). Lastly, we have the economic area. The first economic area is the marine food. The Natural Resources Institute of Finland, called LUKE, uses the data to find sustainable locations for raising trout in the Baltic (*Finding Sustainable Locations for Growing Rainbow Trout in the Baltic Sea | CMEMS*, n.d.). On the coastal services, SeaCras, a Croatian startup, provides sustainable coastal waters monitoring by high-resolution satellites (*Sustainable Monitoring of Transparent Coastal Waters by High-Resolution Satellites | CMEMS*, n.d.). For the trade and marine navigation, the Universitat Politècnica de Catalunya developed a software, called SIMROUTE, aiming to provide a tool easy to use and comprehensive for ship weather routing simulation (Grifoll et al., 2022). And finally, for the natural resources and energy, the Marine Power Systems in collaboration with the European Marine Energy Centre use the data of the CMS in order to find the best deployment site for both floating and wave energy system (*Finding the Best Deployment Site for a Combined Floating Wind and Wave Energy System | CMEMS*, n.d.).

Land Service

The Copernicus Land Monitoring Service is a service operational since 2012 and implemented by the European Environment Agency, the EEA, and the European Commission DG Joint Research Centre, the JRC. The origins of the project can be traced to the ESA project Geoland-1, Geoland-2 and the sixth and seventh framework. It supports applications in various domains, including spatial and urban planning, forest management, water management, agriculture and food security, nature conservation and restoration, rural development, ecosystem accounting, and climate change mitigation and adaptation. The CLMS comprises three primary components: the global component, the pan-European component, and the local component. The global component delivers land information in near real-time and at a 10-day frequency on a global scale, encompassing a broad range of biophysical variables relating to vegetation state, energy budget, and the water cycle. The pan-European component generates land-cover and land-change maps for the entirety of Europe, offering geophysical and vegetation parameters for monitoring seasonal and annual changes. Activities within the pan-European component include the creation of a pan-EU land-cover map, production of high-resolution layers representing different land-cover characteristics, and ongoing monitoring of land-cover transformations. Lastly, the local component focuses on specific areas of interest, providing in-depth supplementary information to the pan-European component. It supplies detailed data concerning urban atlas, biodiversity hotspots, riparian areas, and other selected locations. For the coordination, the JRC is responsible for the global scale, the EEA for the pan-European and Local component (Jutz & Milagro-Pérez, 2018, 2020).

The usage of the land component consists of multiple studies and diverse other usage, such as a complementary for the EGNOS program (*EGNOS Visibility Maps | EGNOS User Support*, n.d.). But in this chapter, we will describe two main programs of the EU, called LUCAS and the EU Sustainable Development Goals indicators(Eurostat (European Commission), 2023).

LUCAS is a survey on the land usage and coverage within the EU. It differentiates the land cover, understood as the biophysical coverage of the land, such as artificial land, cropland, woodland, etc; the land use, understood as the socio-economic usage made of the land, such as the primary, secondary, tertiary sectors and other uses. This survey uses multiple information types and is used in a number of EU policy areas, such as the biodiversity strategy for 2030, the Farm to Fork strategy, ((Eurostat (European Commission), 2021) for agricultural means. (Schiavon et al., 2021) The EU SDG are a set of 17 global goals as part of the 2030 Agenda for Sustainable Development. These goals aim to address various social, economic, and environmental challenges faced by countries around the world. It encompasses a broad range of objectives, including eradicating poverty and hunger, ensuring quality education, promoting sustainable cities and communities, combating climate change, protecting biodiversity, and fostering peaceful and inclusive societies. In order to achieve and monitor these goals, the Land Service is used, especially for the 15th goal, the one that aims to protect, restore and promote the conservation and sustainable use of terrestrial ecosystems (Eurostat (European Commission), 2022).

Climate Change

The Copernicus Climate Change Service, overseen by the ECMWF, is the outcome of a progression of projects carried out under Frameworks 6 and 7. With the support of over 200 partners, the service encompasses a wide array of components. Its fundamental objective is to address the environmental and societal challenges linked to climate variability and human-induced climate change. By providing access to vital information for climate monitoring, prediction, and attribution, the service plays a crucial role in enhancing adaptation and mitigation policies. Through its comprehensive approach, the Copernicus Climate Change Service aims to contribute to a better understanding of climate change dynamics and support the development of sustainable solutions (Jutz & Milagro-Pérez, 2018, 2020; *Providers | Copernicus*, n.d.).

The users and providers of this service are numerous, we will talk about Heineken, the climate change in Costa Rica, the Heat stress in European cities and the mitigation/adaptation efforts in the Mediterranean.

The brewery Heineken is based in Zoeterwoude, in the Netherlands. In order to be more sustainable and more responsible in the water management, the brewery as teamed up with the provincial government and the University of Wageningen. The cooperation is called Green Circles and had the support of the C3S to make the projection of the future supply and quality of the water in the region (*Heineken 'Brewing a Better World' | Copernicus*, n.d.). The Costa Rica, for its part, is an essential country environmentally speaking, housing around 5% of the world biodiversity. However, the Costa Rica lacks the data about the climate change and thus made a partnership with the C3S in order to adapt its policymaking to the global warming (*Climate Change Impacts on Biodiversity in Costa Rica | Copernicus*, n.d.). On the Mediterranean side, the Union for Mediterranean joins forces with the ECMWF and C3S in order to address the climate change in the basin (Caminade et al., 2012). Still, in Europe, urban environments experience higher temperatures than their rural surroundings. These higher temperatures can negatively impact human health, including causing cardiovascular and respiratory disorders, as well as heat stroke. It is therefore crucial to lower heat stress in urban environments, and the C3S allows monitoring these information and helps the policymakers to take decision (*Demonstrating Heat Stress in European Cities | Copernicus*, n.d.).

Security and Autonomy summary

As we have seen, there are different areas of security and autonomy that are touched by the environment services of Copernicus. The main areas touched are the economic, environmental and societal security and autonomy.

The economic aspect of the chapter is undeniable, with the share of a number of private entities using the data to build a business. But it doesn't stop there. Thanks to the different services, some business can forecast the future and adapting to stay relevant. The food industry is also highly reliant on the space data to improve the quality and the rentability of the land. This gives the EU an autonomy and a security in the economic area. The societal aspect is highly linked to the environmental aspect, especially due to the health aspect. With the different services, a number of applications have been put in place to improve the quality of life of the EU citizens, either by providing them information or by analysing and directing the decision makers. Staying on the environmental aspect, the different services are used to mitigate and adapt to the various climatic changes, but also man-made disasters.

But the political aspect should not be overlooked, by allowing the member state and the EU to have access to data freely, without conditions, the politic is less dependent on private and foreign actors.

Industrial Effects

The effects of Copernicus

In addition, to the different services, the Copernicus program has also industrial effects on the space industry in general. As stated previously, the EU has a strong industrial base in the space sector, but this sector is more competitive than ever. Thus, in this chapter, we will discuss the effects of the Copernicus program on the European industry.

First and foremost, the first effect that comes to mind is that the construction of satellites is a business, and every order is an additional sale. But the effects are more diverse than just the direct sales. The first secondary effect on the industry is the skills within the European space sector. It enables equipment manufacturers to produce trustworthy goods, encouraging creativity and recurrent business models. This emphasis on durability and technological advancement creates a "critical mass" for makers of space satellites. A steady stream of Copernicus-related orders guarantees the continuation of Earth observation production and promotes the integration of cutting-edge technologies, encouraging an inventive culture. The program's cutting-edge innovations also have broad-reaching effects. These technologies can be used to benefit upcoming commercial and export clients, establishing European space sector enterprises as suppliers of cutting-edge, "ESA proven" branded goods. This qualitative advantage boosts their competitiveness and allure on a worldwide scale. Another advantage of Copernicus for the industry is the vast amount of data of good quality provided to users worldwide. The confidence in the quality and the durability of the project allowed it to be accepted has a calibrating tool for Earth observation imagery.

One of the biggest problems in order to fully take advantage of the situation is the use of USAian component in the satellites. Due to the presence of these components, the International Traffic in Arms Regulations, the ITAR, and the Export Administration Regulations, the EAR, are applicable. This leads to multiple problems, such as it is necessary to inform the US administration about the export of the specific component and the country interested in purchasing the satellite. However, providing this information to the US administration not only serves as an opportunity to potentially benefit the US industry, but it can also have adverse effects. The strict regulations, particularly in collaboration with China, can result in the deal being jeopardised or even terminated due to the restrictive nature of these regulations. In addition, there are significant confidentiality concerns related to the overall architecture of the products. It is imperative to precisely communicate to the administration the exact location of the component within the satellite's architecture. This level of detail is crucial to implement appropriate measures to ensure the protection of sensitive intellectual property and prevent any breaches of confidentiality. Safeguarding the confidentiality of the product's architecture is vital for maintaining competitiveness and safeguarding trade secrets (Anonymous, personal communication, 2 May 2023; J. Béclard, personal communication, 14 April 2023; O. Lemaire, personal communication, 27 April 2023; P. Messina, personal communication, 29 November 2022).

Autonomy and Security

The autonomy and the economic security of the industry of Copernicus are related to two main theoretical aspects.

On the autonomy, the EU space program had a positive impact on the industrial impact on the continent by assuring the well-being and valuable knowledge to the industry through multiple canals. However, it is not enough to be autonomous for different reasons. The first reason is the influence of the ITAR and EAR regulations. The second reason is the issue of accessing space. The EU had access to multiple local launchers from the Kourou spaceport, but the last Ariane V was planned to be launched on the 15th of June 2023 but has been delayed (Arianespace [@Arianespace], 2023), Ariane VI is officially to be launched by the end of 2023, but nothing is certain in the space launch world. The war in Ukraine, launched on the 24th of February 2022, also plays a role in the lack of access to space. The ESA had an agreement with Roscosmos to launch a variant of the Soyuz-2, called Soyuz-ST, at Kourou, but due to the invasion and the tension between Roscosmos and the other space agencies, the Soyuz cannot be launched again in Kourou. The other problem posed by the war is the last stage motor of the Vega-C rocket, that is built in Ukraine (*La guerre en Ukraine*, 2022). All these issues can also be linked to the economic security. Even if the security is not guaranteed in the space industry, it is not fundamentally threatened.

Example of International Cooperation : The case of GMES and Africa

Outside the general services, Copernicus is also the example of cooperation between the European Union and the African Union, even if the cooperation between the two continents on space-based earth observations is not recent. In this chapter, we will discuss first the timeline of the GMES and Africa program, followed by the history of space base EO; then we will talk about the governance of the project and its uses to finish with the security and autonomy provided to the EU by this program.

Timeline

The history of the GMES and Africa programs starts in 2006 with the Maputo Declaration (*Maputo Declaraion in Support of the 'African GMES' Initiative*, 2006). This Declaration signed by the AU, the ACP, the Regional Economic Communities[4] on the occasion of the 7th EUMETSAT User Forum in Africa demanded the extension of the then known as GMES to Africa. This declaration was followed by multiple reunion in Lisbon, Accra, Ispra, Hammanet (*GMES and Africa | Capacity4dev*, n.d.) that led to a concrete road map in 2014. This road map had a focus on three main thematics : the long-term management of natural resources; marine and coastal area, and finally the water resources management (*OBSERVER: GMES & Africa: Unlocking the Power of EO Data in Africa with Copernicus | Copernicus*, n.d.). The initial phase was launched in 2017 and lasted five years, to end in 2021. The second phase kicked off in 2022 and his planned to end in 2025.

But as stated before, it was not the first space-based EO cooperation between Europe and Africa. Between 2001 and 2017, three other programs existed : Preparation for the Use of MSG in Africa, known as PUMA, from 2001 and 2006; between 2007 and 2013, the program African Monitoring of Environment for Sustainable Development, known as AMESD; and finally, the Monitoring for Environment and Security in Africa, the MESA, between 2013 and 2017 (Ouattara, 2017; Saley, 2020). The PUMA program was focused on the capacity building, training and technical support of African services in order to use efficiently the Meteosat Second Generation, the MSG. Overall, the PUMA program was done to improve the weather and climate information in Africa (EUMETSAT, 2001; *MSG - More than Just the Weather*, n.d.). The AMESD program was the successor of the PUMA program, with the objectives of providing decision-makers at national and regional levels with valuable information in thematic areas such as water resources management, crop and range land management, agricultural and environmental resource management, mitigation of land degradation and conservation of natural habitats, as well as marine and coastal management. The MESA program maintained the PUMA and AMESD infrastructure and took a similar structure as the AMESD program with the different thematics above-mentioned. (*| EStation*, n.d.)

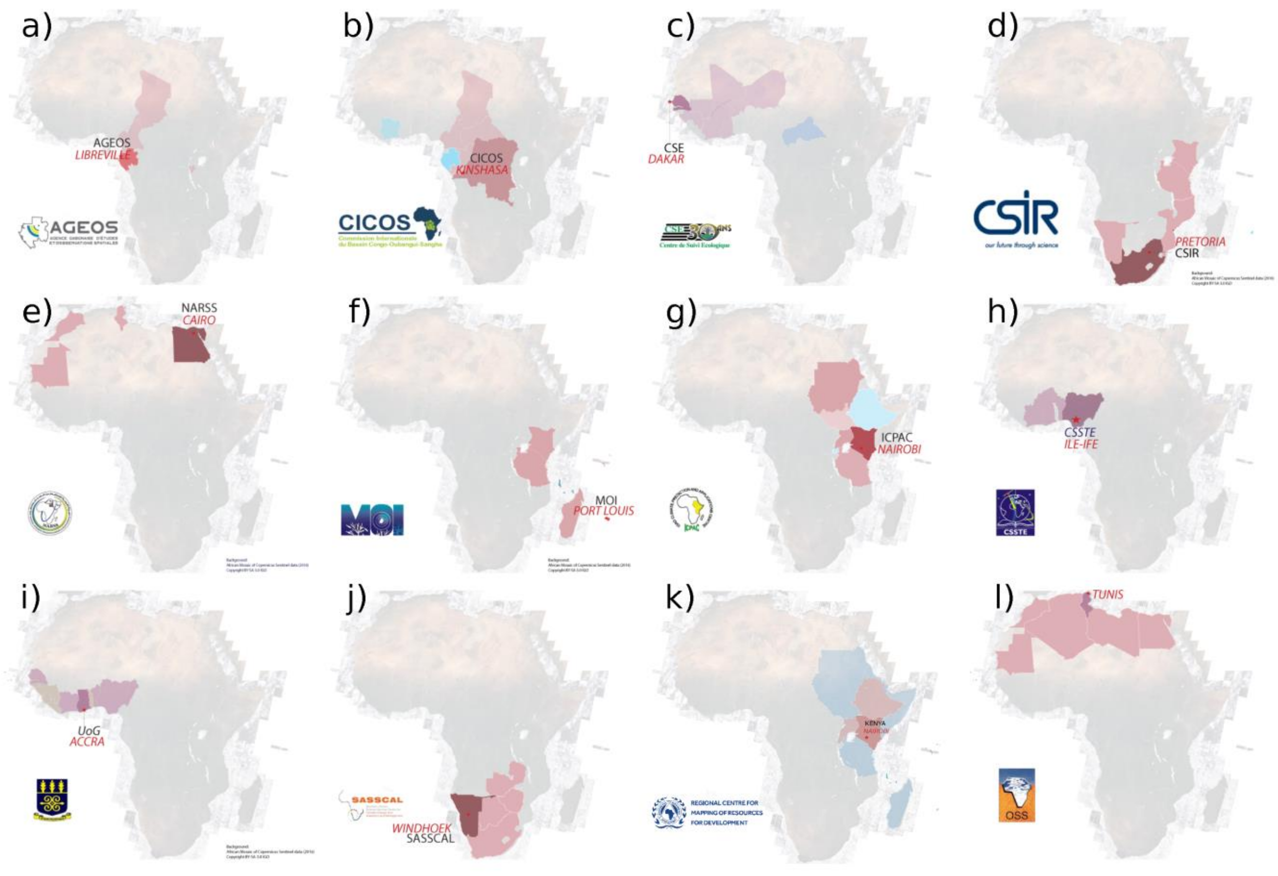
The project

The GMES and Africa programs have multiple objectives, respectively : Implement the Earth Observation segment of the African Space Policy and Strategy; Enhance long-term strategic cooperation for the integration and deployment of African requirements and needs in Copernicus Services; Promote the development of local institutional; human and technical capacities for the access and exploitation of EO-based services for sustainable development in Africa; Enable the two continents

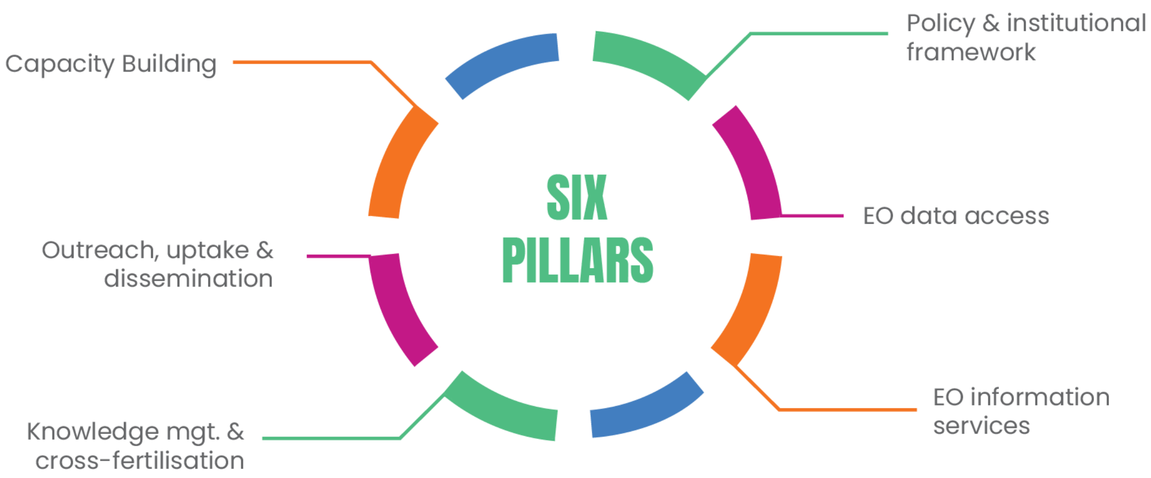
[4] CEMAC, ECOWAS, IOC, IGAD, and SADC

to jointly solve and address specific and global challenges and contribute to the attainment of their overarching development goals that include the AU Agenda 2063; and provide policymakers scientists, businesses and the public with EO services (Saley, 2020).

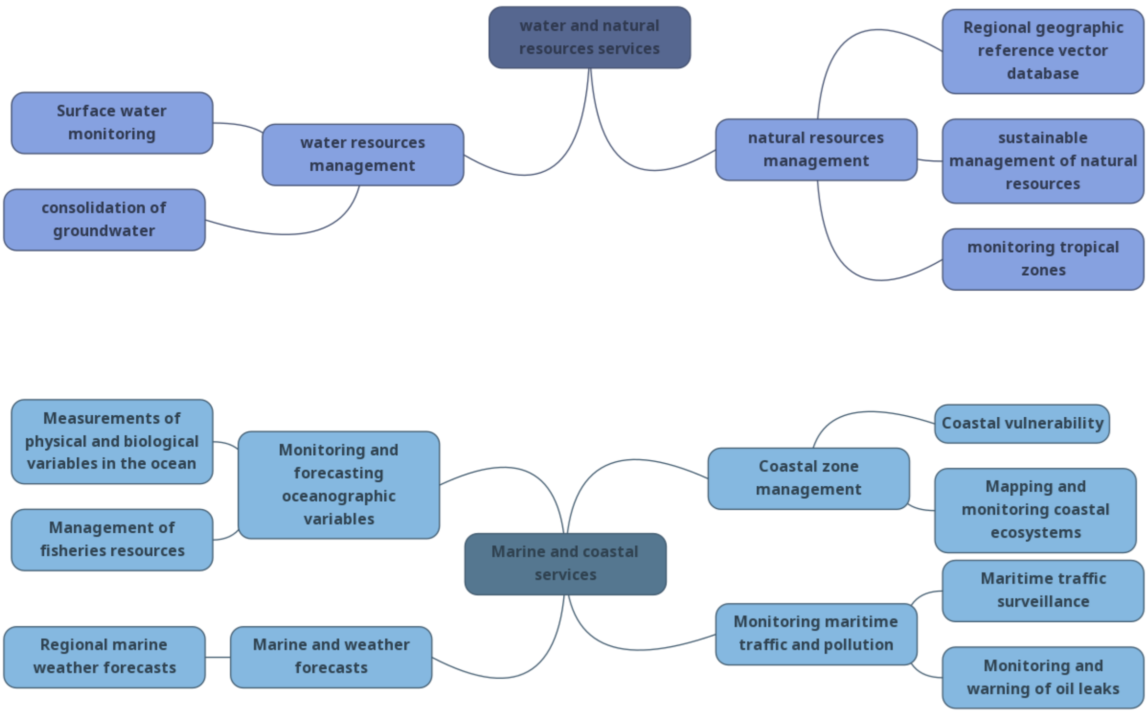
The program is a joint program co-financed by the EU and the AU for a total of around €30 million (*OBSERVER: GMES & Africa: Unlocking the Power of EO Data in Africa with Copernicus | Copernicus*, n.d.). The African Union Commission oversees GMES and Africa at a general level through a Program Management Unit. However, the implementation of GMES and Africa takes place at local, national, and regional levels, led by various Consortia. These Consortia work collaboratively with the AUC, sharing common objectives, expected outcomes, and guiding principles ('Achievements Phase 1', n.d.).



[Fig. 6 : The different partner of the GMES and Africa programs. Source : https://www.copernicus.eu/en/news/news/observer-gmes-africa-unlocking-power-eo-data-africa-copernicus]



[Fig. 7 : The six pillars of GMES and Africa. Source : https://gmes4africa.blogspot.com/p/results-of-phase-1-at-glance.html]



[Fig. 8 : The different services of GMES and Africa. Source : https://gmes4africa.blogspot.com/p/the-programme.html]

General summary on autonomy, security and objectives achievement

In this chapter, we will take the objectives set by the European Union for its Space Program and Copernicus, in addition with the concepts of Security and Autonomy, and we will discuss if these objectives were achieved. The list of objectives is long, we will, as a result, take a look at the main ones. The main objectives are : The access to space with an industrial base able to manufacture satellites; Better scientific knowledge of the Earth and the Universe; an easier sustainable development; a stronger security and defence; aid in development; a more politically recognised EU on the International Stage and being a respected global partner; and finally; having access to reliable information on environment and security.

First, the access to space and the manufacturing of satellites : Today, the access to space is reduced with virtually no mean to send its own satellites into space by European means. However, this situation is not meant to last indefinitely. For the manufacturing of satellites, the industries are fine, even if the autonomy can't be guaranteed due to the issue posed by the ITAR and EAR component, reducing the export of some technologies.

For the access of reliable information on the environment and security, that we will link to the better scientific knowledge of Earth and the Universe and the stronger security questions, we can say that the scientific information, Copernicus is the most advanced and complete EO system today, with reliable information on a multitude of areas and subjects. However, the EU doesn't have a cosmos observation and research project, and thus this objective is not completed. On the security side, we can say that Copernicus missions are not primarily focused on the defence aspect of the EO, but still can play a role, and this role is meant to increase with the Copernicus NextG. For the security, the civil security side of Copernicus is fully used, even if some national implementation of the tools proposed are still to be fine-tuned.

The aid to development can be linked to the "be politically recognised EU on the International Stage and being a respected global partner" question and can be partially responded with the GMES and Africa and the ASEAN fire monitoring programs. They both are international programs, using the capacity of the EU in order to develop their economy and render the life better in non-European area. On the International stage, we can also state that the EU is a reliable partner of the UN agencies in the supply of space-based EO intelligence.

Finally, the sustainable development. The tools have been put in place for all the policy-makers to see, and the same is true for the tools to monitor, adapt and mitigate the effects of the climate changes, but it is up to the decision-maker to implement these advices, and thus not the sole responsibility of the programs if the recommendations are not followed.

Conclusions

The aim of this paper was to explore the relation and the use of Copernicus in the strategic autonomy and security of the European Union. We saw that the concept entered the field of the EU by the Declaration of Saint-Malo, but only included military autonomy, as a way to guarantee the actions of the EU in its neighbourhood. We also saw a renewal of the term by the mid 2010's. This time, the term wasn't enclosed solely by the High Politics aspects of it, but also by the Low Politics aspects, such as the environment and the economy. We've thus linked these to the theory of Security developed by Buzan to define the strategic autonomy as the means for the EU and its member states to maintain the five securities, respectively the Military, Political, Environmental, Economic and Societal security, and that, without relying on external means.

Thanks to this paper, we found that Space has been since the start of its exploration a strategic area, associated with prestige and technology demonstration. We also saw that the sector has been, for a long time, monopolised by two giants, namely the USA and the USSR, and that the other players needed them to launch their satellites. This dependence led to anticompetitive behaviour and the creation of a third way with the Ariane program. This European will to create a more open market forced them to launch the first civil GNSS. The other program launched more or less in parallel was called GMES, and later renamed Copernicus. After that, we also explained the reason why the EU wanted and needed some autonomy in this globalised world. Some of the preeminent reasons were the realisation that international partners had different strategic objectives than the EU and thus, were not always reliable, the need to monitor the Kyoto Protocol engagement, the shift from a Soft power to a some Hard Power, and so on. We also saw the different usages of the different services of Copernicus and their uses, we saw that the capacities were not always used at full capacities by the people that could use it. We also discovered that temporarily, the EU will need to ask foreign countries to send their satellites due to the delay on Ariane VI and the end of the Soyuz-ST. But we also saw that the satellite manufacturing industry in the EU has competencies that can be resold on the open market thanks to the EU space program. We also saw that the capacities of Copernicus are used everywhere in the world, and the cooperation agreements at the international level exist and are renewed.

Our original question was : "Is Copernicus a tool for the Security and Startegic Autonomy of the European Union ?". The response is mixed.

The arguments in favour of a positive response are that the Copernicus program has tools in order to promote the strategic autonomy of the EU as defined in this paper. The space component, composed of the satellites, is also a real asset for the autonomy of the EU, and the Copernicus program is furthermore composed of other parts.

However, the major obstacles to a real strategic autonomy of the EU are three in number. The first obstacle to a fully autonomous EU on the space observation segment is the sources of data. As said, around a fifth of the data used by some services is from foreign country assets, and it's without counting the commercial imagery bought from European sources. The second obstacle of a fully autonomous EU is the delegation to non-EU body of some segments of Copernicus, as the ECMWF. And finally, the third obstacle is the appropriation by the member states of the tools made available, as we saw with Belgium during the flooding.

So, yes, Copernicus is a tool allowing some strategic autonomy of the European Union, and even if it is more used in the civil aspects of the security, and that the program is still evolving, he has, as all tools, the goal to build new capacities and thus, to reduce its dead angles.

Some future research on this subject could include a deeper research on the relations between the European Union and the African Union on the building of space based capacity in Africa and the implication for the European Union. We saw that GMES in Africa was a multidimensional project, but it's not the only cooperation between the EU and AU, or with the continent in general. Another subject of interest could be a study on the impact of the extraterritorial law of the USA on the Space Industry in the EU, especially the ITAR and EAR rules, allowing the USA of capture strategic information from competing industries.

Bibliography

Reviewed Paper

ANGHEL, S. E., Immenkamp, B., LAZAROU, E., Saulnier, J. L., & Wilson, A. B. (2020). *On the path to'strategic autonomy': The EU in an evolving geopolitical environment*. https://doi.org/10.2861/60568

Buzan, B. (1991). New patterns of global security in the twenty-first century. *International Affairs*, *67*(3), 431–451. https://doi.org/10.2307/2621945

Caminade, C., Medlock, J. M., Ducheyne, E., McIntyre, K. M., Leach, S., Baylis, M., & Morse, A. P. (2012). Suitability of European climate for the Asian tiger mosquito *Aedes albopictus*: Recent trends and future scenarios. *Journal of The Royal Society Interface*, *9*(75), 2708–2717. https://doi.org/10.1098/rsif.2012.0138

d'Andrimont, R., Verhegghen, A., Lemoine, G., Kempeneers, P., Meroni, M., & Van der Velde, M. (2021). From parcel to continental scale–A first European crop type map based on Sentinel-1 and LUCAS Copernicus in-situ observations. *Remote Sensing of Environment*, *266*, 112708.

d'Oleire-Oltmanns, S., Riedler, B., Pernkopf, L., Weinke, E., & Lang, S. (2015). Validation strategy for user-specific map products for the European Copernicus security service. *Journal for Geographic Information Science*, *3*, 438–444.

Eurospace, C. G. (2022). Eurospace Position Paper "Copernicus: How to further enhance the impact of a world-class programme". *Eurospace*. https://eurospace.org/eurospace-position-paper-copernicus-how-to-further-enhance-the-impact-of-a-world-class-programme/

Fiott, D. (2020). *The European space sector as an enabler of EU strategic autonomy*. 40. https://doi.org/10.2861/983199

Florio, M., & Morretta, V. (2021). Earth observation and Economic Studies: A cross-fertilization perspective. *Space Policy*, *57*, 101429.

Green, D. B., Bestley, S., Corney, S. P., Trebilco, R., Makhado, A. B., Lehodey, P., Conchon, A., Titaud, O., & Hindell, M. A. (2023). Modelled prey fields predict marine predator foraging success. *Ecological Indicators*, *147*, 109943. https://doi.org/10.1016/j.ecolind.2023.109943

Grifoll, M., Borén, C., & Castells-Sanabra, M. (2022). A comprehensive ship weather routing system using CMEMS products and A* algorithm. *Ocean Engineering*, *255*, 111427. https://doi.org/10.1016/j.oceaneng.2022.111427

Harris, R., & Baumann, I. (2015). Open data policies and satellite Earth observation. *Space Policy*, *32*, 44–53.

Hoerber, T. (2022). From fragmented space to the Space University Institute. *Journal of Chinese Economic and Business Studies*, *20*(3), 287–293. https://doi.org/10.1080/14765284.2022.2081486

Jutz, S., & Milagro-Pérez, M. P. (2020). Copernicus: The European Earth Observation programme. *Revista de Teledetección*, *56*, Article 56. https://doi.org/10.4995/raet.2020.14346

Lippert, B., Ondarza, N. von, Perthes, V., & und Politik-SWP-Deutsches, S. W. (2019). *European strategic autonomy: Actors, issues, conflicts of interests*.

Messina, P. (2021). European Strategic Autonomy in Space, through Space. *EU Policy Review*, *1*, 189–198. https://doi.org/doi.org/10.53121/ELFPP6

Picado, A., Vaz, N., Alvarez, I., & Dias, J. M. (2023). Modelling coastal upwelling off NW Iberian Peninsula: New insights on the fate of phytoplankton blooms. *Science of The Total Environment*, *874*, 162416. https://doi.org/10.1016/j.scitotenv.2023.162416

Rast, M., & Painter, T. H. (2019). Earth observation imaging spectroscopy for terrestrial systems: An overview of its history, techniques, and applications of its missions. *Surveys in Geophysics*, *40*(3), 303–331.

Rodríguez-Benito, C. V., Navarro, G., & Caballero, I. (2020). Using Copernicus Sentinel-2 and Sentinel-3 data to monitor harmful algal blooms in Southern Chile during the COVID-19 lockdown. *Marine Pollution Bulletin*, *161*, 111722.

Schiavon, E., Taramelli, A., Tornato, A., & Pierangeli, F. (2021). Monitoring environmental and climate goals for European agriculture: User perspectives on the optimization of the Copernicus evolution offer. *Journal of Environmental Management*, *296*, 113121. https://doi.org/10.1016/j.jenvman.2021.113121

Słomczyńska, I. (2020). Strategic space autonomy for EU political and security goals. Evolution of organisational capacity. *Przegląd Europejski*, *4*, 25–35.

Transon, J., d'Andrimont, R., Maugnard, A., & Defourny, P. (2018). Survey of hyperspectral earth observation applications from space in the sentinel-2 context. *Remote Sensing*, *10*(2), 157.

'United Space in Europe'? The European Space Agency and the EU Space Programme. (n.d.). *European Foreign Affairs Review*. Retrieved 12 May 2023, from https://kluwerlawonline.com/journalarticle/European+Foreign+Affairs+Review/26.SI/EERR2021025

van der Mheen, M., van Sebille, E., & Pattiaratchi, C. (2020). Beaching patterns of plastic debris along the Indian Ocean rim. *Ocean Science*, *16*(5), 1317–1336. https://doi.org/10.5194/os-16-1317-2020

Books

Al-Ekabi, C. (2015). *European Autonomy in space*. Springer.

BUZAN, B. (1983). *People, States and Fear; The National Secutity Problem in International Relation*. The University of North Carolina Press. http://digilib.fisipol.ugm.ac.id/handle/15717717/12454

Buzan, B., Wæver, O., Wæver, O., & De Wilde, J. (1998). *Security: A new framework for analysis*. Lynne Rienner Publishers.

Krige, J., Russo, A., & Sebesta, L. (2000a). *SP-1235 – A History of the European Space Agency, 1958 – 1987* (Vol. 2). ESA Publications Division.

Krige, J., Russo, A., & Sebesta, L. (2000b). *SP-1235 – A History of the European Space Agency, 1958 – 1987* (Vol. 1). ESA Publications Division.

Li, D., Shan, J., & Gong, J. (2009). *Geospatial technology for earth observation*. Springer Science & Business Media.

Remuss, N.-L. (2018). *Theorising institutional change: The impact of the European integration process on the development of space activities in Europe*. Springer.

Schrogl, K.-U. (2020). *Handbook of Space Security: Policies, Applications and Programs* (2nd ed.). Springer Cham. https://doi.org/10.1007/978-3-030-23210-8

Telò, M. (2005). *Europe: A Civilan Power?*. Springer.

United Nations Conference on Trade and Development. (2022). *Review of Maritime Transport*. https://unctad.org/system/files/official-document/rmt2022_en.pdf

Wouters, J., Hoffmeister, F., Baere, G. D., Ramopoulos, T., Wouters, J., Hoffmeister, F., Baere, G. D., & Ramopoulos, T. (2021). *The Law of EU External Relations: Cases, Materials, and Commentary on the EU as an International Legal Actor* (Third Edition, Third Edition). Oxford University Press.

Books Chapters

Al-Ekabi, C., & Mastorakis, P. (2015). The Evolution of Europe's Launcher and Flagship Space Initiatives. In C. Al-Ekabi (Ed.), *European Autonomy in Space* (pp. 1–45). Springer International Publishing. https://doi.org/10.1007/978-3-319-11110-0_1

de Boissezon, H., & Eddy, A. (2020). Satellite EO for Disasters, Risk, and Security: An Evolving Landscape. In K.-U. Schrogl (Ed.), *Handbook of Space Security: Policies, Applications and Programs* (pp. 733–757). Springer International Publishing. https://doi.org/10.1007/978-3-030-23210-8_93

Doboš, B. (2019). The History of the European Space Program. In B. Doboš (Ed.), *Geopolitics of the Outer Space: A European Perspective* (pp. 83–105). Springer International Publishing. https://doi.org/10.1007/978-3-319-96857-5_5

Jutz, S., & Milagro-Pérez, M. P. (2018). 1.06—Copernicus Program. In S. Liang (Ed.), *Comprehensive Remote Sensing* (pp. 150–191). Elsevier. https://doi.org/10.1016/B978-0-12-409548-9.10317-3

Tortora, J.-J. (2015). European Autonomy in Space: The Technological Dependence. In C. Al-Ekabi (Ed.), *European Autonomy in Space* (pp. 165–172). Springer International Publishing. https://doi.org/10.1007/978-3-319-11110-0_11

Wouters, J., & Hansen, R. (2015). Strategic Autonomy in EU Space Policy: A Conceptual and Practical Exploration. In C. Al-Ekabi (Ed.), *European Autonomy in Space* (pp. 49–61). Springer International Publishing. https://doi.org/10.1007/978-3-319-11110-0_2

Interviews

Anonymous. (2023, May 2). Interview Centre for Decurity, Diplomacy and Strategy [Personal communication].

Béclard, J. (2023, April 14). Interview SPF Affaires Etrangères [Personal communication].

Grudler, C. (2022, November 30). Interview Member of the European Parliament [Personal communication].

Lemaire, O. (2023, April 27). Interview ASD Eurospace [Personal communication].

Messina, P. (2022, November 29). Interview European Space Agency [Personal communication].

Reports

Aliberti, M., & Lahcen, A. (2015). *The Future of European Flagship Programmes in Space*. European Space Policy Institute. https://www.espi.or.at/wp-content/uploads/espidocs/Public%20ESPI%20Reports/ESPI_Report_53.pdf

Baudoin-Naneix, S., & Raïs, L. (2019). *The European Union and Space Defence* (Food for Thought, p. 19). FINABEL. https://finabel.org/the-european-union-and-space-defence/

EUMETSAT. (2001). *Preparation for the use of MSG in Africa (PUMA)—Status of Project* (CGMS-XXIX EUM-WP-10).

European Court of Auditors. (2021). *Frontex's support to external border management: Not sufficiently effective to date. Special report No 08, 2021*. Publications Office of the European Union. https://data.europa.eu/doi/10.2865/237222

European Environment Agency (EU body or agency). (2021). *Consolidated annual activity report 2020*. Publications Office of the European Union. https://data.europa.eu/doi/10.2800/963701

European External Action Service. (2016). *Vision partagée, action commune: Une Europe plus forte : une stratégie globale pour la politique étrangère et de sécurité de l'Union européenne*. Publications Office of the European Union. https://data.europa.eu/doi/10.2871/3451

European Maritime Safety Agency (EU body or agency). (2022). *European maritime safety report 2022*. Publications Office of the European Union. https://data.europa.eu/doi/10.2808/914730

European Union Satellite Centre (EU body or agency). (2020). *EU SatCen: Annual report 2019*. Publications Office of the European Union. https://data.europa.eu/doi/10.2820/521085

European Union Satellite Centre (EU body or agency). (2023). *SatCen: Annual report 2022*. Publications Office of the European Union. https://data.europa.eu/doi/10.2820/00882

Eurostat (European Commission). (2021). *LUCAS: The EU's land use and land cover survey : 2021 edition*. Publications Office of the European Union. https://data.europa.eu/doi/10.2785/608

Eurostat (European Commission). (2022). *Sustainable development in the European Union: Monitoring report on progress towards the SDGs in an EU context : 2022 edition*. Publications Office of the European Union. https://data.europa.eu/doi/10.2785/313289

Eurostat (European Commission). (2023). *Statistical requirements compendium: 2023 edition*. Publications Office of the European Union. https://data.europa.eu/doi/10.2785/562159

Järvenpää, P., Major, C., & Sakkov, S. (2019). *European Strategic Autonomy Operationalising a Buzzword* (p. 28). International Centre for Defence and Security. https://icds.ee/en/european-strategic-autonomy-operationalising-a-buzzword/

Mauro, F. (2018). *Strategic autonomy: The new Grail of European defense* (No. 2018/1; p. 32). https://www.grip.org/strategic-autonomy-the-new-grail-of-european-defense/

Presentations

Borrell, J. (2022, October 10). *EU Ambassadors Annual Conference 2022: Opening speech by High Representative Josep Borrell* [Opening Speech]. EU Ambassadors Annual Conference 2022, Brussels. https://www.eeas.europa.eu/eeas/eu-ambassadors-annual-conference-2022-opening-speech-high-representative-josep-borrell_en

CAMS Policy Tools for Decision Maker. (2019). https://atmosphere.copernicus.eu/sites/default/files/2021-04/CAMS_policy_tools_factsheet_20210401.pdf

CEMS Flyer DroughtsEDO. (2020). https://emergency.copernicus.eu/downloads/CEMS_Flyer_DroughtsEDO_2020.pdf

CEMS Flyer Rapid Mapping. (2021). 75. https://emergency.copernicus.eu/downloads/CEMS_FlyerRapidMapping_2021.pdf

CEMS Flyer Risk Mapping. (2021). 76. https://emergency.copernicus.eu/downloads/CEMS_FlyerRiskMapping_2021.pdf

Copernicus Service in support to EU External Action. (n.d.).

Ouattara, T. (2017). *GMES and Africa state of Play*. https://www.unoosa.org/documents/pdf/copuos/stsc/2017/tech-59E.pdf

Saley, M. B. (2020, December 15). *GMES AND AFRICA: An initiative to integrate and promote the development of local capacities in access to Earth Observation based services in Africa*. https://asrenorg.net/eage20/sites/default/files/GMES%20and%20Africa.pdf

Legislation

ANNEX to the Commission Implementing Decision on the financing of the Union Space Programme and the adoption of the work programmes 2021 (direct management) and 2021-2027 (indirect management) Copernicus part of the 2021 (direct management) and 2021-2027 (indirect management) work programmes of the Union Space Programme, (2010).

Communication from the Commission to the Council and the European Parliament - Europe and Space: Turning to a new chapter, (2000). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52000DC0597&qid=1683919793932

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Space Strategy for Europe, (2016). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52016DC0705&qid=1683919892418

Cooperation Arrangement Between The European Commission And The Government Of The United States Of America On Cooperation On Earth Observation Data Related To The Copernicus Programme, 3 (2015). https://repository.library.noaa.gov/view/noaa/11889

Decision No 1513/2002/EC of the European Parliament and of the Council of 27 June 2002 concerning the sixth framework programme of the European Community for research, technological development and demonstration activities, contributing to the creation of the European Research Area and to innovation (2002 to 2006), 232 OJ L (2002). http://data.europa.eu/eli/dec/2002/1513/oj/eng

Decision No 1982/2006/EC of the European Parliament and of the Council of 18 December 2006 concerning the Seventh Framework Programme of the European Community for research, technological development and demonstration activities (2007-2013)#Statements by the Commission, 412 OJ L (2006). http://data.europa.eu/eli/dec/2006/1982/oj/eng

ESA convention and council rules of procedure, SP-1337/EN (1975).

EUROPE 2020 A strategy for smart, sustainable and inclusive growth, (2010). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52010DC2020&qid=1687017288909

JOINT COMMUNICATION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL European Union Space Strategy for Security and Defence, (2023). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023JC0009&qid=1683914645303

Règlement (UE) 2021/696 du Parlement européen et du Conseil du 28 avril 2021 établissant le programme spatial de l'Union et l'Agence de l'Union européenne pour le programme spatial et abrogeant les règlements (UE) no 912/2010, (UE) no 1285/2013 et (UE) no 377/2014 et la décision no 541/2014/UE, 170 OJ L (2021). http://data.europa.eu/eli/reg/2021/696/oj/fra

Règlement (UE) n ° 377/2014 du Parlement européen et du Conseil du 3 avril 2014 établissant le programme Copernicus et abrogeant le règlement (UE) n ° 911/2010 Texte présentant de l'intérêt pour l'EEE, 122 OJ L (2014). http://data.europa.eu/eli/reg/2014/377/oj/fra

Règlement (UE) n o 911/2010 du Parlement européen et du Conseil du 22 septembre 2010 concernant le programme européen de surveillance de la Terre (GMES) et sa mise en œuvre initiale (2011-2013) Texte présentant de l'intérêt pour l'EEE, 276 OJ L (2010). http://data.europa.eu/eli/reg/2010/911/oj/fra

TRIPARTITE WORKING ARRANGEMENT between The European Border and Coast Guard Agency (Frontex) andthe European Fisheries Control Agency (EFCA) and The European Maritime Safety Agency (EMSA).

White paper - Space: A new European frontier for an expanding Union - An action plan for implementing the European Space policy {SEC (2003) 1249 }, (2003). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52003DC0673&qid=1683919654674

Websites

| eStation. (n.d.). Retrieved 18 June 2023, from https://estation.jrc.ec.europa.eu/projects

Air composition data for businesses | Copernicus. (n.d.). Retrieved 18 June 2023, from https://atmosphere.copernicus.eu/air-composition-data-businesses

Air composition data for policymakers | Copernicus. (n.d.). Retrieved 18 June 2023, from https://atmosphere.copernicus.eu/air-composition-data-policymakers

Belga -. (2023, June 18). *Intempéries: Seules quatre des 25 notifications EFAS reçues par le SPW concernaient la Wallonie*. La Libre.be.

https://www.lalibre.be/belgique/societe/2021/07/23/intemperies-seules-quatre-des-25-notifications-efas-recues-par-le-spw-concernaient-la-wallonie-3EFP6WIBBBAUTMMSSCDJW7LBRM/

Climate change | Copernicus. (n.d.). Retrieved 12 May 2023, from https://www.copernicus.eu/en/copernicus-services/climate-change

Climate change impacts on biodiversity in Costa Rica | Copernicus. (n.d.). Retrieved 18 June 2023, from https://climate.copernicus.eu/climate-change-impacts-biodiversity-costa-rica

Contributing Missions. (n.d.). Copernicus Contributing Missions Online. Retrieved 17 June 2023, from https://spacedata.copernicus.eu/contributing_missions

copernicus. (n.d.). *CMS - Areas of activity*. Retrieved 20 June 2023, from https://emsa.europa.eu/copernicus/areas-of-activity.html

Copernicus Emergency Management Service. (n.d.). Retrieved 20 June 2023, from https://emergency.copernicus.eu/faq.html

Copernicus Sentinel Expansion missions. (n.d.-a). Retrieved 18 June 2023, from https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Copernicus_Sentinel_Expansion_missions

Copernicus Sentinel Expansion missions. (n.d.-b). Retrieved 19 June 2023, from https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Copernicus_Sentinel_Expansion_missions

Data | Copernicus. (n.d.). Retrieved 20 June 2023, from https://atmosphere.copernicus.eu/data

Demonstrating heat stress in European cities | Copernicus. (n.d.). Retrieved 18 June 2023, from https://climate.copernicus.eu/demonstrating-heat-stress-european-cities

EFFIS - Long-term fire weather forecast. (n.d.). Retrieved 18 June 2023, from https://effis.jrc.ec.europa.eu/apps/effis.longterm.forecasts/

EFFIS - Statistics Portal. (n.d.). Retrieved 18 June 2023, from https://effis.jrc.ec.europa.eu/apps/effis.statistics/

EFFIS - Welcome to EFFIS. (n.d.). Retrieved 18 June 2023, from https://effis.jrc.ec.europa.eu/

EGNOS visibility maps | EGNOS User Support. (n.d.). Retrieved 18 June 2023, from https://egnos-user-support.essp-sas.eu/resources-tools/egnos-visibility-maps

Espagne: Le feu de forêt qui a ravagé près de 12.000 hectares dans l'ouest du pays est 'stabilisé'. (n.d.). BFMTV. Retrieved 18 June 2023, from https://www.bfmtv.com/international/europe/espagne/espagne-le-feu-de-foret-qui-a-ravage-pres-de-12-000-hectares-dans-l-ouest-du-pays-est-stabilise_AD-202305200424.html

Europe suffering worst drought in at least 500 years – European Commission. (n.d.). CapeTalk. Retrieved 18 June 2023, from https://www.capetalk.co.za/articles/452946/europe-suffering-worst-drought-in-at-least-500-years-european-commission

European Flood Awareness System – EFAS | Copernicus EMS - European Flood Awareness System. (n.d.). Retrieved 18 June 2023, from https://www.efas.eu/en/european-flood-awareness-system-efas

Final Report Summary—G-NEXT (GMES pre-operational security services for supporting external actions) | FP7 | CORDIS | European Commission. (n.d.). Retrieved 27 April 2023, from https://cordis.europa.eu/project/id/312703/reporting/fr

Finding sustainable locations for growing rainbow trout in the Baltic Sea | CMEMS. (n.d.). Retrieved 18 June 2023, from https://marine.copernicus.eu/services/use-cases/finding-sustainable-locations-growing-rainbow-trout-baltic-sea

Finding the best deployment site for a combined floating wind and wave energy system | CMEMS. (n.d.). Retrieved 18 June 2023, from https://marine.copernicus.eu/services/use-cases/finding-best-deployment-site-combined-floating-wind-and-wave-energy-system

Frontex helps seize 40 tonnes of hashish in operation in Spain. (n.d.). Retrieved 18 June 2023, from https://frontex.europa.eu/media-centre/news/news-release/frontex-helps-seize-40-tonnes-of-hashish-in-operation-in-spain-7RpdCA

Global Flood Awareness System. (n.d.). Retrieved 18 June 2023, from https://www.globalfloods.eu/general-information/about-glofas/

GMES and Africa | Capacity4dev. (n.d.). Retrieved 18 June 2023, from https://capacity4dev.europa.eu/projects/gmes-global-monitoring-for-environment-and-security/info/gmes-and-africa

GWIS - Welcome to GWIS. (n.d.). Retrieved 18 June 2023, from https://gwis.jrc.ec.europa.eu/

Heineken 'Brewing a better world' | Copernicus. (n.d.). Retrieved 18 June 2023, from https://climate.copernicus.eu/heineken-brewing-better-world

Incendies en Europe: Déjà plus de surface brûlée dans l'UE qu'en 2021. (n.d.). RTBF. Retrieved 18 June 2023, from https://www.rtbf.be/article/incendies-en-europe-deja-plus-de-surface-brulee-dans-l-ue-qu-en-2021-11035357

Infographics—EMSA - European Maritime Safety Agency. (n.d.). Retrieved 20 June 2023, from https://emsa.europa.eu/infographics-2.html

La guerre en Ukraine: Quelles conséquences pour le spatial ? (2022a, February 27). Destination Orbite. https://destination-orbite.net/astronautique/actualite/la-guerre-en-ukraine-quelles-consequences-pour-le-spatial

La guerre en Ukraine: Quelles conséquences pour le spatial ? (2022b, February 27). Destination Orbite. https://destination-orbite.net/astronautique/actualite/la-guerre-en-ukraine-quelles-consequences-pour-le-spatial

Les autorités auraient-elles pu mieux anticiper les inondations de juillet ? Ce que disaient les prévisions de l'EFAS. (n.d.). RTBF. Retrieved 18 June 2023, from https://www.rtbf.be/article/les-autorites-auraient-elles-pu-mieux-anticiper-les-inondations-de-juillet-ce-que-disaient-les-previsions-de-l-efas-10842799

Les prévisions de l'EFAS n'ont pas été consultées avant les inondations en Wallonie: 'L'ingénieur de garde n'a pas été se connecter'. (n.d.). RTBF. Retrieved 18 June 2023, from https://www.rtbf.be/article/les-previsions-de-lefas-nont-pas-ete-consultees-avant-les-inondations-en-wallonie-lingenieur-de-garde-na-pas-ete-se-connecter-10844042

List of EMS Rapid Mapping Activations. (n.d.). Copernicus EMS - Mapping. Retrieved 18 June 2023, from http://emergency.copernicus.eu/mapping/list-of-activations-rapid

List of EMS Risk and Recovery Mapping Activations. (n.d.). Copernicus EMS - Mapping. Retrieved 18 June 2023, from http://emergency.copernicus.eu/mapping/list-of-activations-risk-and-recovery

Marine | Copernicus. (n.d.-a). Retrieved 12 May 2023, from https://www.copernicus.eu/en/copernicus-services/marine

Marine | Copernicus. (n.d.-b). Retrieved 20 June 2023, from https://www.copernicus.eu/en/copernicus-services/marine

Marine Data Viewer: Uniting In-Situ Measurements, Models, and Satellites for Essential Ocean Variables | CMEMS. (n.d.). Retrieved 18 June 2023, from https://marine.copernicus.eu/services/use-cases/marine-data-viewer-uniting-situ-measurements-models-and-satellites-essential

Mission ends for Copernicus Sentinel-1B satellite. (n.d.). Retrieved 18 June 2023, from https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Sentinel-1/Mission_ends_for_Copernicus_Sentinel-1B_satellite

MSG - More than just the weather. (n.d.). Retrieved 18 June 2023, from https://www.esa.int/Applications/Observing_the_Earth/Meteorological_missions/Meteosat/MSG_-_More_than_just_the_weather

OBSERVER: Copernicus—Eyes on the EU's external borders | Copernicus. (n.d.). Retrieved 20 June 2023, from https://www.copernicus.eu/en/observer-copernicus-eyes-on-EU-external-borders

OBSERVER: GMES & Africa: Unlocking the power of EO data in Africa with Copernicus | Copernicus. (n.d.-a). Retrieved 18 June 2023, from https://www.copernicus.eu/en/news/news/observer-gmes-africa-unlocking-power-eo-data-africa-copernicus

OBSERVER: GMES & Africa: Unlocking the power of EO data in Africa with Copernicus | Copernicus. (n.d.-b). Retrieved 18 June 2023, from https://www.copernicus.eu/en/news/news/observer-gmes-africa-unlocking-power-eo-data-africa-copernicus

OBSERVER: GMES & Africa: Unlocking the power of EO data in Africa with Copernicus | Copernicus. (n.d.-c). Retrieved 18 June 2023, from https://www.copernicus.eu/en/news/news/observer-gmes-africa-unlocking-power-eo-data-africa-copernicus

Parliament to sound the alarm about the water crisis in Europe | 12-06-2023 | News | European Parliament. (2023, June 8). https://www.europarl.europa.eu/news/en/agenda/briefing/2023-06-12/7/parliament-to-sound-the-alarm-about-the-water-crisis-in-europe

Providers | Copernicus. (n.d.-a). Retrieved 18 June 2023, from https://climate.copernicus.eu/providers-view

Providers | Copernicus. (n.d.-b). Retrieved 20 June 2023, from https://climate.copernicus.eu/providers-view

Real-time assessment of MPAs with marine megafauna movements and bio-physical ocean variables | CMEMS. (n.d.). Retrieved 18 June 2023, from https://marine.copernicus.eu/services/use-cases/wildlife-tracker

SEA CLEARLY - A tool to assess ocean plastic transport on and by aquaculture farms | CMEMS. (n.d.). Retrieved 18 June 2023, from https://marine.copernicus.eu/services/use-cases/sea-clearly-ocean-plastic-tool

SPOT – User-friendly oil spill model | CMEMS. (n.d.). Retrieved 18 June 2023, from https://marine.copernicus.eu/services/use-cases/spot-user-friendly-oil-spill-model

Sustainable monitoring of transparent coastal waters by high-resolution satellites | CMEMS. (n.d.). Retrieved 18 June 2023, from https://marine.copernicus.eu/services/use-cases/sustainable-monitoring-transparent-coastal-waters-high-resolution-satellites

Two tons of cocaine seized from Atlantic fishing boat. (2017, May 15). Euronews. https://www.euronews.com/2017/05/15/two-tons-of-cocaine-seized-from-atlantic-fishing-boat

Miscellaneous

Achievements Phase 1. (n.d.). *Achievements Phase 1*. Retrieved 18 June 2023, from https://gmes4africa.blogspot.com/p/results-of-phase-1-at-glance.html

Arianespace [@Arianespace]. (2023, June 15). *Un fait technique en production a mis en évidence un risque sur la redondance d'une fonction critique du lanceur Ariane 5. Conformément à ses exigences de fiabilité, Arianespace a décidé d'ajourner le transfert du lanceur #VA261 .* [Tweet]. Twitter. https://twitter.com/Arianespace/status/1669377634168340486

Council of the European Union. (2022). *Outcome of proceedings: A Strategic Compass for Security and Defence—For a European Union that protects its citizens, values and interests and contributes to international peace and security*.

European Commission. (2017a). *Copernicus Atmosphere monitoring Service*.

European Commission. (2017b). *Copernicus Emergency Management Service*.

European Commission. (2017c). *Copernicus Land Monitoring Service*.

European Commission. (2017d). *Copernicus Security Services*. https://www.copernicus.eu/sites/default/files/documents/Copernicus_Security_October2017.pdf

Europe's next crisis: Water. (2023, April 28). *POLITICO*. https://www.politico.eu/article/europe-next-crisis-water-drought-climate-change/

Gianinetto, M., Aiello, M., Marchesi, A., Topputo, F., Massari, M., Lombardi, R., Banda, F., & Tebaldini, S. (2016). OBIA ship detection with multispectral and SAR images: A simulation for Copernicus security applications. *2016 IEEE International Geoscience and Remote Sensing Symposium (IGARSS)*, 1229–1232.

Maputo Declaraion in Support of the 'African GMES' Initiative, (2006).

Morand, G., & Poulain, S. (2023). *GeoEnrich v0.5.8: A new tool for scientists to painlessly enrich species occurrence data with environmental variables* (v0.5.8). Zenodo. https://doi.org/10.5281/ZENODO.6458090

Products – Copernicus SEA. (n.d.). Retrieved 18 June 2023, from https://sea.security.copernicus.eu/products/

Showstack, R. (2014). *Sentinel satellites initiate new era in earth observation*. 2.

The Programme. (n.d.). *The Programme*. Retrieved 18 June 2023, from https://gmes4africa.blogspot.com/p/the-programme.html

U.S.-EU Satellite Data Arrangement Aids in Hurricane Harvey and Hurricane Irma Efforts. (n.d.). *United States Department of State*. Retrieved 27 April 2023, from https://2017-2021.state.gov/u-s-eu-satellite-data-arrangement-aids-in-hurricane-harvey-and-hurricane-irma-efforts/

Magazine

Haljnalka, V. (2022, June). Copernicus et Galileo, Reflets spatiaux des dilemmes stratégiques de l'Europe. *DefTech*, *2*, 6.