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SENTINELS IN ORBIT

The role of satellites
from the Cold War to global warming

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«Two things fill the mind with ever new and increasing admiration and awe, the more often and steadily we reflect upon them: the starry heavens above me and the moral law within me. I do not seek or conjecture either of them as if they were veiled obscurities or extravagances beyond the horizon of my vision; I see them before me and connect them immediately with the consciousness of my existence».

Immanuel Kant, *Critique of Practical Reason*

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CHAPTER GLOSSARY

(AAAS)	American Association for the Advancement of Science
(AFOLU)	Agriculture, Forestry and Other Land Uses
(AGARD)	Advisory Group for Aerospace Research & Development
(API)	Application Programming Interface
(AM)	Aeronautica Militare
(ASI)	Italian Space Agency
(AWI)	Alfred Wegener Institute for Polar and Marine Research
(C2)	Command & Control
(CBD)	Convention on Biological Diversity
(CDR)	Carbon dioxide removal
(CERN)	European Organization for Nuclear Research
(CIA)	Central Intelligence Agency
(CMSA)	China Manned Space Agency
(CNSA)	China National Space Administration
(CNR)	Consiglio Nazionale delle Ricerche
(CO2)	Carbon Dioxide
(COMSAT)	Communications Satellite
(COP)	Conference of the Parties
(COPERS)	European Preparatory Commission for Space Research
(COPUOS)	Committee on the Peaceful Uses of Outer Space
(COSPAR)	Committee on Space Research
(CRS)	Commissione per le Ricerche Spaziali
(CS)	Commercial Services
(DDT)	Dichloro-diphenyl-trichloroethane
(DSDG)	Division for Sustainable Development Goals
(DTE)	Direct-to-Earth
(ECSC)	European Coal and Steel Community

(EEC)	European Economic Community
(EJ)	Exajoule
(EO)	Earth Observation
(ESA)	U.S. Environmental Protection Agency
(ESLAR)	European Space Agency
(ESRIN)	European Space Laboratory for Advanced Research
(ESRO)	European Space Research Institute
(ESTEC)	European Space Research Organization
(EUSPA)	European Space Research and Technology Centre
(FAO)	European Union Agency for the Space Program
(FLI)	Food and Agriculture Organization (of the United Nations)
(GEF)	Food Loss Index
(GEO)	Global Environment Facility
(GHG)	Geostationary orbit
(GMES)	Greenhouse gases
(GNSS)	Global Monitoring for Environment and Security
(GPS)	Global navigation satellite system
(GSDR)	Global Positioning System
(GSE)	Global Sustainable Development Report
(GTO)	Global Satellite Engineering
(IAEA)	Transfer orbits and geostationary transfer orbits
(IAI)	International Atomic Energy Agency
(IC)	Italian Institute of International Affairs
(ICG)	Intelligence Community
(ICT)	International Committee on Global Satellite Systems
(IGFA)	Information Communication Technology
(IGOS)	International Group of Funding Agencies
(IGOS-P)	Integrated Global Observation Strategy

(IASC)	IGOS Partnership
(ILO)	International Arctic Science Committee
(INSPIRE)	International Labour Organization
(IPCC)	Infrastructure for Spatial Information in the European Union
(IR)	Intergovernmental Panel on Climate Change
(ISPI)	International Relations Italian Institute for International Political Studies
(ISS)	International Space Station
(ITU)	International Telecommunications Union
(KSC)	Kennedy Space Center
(L-points)	Lagrange points
(LEO)	Low Earth orbit
(MDGs)	Millennium Development Goals
(MEO)	Medium Earth Orbit
(NACA)	National Advisory Committee on Aeronautics
(NASA)	National Aeronautics and Space Administration
(NATO)	North Atlantic Treaty Organization
(NDCs)	Nationally Determined Contributions
(NGO)	Non-Governmental Organization
(NOAA)	National Oceanic and Atmospheric Administration
(NOTS)	Naval Ordinance Test Station
(OECD)	Organization for Economic Co-operation and Development
(PPP)	Public-Private Partnership
(ppm)	Parts per million
(R&D)	Research and Development
(SAC)	Strategic Air Command (now United States Strategic Command)

(SAR)	Synthetic Aperture Radar
(SCAR)	Scientific Committee on Antarctic Research
(SDGs)	Sustainable Development Goals
(SEIS)	Shared Environmental Information System
(SIDS)	Small Island Developing States
(SIRAL)	SAR Interferometric Radar Altimeter
(SMEs)	Small and Medium Enterprises
(SN)	Space Network
(SSERVI)	NASA Solar System Exploration Research Virtual Institute
(SSO)	Polar orbit and Sun-synchronous orbit
(UN)	United Nations
(UNDESA)	United Nations Department of Economic and Social Affairs
(UNDRIP)	United Nations Declaration on the Rights of Indigenous Peoples
(UNDROP)	United Nations Declaration on the Rights of Peasants and Other People Working in Rural Areas
(UNEP)	United Nations Environment Program
(UNFCCC)	United Nations Framework Convention on Climate Change
(UNOOSA)	United Nations Office for Outer Space Affairs
(US)	United States of America
(USAF)	United States Air Force
(USDA)	United States Department of Agriculture
(USSR)	Union of Soviet Socialist Republics
(WHO)	World Health Organization

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ABSTRACT

The aim of this thesis is to let emerge the observation of our planet, map and connect it from the orbital perspective. It is the perspective of space that could help our planet, in terms of human survival, climate change and food security. These days, many discussions are related to the «new space race», Mars colonization, nanosatellites, new commercial actors and space tourism. Space is becoming always more part of our daily life. Not only the Internet, TV, phone calls... but also technological tools useful to reduce the risks of climate change, to help agriculture, so water and food supply. What can space deliver? What kind of opportunities and challenges? What kind of historical trends happened in technological innovation? European Union, United States, China, India, and many other countries are investing huge financial resources in the space economy. However, the most exciting gift we could have from space is how to care for and protect our incredible planet that contains unique living conditions for humans, plants and animals. In this thesis, we will investigate the importance of space as the fourth dimension for the benefit of humanity through a new approach. A holistic approach to pursue a new form of equilibrium with Nature, more respectful and grateful to Earth. This is a hope, a challenge and an engagement we should all sustain.

INTRODUCTION: SCIENCE DIPLOMACY

Science diplomacy is a national issue that unifies two different worlds: science and foreign policy[1]. Science involves the production of knowledge, and it is conducted by scientists and researchers. On the other hand, diplomats represent the world of foreign policy, connected with domestic interests of national states. Surprisingly, science diplomacy converges the figures of the scientist and the diplomat, driven by very different values and goals.

Pierre Bruno Ruffini attributes this convergence to three main reasons:

1) Science is engaged in **industrial processes**, incorporated into innovation and technical progress. Theoretical knowledge became difficult to be distinguished by its applications, and this is the case of applied research. Scientists are confronted with national contrasts, indeed the entry into the atomic age is the strongest evidence of this fact.
2) The methods of organization and funding of science are related to policies taken into a **national framework**. The public funds are the basis on which research and innovation are grounded. Firms are dependent on investments not only private but also public. Then, innovation needs infrastructure and networks, higher education system and access to data. The human capital is at the heart of the production of knowledge.
3) Even if science is universal and knows no boundaries, it is necessary to distinguish between science and the scientist as a person. Hunger for power, competition for funding, scientific frauds are part of the reality. The national belongingness in science is influenced by **national rivalries**, whether in an open war or a cold war.

Science and technology are essential for economic and social developments that depend on long-term efforts by governments. They can lead to immense benefits and prestige, in both the domestic and the international sphere. **Attraction,**

[1] RUFFINI P. B., 2017, *Science and Diplomacy. A New Dimension of International Relations*, Berlin, Springer p. 27.

cooperation, and influence are the three key words for science diplomacy[2]. For example, the United States is the top destination for both Germans and Jews migrant researchers. Experts recruited by an international or foreign organization are at the service of its interests and not those of their country of origin. So, attracting expertise is considered as a tool of soft power for a country.

The starting point for the conceptualisation of science diplomacy divided it into a taxonomy with three categories:

- ❖ *Science in Diplomacy*: giving useful information about foreign policy objectives and methods with scientific advice;
- ❖ *Diplomacy for Science*: promoting international science cooperation;
- ❖ *Science for Diplomacy*: using science cooperation to foster international relations between countries.

Social constructivism focuses on the collaborative nature of learning. Knowledge develops from how people interact with each other, their culture and society.

The growing role of science and technology stand in most existing analytical frameworks. Material elements, technical instruments and scientific practices entail many aspects of global politics. The discipline of International Relations (IR) tends to conceptualize this topic as an exogenous phenomenon. Mayer, Carpes and Knoblich suggest studying the intersection of science and technology with International and global affairs[3]. Conceptually, the notion of **techno-politics** involves two broad sets of approaches: *interaction* and *co-production*. The main difficulty for the study of science and technology is related to the fact that it seems technological determinism cannot relate to social constructivism.

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[2] RUFFINI P. B., 2017, *Science and Diplomacy. A New Dimension of International Relations*, p. 33, Berlin, Springer.

[3] MAYER M. - CARPES M. - KNOBLICH R, 2014, *A Toolbox for Studying the Global Politics of Science and Technology*, in *The Global Politics of Science and Technology*, 2 - *Cases, Perspectives, and Methods*, Berlin, Springer International, p. 4.

Tab.1 – Techno-politics analytical framework. MAYER M. – CARPES M. – KNOBLICH R., 2014, *A Toolbox for Studying the Global Politics of Science and Technology*, in *The Global Politics of Science and Technology*, 2, *Cases, Perspectives, and Methods*, Berlin, Springer International.

Conceptual frameworks	**Main ontological domain**	**Mode of explanation**	**Carriers of agency**
Social constructivism	Ideational factors	Intersubjective meaning invested into materials /technology is a matter of interpretation	Social actors, speech, texts, intersubjective practices
Technological determinism	Material factors	Material determination of social formations	Material/ technical systems and structures
Institutional externalism	Rational interactions	Institutional constraints/ conditions and patterns of calculation	Social actors, strategic practices
Techno-politics	Symmetrical treatment of ideational and material factors, hybridization, and post-dualism	Interaction/co-production creates/changes political order/ collectives	Collectives, assemblages, networks, mediating coalitions

This table, proposed by Mayer, Carpes, and Knoblich illustrates that techno-politics in pragmatic terms refers to different real-types of research designs and analytical frameworks in connection.

The **interactional** approach explores the interactions and conflicts between entities, groups or processes such as social practices and technological innovation. This approach is concerned with how established practices or principles such as sovereignty or foreign policy are facing technological changes. For example, a study published in 2009 by Duvall and Havercroft presents how U.S. hegemony in space weaponization would re-constitute global political order.

The **co-productive** approach makes emerge the co-production and stabilization of new things, groups or practices. New structures, actors and identities enter relation with politics when contestation, resistance and negotiation take place. Conceptualizations of interaction or co-production into theories of International **Techno-political Economy** pave the way to approaches interested in technological micro-practices and macro-processes to stabilize the world economy. This conceptual shift tries to understand how technological monopolies produce **new kinds of power**. For instance, in 2002, Karen T. Liftin published an analysis of space technologies, investigating the role of satellites as the **technology of surveillance**, for military technological networks[4]. The use of cameras from aircraft first became a valued tactical/operational intelligence collection discipline during the First World War[5]. With the emergence of the USSR as the most significant threat to US national security, photoreconnaissance played a central role in the strategic reconnaissance of the Soviet state.

Since its establishment in 2008, the American Association for the Advancement of Science (AAAS) Center for Science Diplomacy has the aim to conceptualize science diplomacy to analyse how science can build bridges between societies where official relationships may be strained; interactions and partnerships between the scientific and diplomatic communities may be strengthened and the intellectual framework and training to support the practice of science diplomacy may be developed.

It focuses its research and activities around three pillars:

- *Community*: Build and maintain a community of diverse stakeholders in science, technology and policy, who contribute to science diplomacy;

[4] LIFTIN K., 2002, *Public eyes. Satellite imagery, the globalization of transparency, and new networks of surveillance. Information Technology and Global Politics. The Scope of Power and Governance*, Albany, State University of New York Press pp. 65- 89.

[5] CADDELL J., 2016, *Corona over Cuba. The missile crisis and the early limitations of satellite imagery intelligence. Intelligence and National Security*, 31, 3, p. 419. http://dx.doi.org/10.1080/02684527.2015.1005495 (consulted in September 2021).

- *Capacity*: Empower scientists and policymakers around the world to be future leaders at the intersection of science and diplomacy;
- *Relationships*: Highlight the potential for science to help build relationships across disciplines, sectors and borders and impact diplomatic efforts.

The leading efforts of the United Nations and especially the Organisation for Economic Co-operation and Development (OECD) helped national governments to establish their research and development systems, in terms of science, technology policy and economic development policy.

OUTLINE OF THE RESEARCH

The research is divided into three parts. The first chapter 1 illustrates the conflict between the two superpowers – the US vs USSR block – but also it introduces the background, the relationships and, to a certain extent, their origins in philosophical thought of economic powers as Japan, China, India, the European Union, and Italy. The first chapter reconstructs the philosophical foundations of the Cold War and its military and technological application in space race and traces their subsequent development in treaties and institutions. Through this analysis, the space race is considered as a turning point, for the fact that until the Apollo 11's achievement, the present has been perceived in a linear process on a positivist point of view. On the contrary, on 20th July 1969, when man landed on the Moon, humankind never felt so small as in front of the vastity of the universe. In the second chapter, humanity rediscovered a new present laid on a new political awareness, also for 'new' environmental issues and debates. Two women took a «wind of change». Rachel Carson introduces the obligation to endure and the principle of precaution, driving a change from the bottom-up, inspiring the birth of environmental NGOs in the United States. Barbara Ward, a pioneer economist, and political adviser was one of the first people to articulate the concept of sustainable development. Through her vision of a "shrinking world" in a "global village", she was aware of the globalization change that led the world to be always more interconnected. In August 1959, the U.S. unmanned spacecraft Explorer 6 is launched into an orbit around the earth transmitted the first picture of the Earth's surface from 17,000 miles. In May

1985, the discovery of the Antarctic Ozone Hole was a black swan event in environmental sciences. The issues of climate change are deepen, with its risks and solutions, and its political implementation through environmental treaties and policies at the international level.

Chapter 3 deals with the delicate phase of space application through Earth observation – a bridge between theory and research, Earth and its orbits, the past and the future of humankind. This chapter tackles the concrete problem of climate change and implications for agriculture (in particular, food security) from two practical case studies:

- CryoSat: ESA's ice mission
- FLEX: ESA's plant health mission

As the European Union, through the autonomous organization ESA, become a leader in Earth Observation programs, we will focus on how the Copernicus services carried out by the Sentinels transform data into value-added information by processing and analysing the data for policymakers and public authorities. Italy plays an important role in space in general and EO in particular, of the fact that ESA-ESRIN is the European centre of excellence for exploitation of Earth observation missions. Italian history in space is told through the words of Ambassador Umberto Vattani, a special guest at three conferences organized by Professor David Burigana, in the framework of the InsSciDE project, funded by Horizon 2020, for the development of shared science diplomacy across Europe through international and interdisciplinary research.

The research question of this qualitative work is: "why space services and their application on Earth are essential to protect the environment and contribute to the pacific use of space?

I hope this research can be a novel for many people who are not specialists in space issues, however, as there is a creative component, a certain level of uncertain is required. This work attempts to balance this uncertainty level with systematic and transferable data.

1945 – 1960s: THE DOMINION OF EARTH FROM SPACE

1.1. THE CONFLICT

The relationship between the United States and the Soviet Union in space is quite accurately portrayed as one of fierce competition[6]. The launch of the Sputniks in 1957 and Jurij Gagarin's flight in 1961 have been seen as one of the most dangerous threats for America. By the summer of 1962, Corona satellites had already provided the US intelligence community (IC) critical information on Soviet Bloc and Chinese strategic infrastructure[7]. After the Bay of Pigs, during the thirteen tense days of the crisis, the American public learned that nuclear war was an imminent possibility on Monday, October 22, 1962[8]:

> This Government, as promised, has maintained the closest surveillance of the Soviet military build-up on the island of Cuba.

President John F. Kennedy began in what must be counted as the scariest presidential address of the Cold War[9]

> Within the past week, unmistakable evidence has established the fact that a series of offensive missile sites is now in preparation on that imprisoned island. The purpose of these bases can be none other than to provide a nuclear strike capability against the Western Hemisphere.

Former Secretary of State Acheson, one of the most notorious Cold War diplomats, urged an immediate surprise assault to destroy the missiles. The CIA indeed missed the deployment of the medium- and intermediate-range missiles until it was almost too late to respond, but it was also unaware that the Soviets had on hand 35 LUNA battlefield nuclear weapons. The diplomat Adlai Stevenson noted[10]:

> To start or risk starting a nuclear war is bound to be divisive at best and the judgements of history rarely coincide with the tempers of the moment.

He added:

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[6] KRIGE J. - LONG CALLAHAN A. - MAHARAJ A., 2013, *NASA in the world. 50 years of international collaboration in space*, London, Palgrave MacMillan, p.127.
[7] CADDELL J., 2016, *Corona over Cuba. The missile crisis and the early limitations of satellite imagery intelligence. Intelligence and National Security*, 31, 3, p. 417. http://dx.doi.org/10.1080/02684527.2015.1005495 (consulted in September 2021)
[8] SHERWIN M. J., 2012*, One Step from Nuclear War. The Cuban Missile Crisis at 50. In Search of Historical Perspective*, Prologue Magazine 44, https://www.archives.gov/publications/prologue/2012/fall/cuban-missiles.html (consulted in September 2021).
[9] *Ibidem*.
[10] *Ibidem*.

> The means adopted have such incalculable consequences that I feel that you should have made it clear that the existence of nuclear missile bases anywhere is negotiable before we start anything.

Adlai Stevenson, the US representative to the UN, showed the Security Council aerial photos which clearly revealed what the Soviet Union was doing, and he also indicated what military action the US was prepared to take against Cuba and the Soviet Union[11].

Corona satellites' low image resolution was the core reason why it failed to identify Soviet missile deployments. A second factor was the weather. The haze over San Cristo´bal and Guanajay on the afternoon of 1 October significantly reduced the interpretability of those areas and further precluded any chance the SAC interpreters might have had of identifying ballistic missiles there[12]. The Cuban nuclear crisis was a transformative event for Cold War relations. Nuclear deterrence could no longer be viewed as a condition for stability and security that allowed governments to use nuclear weapons for diplomatic advantage. The crisis had manifested the policy of deterrence's fragilities, requiring a delicately balanced process. However, to understand the historical dynamic that led to this global crisis we must come back 17 years before, going back to Hiroshima.

In February 1945, U.S. President Franklin D. Roosevelt, British Prime Minister Winston Churchill and the Secretary-General of the Communist Party of the Soviet Union Stalin met in Yalta, Crimea, to discuss the future of post-conflict Europe. As accorded, the Soviet Union was appointed to invade Japan to end the war. Meanwhile, US President Harry Truman had mentioned a new secret powerful weapon to Stalin during the meeting. The bombing of Hiroshima and Nagasaki marked the beginning of the nuclear arms race that underscored geopolitical considerations of both the United States and the Soviet Union throughout the Cold War.

It is no surprise that for years, the devastation of Hiroshima and Nagasaki remained at the forefront of their collective conscience, and that part of the healing process

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[11] REINALDA B., 2019, *Routledge History of International Organization. From 1815 to the Present Day* 2013th ed., New York, Routledge, p. 376.

[12] CADDELL J., 2016, *Corona over Cuba. The missile crisis and the early limitations of satellite imagery intelligence. Intelligence and National Security*, p. 433, 31, 3, http://dx.doi.org/10.1080/02684527.2015.1005495 (consulted in September 2021).

meant returning to this imagery in literature, music, and art[13]. One of the most famous Japanese art directors, Hayao Miyazaki, let emerge this abuse of technology in his animated motion pictures, despite his family business «Miyazaki Airplanes» manufactured parts for warplanes in World War II. In *Princess Mononoke*, there is a struggle between the guardians of the Sacred Forest and the humans who exploit natural resources. In Miyazaki's eyes, progress is an ambivalent concept and technology is not evil per se, but its misuse of technology can be destructive. The Iron Town symbolizes industry, human expansion, economic growth and greed. However, the forest's death is destructive to the town that depends on the forest's products for its industrial growth. Death and rebirth are used as common themes to symbolize Japan's wartime and post-war experiences. In the post-war period, Japan became an economic superpower and a world leader in technology production.

After World War II, practically speaking, the United States was assuming the role played by Britain during its period of greatness[14]. John Krige helps us to understand that the concepts of «hegemony» and «empire» as developed by diplomats and historians do not refer to a territorial acquisition but from a balance of power to a preponderance of power on a global scale. The «coproduction of hegemony» in the scientific in the interests of rebuilding Europe - maintaining US leadership without the use of force - was supported by European scientists and governments to strengthen science in the Old Continent. During the war, European laboratories and industries were destroyed and, in the case of Germany, were strictly controlled. Many Jewish scientists left for the United States in search of protection from Nazism, while after the conflict, many impoverished European scientists chose the United States for better work conditions. The «American Dream» was the national ethos of the United States, in which democracy, liberty, the opportunity for prosperity and success are the core values. The first Soviet Five-Year Plan for economic development was heavily based on American technology. These transfers

[13] FULLER F., 2020, *The Deep Influence of the A-Bomb on Anime and Manga*, https://theconversation.com/the-deep-influence-of-the-a-bomb-on-anime-and-manga-45275 (consulted in September 2021).

[14] DE MONTBRIAL T., 1975, *For a New World Economic Order*, Foreign Affairs edition, https://www.foreignaffairs.com/articles/1975-10-01/new-world-economic-order (consulted in October 2021).

from west to east fit better widely held perceptions of American «superiority» and Russian «backwardness»[15].

Krige argues that the immense scientific and technological achievements in the United States during the war and the ongoing support for research in the country after 1945 contrasted sharply with the situation in post-war Europe[16]. The Marshall Plan was an economic and social reconstruction plan for Europe designed to accelerate recovery after WWII. At the same time, it was also a direct consequence of the Containment policy. European industrial production and standards of living increased rapidly. Experts largely agree that it sped up recovery, was certainly instrumental in reducing political discontent and stemming the communist tide in Western Europe[17]. The Iron Curtain was the political, military and ideological barrier erected by the Soviet Union after World War II to divide eastern and central European allies from the West. The «American Dream» was challenged by the communist utopia.

However, all over the world, people have formed a constellation of different kinds of cultural and spiritual relationships with the natural environment, as Holmes Rolston III described[18]:

> Metaphysically, there are, of course, differing conceptions of nature. Materialists have one, Christians another, Buddhists still another; the Druid concept of nature is this way; Einstein's is that way, seen quite differently. Nature is a loaded word, as is revealed by the metaphors that have been used to describe it: the creation of God, the Great Chain of Being, a clockwork machine, chaos, an evolutionary ecosystem, Mother Nature, Gaia, a cosmic egg, maya (appearance, illusion) spun over Brahman, or samsara (a flow, a turning) which is also sunyata, the great Emptiness, or yang and yin ever recomposing the Tao.

1.2. CULTURAL MYTHS

Cultural myths become the foundations for national and group identities. Within this conflictual framework, Slava Gerovitch stated that the Stalin era built the mythology of the aviation heroes, then incorporated in the Soviet regime's culture. Then, Soviet space mythologies contributed to the making of cultural identity to

[15] MOON D., 2020, *The American steppes. The unexpected Russian roots of Great Plains agriculture, 1870s–1930s*, Cambridge, Cambridge University Press p. 5.

[16] KRIGE J., 2006, *American hegemony and the postwar reconstruction of science in Europe*, pp. 3-14, Cambridge, MIT Press.

[17] The UNC Center for European Studies, a Jean Monnet Center of Excellence, U.S. Department of Education Title VI National Resource Center, https://europe.unc.edu (Consulted on 10.10.21).

[18] HOLMES R., 1997, *Nature, the Genesis of Value, and Human Understanding*, in *Environmental Values* 6, 3, pp. 361–65.

enforce the Soviet power perception and dictatorship. Cosmonauts, meanwhile, had to conform to historical heroes of Soviet aviation and the prototypical vision of the «New Soviet Man», the builder of communism[19]. The official mythology surrounding the cosmonauts came not only from above, but from the contributions of historical actors within the State, the space program, and society. It manifests in mass celebrations through the propaganda used for political and cultural scopes, well documented in the production of images, songs, films and memories. The myth was a tool in consolidating the cultural identities of the rocket engineers and the cosmonauts. They played an important role to stimulate atheism and scientific education. A culture based on technocratic values, faith in automation and a techno-utopian vision of the future. Public opinion on cosmonauts as humans of higher intellectual skills and physical constitution. However, the official narration exalted only the heroic part of the result, not concerning about all the working effort, sacrifices and the process behind it. In the Soviet Union, strictly enforced secrecy did not reveal any kind of clue, except vague and limited information through the secret services[20].

During the early 1960s, Sergej P. Korolëv campaigned to send a Soviet cosmonaut to the Moon. Nikolaj Kamanin was the Commander of the cosmonaut's corps and the head of cosmonaut training in the Soviet space program. He recruited cosmonauts of age between 23 and 34. In 1960, the six chosen were Jurij Gagarin, German Titov, Anatolij Kartašov, Andrijan Nikolaev, Pavlo Popovyč, and Valentin Varlamov: not only men but also women. Kamanin managed to convince Korolëv to support the idea of a first female flight. Six months later, the Central Committee of the Communist Party agreed to recruit 60 more cosmonauts, including five women[21]. Valentina Tereškova represented the «New Soviet Woman», to promote Soviet girls' competencies in science and engineering. Even Clare Booth Luce, ambassador to Italy and Brazil, known for her anti-communist views, wrote in 1963

[19] GEROVITCH S., 2015, *Soviet space mythologies. Public images, private memories, and the making of a cultural identity*, Pittsburgh, University of Pittsburgh Press p.128.

[20] CAPRARA G., 2021, *Breve Storia Dello Spazio* Milano, Salani, p.91.

[21] MALASHENKO U., *The First Group of Female Cosmonauts Were Trained to Conquer the Final Frontier. Two Decades before the First American Woman Flew to Space, a Group of Female Cosmonauts Trained in Star City of the Soviet Union*, Supercluster, https://www.smithsonianmag.com/science-nature/first-group-female-cosmonauts-trained-conquer-final-frontier-180971900/ (consulted on 11/04/2021).

that Tereškova «orbits over the sex barrier» and claimed this was possible only because communist ideology promoted gender equality. In 1925, Zinaida Kokorina was heralded as the Soviet Union's first female military pilot - the first woman in the world to hold both military ranks and fly military aircraft[22] (Pennington, 2014). During WW2, like Jacqueline Cochran and Nancy Love in the US, VVS navigator Lt. Marina M. Raskova was a supporter of female pilots' skills to help the military in times of war. Unlike the Americans, Raskova advocated women for combat roles. So «Night witches» appellation has become popular for all Soviet female but is properly applied only to the women who flew night bombers.

Fig. 1 Professional skydiver Tatyana Morozycheva competed with Valentina Tereškova for a spot on the female space unit and lost.
Photo illustration by Angela Church for Supercluster.

Space historian Anton Pervušin confessed[23]:

> I have no doubt that Ponomareva was the best fit for the first female flight, but unlike the case of Gagarin, the final decision was made not by specialists but by top-ranking politicians, including Soviet leader Nikita Khrushchev who was looking for a «Gagarin in a skirt». Khrushchev believed Tereshkova would be a better representation of the ideal Soviet Woman, and not only because she was a worker, but because the textile industry she represented played a key role in his domestic policies.

[22] PENNINGTON R., 2014, *Not just night witches*, AIR Force magazine, https://www.airforcemag.com/PDF/MagazineArchive/Magazine%20Documents/2014/October%202014/1014Witches.pdf (consulted in September 2021).

[23] MALASHENKO U., *The First Group of Female Cosmonauts Were Trained to Conquer the Final Frontier - Two Decades before the First American Woman Flew to Space, a Group of Female Cosmonauts Trained in Star City of the Soviet Union*, Supercluster, https://www.smithsonianmag.com/science-nature/first-group-female-cosmonauts-trained-conquer-final-frontier-180971900/ (consulted in April 2021).

At the time, Soviet cosmonauts were treated as national icons and cosmonauts' role served as a symbol of technological progress.

1.3. US FOREIGN POLICY AND GEOPOLITICAL INTERESTS

Diplomacy is based on the sovereignty of states, engaging the use of dialogue, negotiation and representation in international relations. Embassies and consulates that a country deploys abroad are key components of the diplomatic infrastructure[24]. The Vienna Convention on Diplomatic Relations (1964) defines the main functions of a diplomatic mission as: representing the sending state to protect its interests and those of its nationals, ascertaining conditions and developments in the receiving state and negotiating with the government of the receiving state and finally, promoting friendly relations and developing economic, cultural and scientific relations with the receiving state. The increasing complexity in society influenced diplomacy in the measure that led to the specialisation of diplomacy to specific fields such as science diplomacy. Nation states therefore make use of diplomacy at the bilateral level, at the regional level or at the global level being part of international organisations.

At the beginning of the Cold War, George Frost Kennan was one of the most influent diplomats and historians about American diplomacy. Kennan, as Counsellor to the State Department, was the mind of the ideation and advocacy of a «containment policy» to oppose Soviet expansionism.

In 1952, the American ambassador wrote a letter[25] to the Deputy Under Secretary of State Matthews from Moscow:

> With the increasing isolation of the diplomatic corps, the curtailment of travel facilities, and the constant increase in Soviet vigilance vis-à-vis foreigners, you have the ruin of those last vestigial positions which made possible, even in a minor way, something resembling normal life and travel in this country […].

In the aftermath of World War II, **the Truman administration (1945 -1953)** was presented with both a challenge and an opportunity[26]. The challenge was to

[24] RUFFINI P. B., 2017, *Science and Diplomacy. A New Dimension of International Relations*, Berlin, Springer, pp. 27-45.

[25] KENNAN F. G., 18 June 1952*, Letter from the Ambassador to the Soviet Union (Kennan) to the Deputy Under Secretary of State (Matthews)*, US National Archives, https://history.state.gov/historicaldocuments/frus1950-55Intel/d118 (consulted in September 2021).

[26] PAULY R. J., 2009, *US foreign policy during the cold war from the Ashgate research companion to us foreign policy*, London, Routledge, p. 31.

reconstruct Western Europe generally, but also Germany. Subsequently, the United States could maintain a military presence on the continent to prevent Soviet expansion and the reminiscence of German power. The Truman government used Marshall Plan aid as an inducement to encourage the creation of intra-European institutions (most notably the European Coal and Steel Community [ECSC] in 1952 and the European Economic Community [EEC] in 1957)[27]. After the wars, a new social and political order, in which the old European balance of power was replaced by the global balance of power between the United States of America and the Soviet Union, was established.

The «Truman Doctrine» offered American financial assistance to any «free peoples» engaged in a struggle against «terror and oppression». George Frost Kennan, who formulated the basic United States strategy for fighting the cold war, wrote: «must be that of a long-term, patient but firm and vigilant containment of Russian expansive tendencies».[28]

In the first period of the Cold War, there were few occasions during which US and Soviet diplomats made use of atomic diplomacy as an instrument by either side of the conflict. During **President Eisenhower's administration** (1953-1960), «Atoms for Peace» speech in 1953 embodied his most important nuclear initiative as President[29]. The «Atoms for Peace» speech reflected the deep concern about «Atoms for War». This marked a new effort to have reactive allies and to set rules inside the competition about non-proliferation. Given that the nuclear powers (the US, the Soviet Union, the UK, and soon France) were not prepared to transfer part of their nuclear arsenals to an international body, the way forward seemed to be cooperating on research to find peaceful applications for nuclear power[30]. For instance, the creation of the International Atomic Energy Agency (IAEA) became operative in 1957 to increase the contribution made by nuclear power to peace, preventing it being used for military objectives. The Treaty of Non-Proliferation of

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https://www.routledgehandbooks.com/doi/10.4324/9781315613727.ch2 (consulted in September 2021).

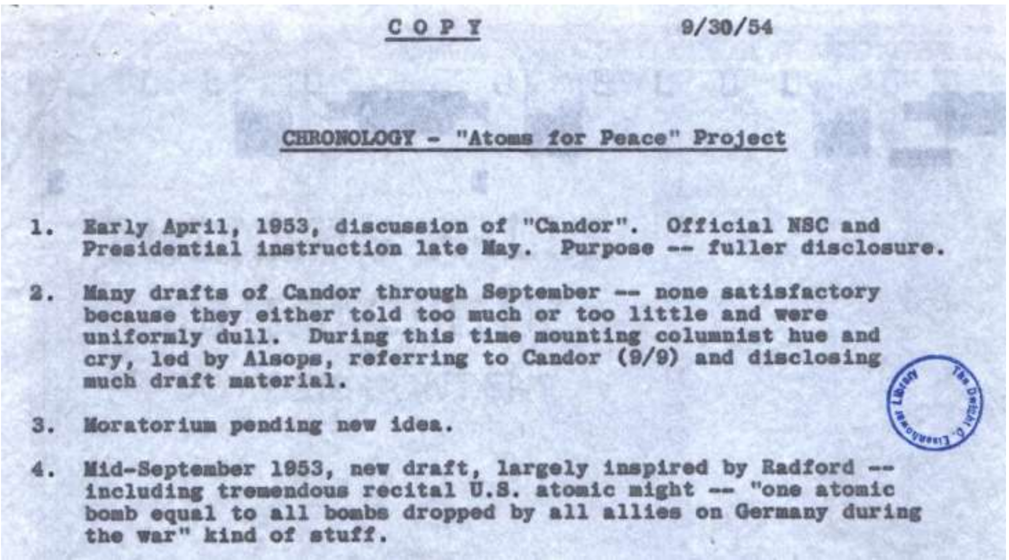
[27] *Ibidem*.

[28] Office of the Historian, https://history.state.gov (consulted on 10.10.21).

[29] Eisenhower Presidential Library, https://www.eisenhowerlibrary.gov (consulted on 10.12.21).

[30] REINALDA B., 2019, *Routledge History of International Organizations From 1815 to the Present Day*, 2013th ed., London, Routledge p. 374.

nuclear weapons was signed by the US, the UK and the Soviet Union, but not by France and China. It placed the responsibility for supervising non-proliferation on IAEA. This was the moment to explore «a new avenue of peace» to be «constructive, not destructive»[31].



C O P Y 9/30/54

CHRONOLOGY - "Atoms for Peace" Project

1. Early April, 1953, discussion of "Candor". Official NSC and Presidential instruction late May. Purpose -- fuller disclosure.

2. Many drafts of Candor through September -- none satisfactory because they either told too much or too little and were uniformly dull. During this time mounting columnist hue and cry, led by Alsops, referring to Candor (9/9) and disclosing much draft material.

3. Moratorium pending new idea.

4. Mid-September 1953, new draft, largely inspired by Radford -- including tremendous recital U.S. atomic might -- "one atomic bomb equal to all bombs dropped by all allies on Germany during the war" kind of stuff.

Fig. 2 'Chronology of Atoms for Peace Project, [C.D. Jackson Papers, Box 29, Atoms for Peace-Evolution (1); NAID #12022913]', 30 September 1954. Eisenhower Presidential Library.

www.eisenhowerlibrary.gov

One of the most successful examples of science diplomacy is the European Organization for Nuclear Research (CERN), an example of a multinationalism of thought and a logic without borders, when science and technology meets diplomacy, through a new intersectional approach[32]. CERN was set in 1954 as the first multilateral **European collaboration in Big Science**. It was a fusion of science, technology and engineering. «Jobs and comfort came from American uranium», the message went[33]. Through the «Marshall Plan for Science», the United States helps the foundation of CERN scientific laboratory, in line with its geopolitical interests, removing the risk of nuclear proliferation through independent national research projects. In Western Europe, the growth of Big

[31] KRIGE J., 2006, *Atoms for Peace, Scientific Internationalism, and Scientific Intelligence*, in *Osiris, Science and Technology in International Affairs*, 21, p.161.
[32] CAPRARA G., 2022, *ExPoST ID Spring School - Università Degli Studi Di Padova e Roma 3*, Padova.
[33] LAVINE M., 2015, *Radiation in the Postwar American Mind. From Wonder to Worry*, https://theconversation.com/radiation-in-the-postwar-american-mind-from-wonder-to-worry-41069 (consulted in September 2021).

Science was conditional upon the willingness of European governments to cooperate[34]. The history of collaborative European Big Science projects was possible also through the political and diplomatic conditions at the time of realization. Big Science facilities are conceived as answers to specific needs, brought to a political level by scientific lobbying efforts, because of negotiation and cooperation. In countries whose scientists and governments had an interest not in preparing for a third world war hut in rebuilding themselves on the ruins of the second, the atom was an opportunity, a symbol of modernity and a better world to come, and nuclear power a promise for energy and independence[35].

By the time Eisenhower made Atoms for Peace an essential feature of **U.S. foreign policy**. The political logic that underlines this choice was the immense importance of atomic energy for the ending of World War II.

The launch of Sputnik exacerbated the arms race and Cold War tensions. During the 1950s, both the United States and the Soviet Union were developing new technology. President Eisenhower put additional funds and resources into the space program. Eisenhower supported a doctrine of **massive retaliation**, to develop the necessary technologic system to surpass Soviet nuclear capability. On January 31, 1958, the United States succeeded in launching its first satellite, the *Explorer*. NASA made use of the already existing vectors Vanguard, Juno, Redstone, Thor and Atlas, born for the need of defense but now precious for space exploration[36]. The Pioneer 3 probe reached the record distance from Earth of 102,000 km and it was discovered that the Van Allen belts which enveloped the Earth protecting it were three at different heights, and not just one[37]. The Soviets responded with yet another launch and the satellite race continued.

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[34] HALLONSTEN O., 2014, *The politics of European collaboration in big science. The Global Politics of Science and Technology*, 2, Berlin, Springer, p.32. https://www.researchgate.net/publication/300335019_The_Politics_of_European_Collaboration_in_Big_Science (consulted in September 2021).

[35] KRIGE J., 2006, *Atoms for Peace, Scientific Internationalism, and Scientific Intelligence*, in *Osiris, Science and Technology in International Affairs*, 21, p. 170.

[36] CAPRARA G., 2021, *Breve Storia Dello Spazio*, Milano, Salani p. 86.

[37] *Ibidem.*

1.4. TECHNOLOGY OF SURVEILLANCE

In the 1960s, equipment transmitting and receiving signals was used by experts who had first used radio pulses in military operations during the war. Signal propagation represented an essential part of devices used for the navigation of aircraft and satellites and missile operations. When the Sputnik began to send radio pulse, it was strategic finding a way for tracking the satellites. United States Air Force (USAF) was assigned for the constant surveillance on space objects. In this context, the word «environment» defined a natural space in a topographical sense to map nature for **warfare purposes**.

In Europe and the United States, the advent of industrialisation led to the gradual awareness of the potential destruction of the nature. One of the effects of bombardments during the World Wars is how the urban landscape had been transformed. The use of these images or real-time footage has a **dual use**: it can serve both as **military** and **environmental protection**. The US government became the main sponsor for environmental research because of its importance in the Cold War. Meteorologists and oceanographers were recruited in military research organizations to monitor how weather factors and sea changes influenced military operations. For example, testing of nuclear explosions would cause earthquakes and massive perturbations in the atmosphere. The connection between nuclear weapons and weather monitoring represents **one of the most evident examples of co-production**.

Alessandro Politi stresses that by time satellites, drones and electronic wiretapping are constantly evolving video surveillance technologies that provide solutions and problems that were not there before. They reduce the costs of information collection, shortening decision-making times, and consist of an immense amount of information to be filtered. However, a piece of information or a photo without context analysis is misleading. The most important part of the process is to verify the information, otherwise, the questions left open are for mere speculation[38].

[38] POLITI A., 2022, *L'Artico Dopo La Guerra in Ucraina*, Rome, SIOI, consulted in September 2021.

Simone Turchetti underlines how the term «remote sensing» describes the use of technological devices as electronic eyes and ears to «sense» from distance the world around us[39]. The innovative feature here was its **remoteness**.

1.5. ENVIRONMENT

Topography, climate and vegetation are three characteristics in common between the Great Plans in North America and the Steppes in Russia. They share similar environments: semi-arid grasslands, prone to droughts, high winds, fertile soils. In both countries, agricultural settlers received advice from their governments and institutions established to produce scientific expertise to support the **agricultural development** of the grasslands[40]. The main institutions were the United States Department of Agriculture (USDA), agricultural universities, agricultural and forestry experiment stations and their counterparts in the Russian Empire and the Soviet Union. Many agricultural scientists conducted fieldwork to assist them. Some American scientists became aware of this Russian prior experience, recognizing it could be useful in the Great Plains too. This learning process took time because of **cultural barriers**. A significant barrier was a widespread prejudice among Americans that their state could have little to learn from a technologically and industrialised backward country. Transfers from the steppes to the Great Plains are not only due to environmental similarities, but also to a **human dimension** involving the choices made by people to settle in these unfamiliar environments.

The Cold War was a time of effective use of science diplomacy. The objective was to create a double track between national rivalries: to build bridges and dialogue despite the atmosphere of great political tensions. Scientific exchanges between civilian researchers from the USSR and the US were never interrupted.

During «post-Cold War period», the relationships between science and foreign policy saw a new dawn. The «post-Cold War» period was a time when some unresolved issues of the Cold War were clarified. For example, a thorny question was raised: the reintegration into civilian activities of staff employed by the USSR and its allies in the production of chemical, biological and nuclear weapons. The

[39] TURCHETTI S., 2018, *Greening the alliance. The diplomacy of NATO's science and environmental initiatives*, Chicago, University of Chicago Press p. 2.

[40] MOON D., 2020, *The American steppes. The unexpected Russian roots of Great Plains agriculture, 1870s–1930s*, Cambridge, Cambridge University Press.

future of these researchers, engineers and technicians of the military-industrial complex was a deep concern for Western governments, who feared that they could offer their skills and competences to «hostile» countries, for example North Korea, Iran or Libya. Following a US-Russian initiative in 1992, a new intergovernmental organization was created: the International Science and Technology Center (ISTC). Its key-mission was «to give weapons scientists and engineers, particularly those who possess knowledge and skills related to weapons of mass destruction or missile delivery systems [...] to redirect their talents to peaceful activities». I consider as an extraordinary success that, over the 1994–2014 period, more than 75,000 researchers and technicians of the beneficiary countries (Russia with other ex USSR satellites states) were funded by the programs of the Centre.

The end of the bipolarity of the world opened new landscapes for science and diplomacy in international relations. The fall of the Berlin Wall removed the general paranoia of nuclear war.

An Italian song suggests that «certain loves make immense turns and then return». On the contrary, some dormant conflictual tensions broke out with the 2014 Russian annexation of Crimea, marking a significant deterioration of US-Russia relations. External conflict dynamics to the Arctic had both direct and indirect effects on Arctic cooperation, but Russian-Western cooperation in the Arctic remained mild. It was in February 2022, after Russia's invasion of Ukraine, that A7 – Canada, the Kingdom of Denmark, Finland, Iceland, Norway, Sweden, and the United States – paused their participation in meetings of the Arctic Council, currently chaired by Russia. This lack of agreement is due to defence, security and geopolitical strategy to deal with Russia in the Arctic. However, it negatively affected Arctic cooperation to change climate change globally and went to a opposite direction from Antarctica.

In the pages of *Cosmos: A Sketch of a Physical Description of the Universe* (1845), Alexander von Humboldt, a German scientist and explorer, stated that the study of nature was inseparable from the study of the mind in its material, social and cultural context. However, **natural resources** have been considered as a part of the environment to extract and exploit for human purposes. In *The Mental and the*

Material (1986), a French anthropologist, Maurice Godelier, develops the concept that: «Humans have the unique capacity to appropriate and transform nature»[41].
In the post-war period, the industrializing countries dominated the global market. Since the great acceleration of the 1950s, ecosystems are threatened by the increasing economic exploitation of natural resources. Understanding the interrelations between resource use and social factors is important when societies must change long-established patterns of unsustainable resource use and societal inequality[42]. These insights are of high relevance for **global environmental justice**. Complex relations between resources and labour emerged in international debates and historical studies.

1.6. TREATIES

After World War II, many states tried to advance the Antarctica question. Territorial interests of Antarctica-claimant countries and the geopolitical interests of the United States and the Soviet Union were the main factors for excluding military action on Antarctica. In 1957–1958, twelve countries agreed to cooperate to limit any political activity. The United States proposed a multilateral treaty to let Antarctica as an international laboratory for scientific researchers. The main objective was to ensure that it was used **only for peaceful purposes**. The Antarctic, in many ways, represents **the apex** of post–World War II **science diplomacy**[43].
Both the Outer Space Treaty and the Antarctic Treaty were signed in the early years of the Cold War and were initially relevant to a fairly small number of states, though this number increased as more states became involved in either outer space or Antarctica[44].
When the satellite telecommunications industry grew, private interests in the exploitation of space resources have exposed many gaps in the current legal framework.

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[41] GODELIER M., 1986, *The Mental and the Material*, 2002nd ed., London - New York, Verso books, p. 2.
[42] BARBIER E. B., 2019, *Natural Resource-Based Economic Development in History*, p. 49, Cambridge, Cambridge University Press, https://doi.org/doi:10.1017/9781316875681.003 (consulted in September 2021).
[43] GLUCKMAN P. D. - TUREKIAN V. C. - GRIMES R. W. - KISHI T., 2018, *Science Diplomacy. A Pragmatic Perspective from the Inside*, in *Science & Diplomacy*, 6, 4, p. 14.
[44] REED J., 2017, *Cold War Treaties in a New World. The Inevitable End of the Outer Space and Antarctic Treaty Systems*, in *Air and Space Law*, 42, p. 466.

The UN-sponsored treaties that set the rules for exploration and use of outer space were drafted during the Cold War era at a time when all human activity in space was conducted by state actors[45]. So, space treaties were seen as a legal instrument to set the rules of the game of the Cold War.
The COPUOS treaties commonly referred to as the «five United Nations treaties on outer space»:

- The 1967 «*Outer Space Treaty*»: the Treaty regulated extra-terrestrial activity for all and established **the impossibility of claiming property rights on extra-planetary resources**.
- The «*Rescue Agreement*» (1968): the Agreement provides that States shall take **all possible steps to rescue and assist astronauts in distress** and promptly return them to the launching State, and that States shall, upon request, provide assistance to launching States in recovering space objects that return to Earth outside the territory of the Launching State[46].
- The «*Liability Convention*» (1972): the Liability Convention affirms that a launching State shall be **absolutely liable to pay compensation for damage** caused by its space objects on the surface of the Earth or to aircraft, and liable for damage due to its faults in space[47].
- The «*Registration Convention*» (1975): it is a convention on «*Registration of Objects Launched into Outer Space*». Its main function is to address issues relating to **States Parties' responsibilities concerning their space objects**. The Online Index of Objects Launched into Outer Space provides a means to access information provided to the United Nations in accordance with this Convention[48].

[45] Georgetown University website, https://guides.ll.georgetown.edu (consulted on 27/09/2021).
[46] UNOOSA, https://www.unoosa.org (consulted on 27/09/2021).
[47] *Ibidem.*
[48] *Ibidem.*

- The «*Moon Agreement*» (1979): the Agreement reaffirms that the Moon and other celestial bodies should be used exclusively for peaceful purposes. The Agreement also **forbids the use or threat of use of force**, or **any other hostile action or threat on the Moon**, in relation to the Earth, the Moon, spacecraft, the personnel of spacecraft or man-made space objects[49]. In addition, the Agreement affirmed that the Moon and its **natural resources are the common heritage of mankind**.

Principles and guidelines adopted by the UN General Assembly and by UN agencies produce also **soft law instruments**. Although not legally binding, these principles and guidelines are adopted by states and by non-state actors[50]. The UN Office of Outer Space Affairs has identified the following **five declarations and legal principles** of the «five United Nations treaties on outer space»:

1. The «*Declaration of Legal Principles*» (1963)

The 1963 Declaration is concerned with **the freedom of all States to explore outer space**. However, it establishes broad principles concerning the **responsibility** of States and international organizations for activities in outer space, jurisdiction and control of objects launched, re-entry, landing and return of astronauts and vehicles, and liability for injury or damage caused by space vehicles[51].

2. The «*Broadcasting Principles*» (1982)

Activities in the field of international direct television broadcasting by satellite should be in line with the **sovereign rights** of States, as well as with **the right of everyone to seek, receive and impart information and ideas**. Such activities should promote the mutual exchange of information and knowledge in cultural and scientific fields for the strengthening of friendly relations among all States.

3. The «*Remote Sensing Principles*» (1986)

[49] The Nuclear Threat Initiative, https://www.nti.org (consulted on 27/09/2021).
[50] Georgetown University website, https://guides.ll.georgetown.edu (consulted on 27/09/2021).
[51] Space Legal Issues, https://www.spacelegalissues.com (consulted on 27/09/2021).

Remote sensing is a way of collecting and analysing data to get information about an object without the instrument used to collect the data being in direct contact with the object.
In *remote sensing*, three elements are essential[52]:

I. a **platform** to hold the instrument
II. a **target object** to be observed
III. an instrument or **a sensor** to observe the target

The main purpose of remote sensing systems is the information that is obtained from the acquired data, and how it is used and stored. **Remote sensing activities shall be conducted in accordance with international law**, including the Charter of the United Nations, the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, and the relevant instruments of the International Telecommunication Union[53].

4. The «*Nuclear Power Sources Principles»* (1992)

Guidelines and criteria for **safe use** are laid down not to ban the use of nuclear power, but to minimize the quantity of radioactive material in space and the risks involved.

5. The «*Benefits Declaration*» (1996)

This is the Declaration on international cooperation in **the exploration and use of Outer Space for the benefit and in the interest of all states**, focusing on the needs of Developing Countries. Considering the needs of developing countries, international cooperation should achieve these goals:

a) Promoting the development of space science and technology and of its applications;
b) Fostering the development of space capabilities in interested States;

[52] ESA, https://www.esa.int (consulted on 27/09/2021).
[53] UNOOSA, www.unoosa.org (consulted on 27/09/2021).

c) Facilitating the exchange of know-how and technology among States on a mutually acceptable basis.

Among other multilateral treaties on outer space, the «Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space, and Under Water», signed by President Kennedy in 1963, prohibits nuclear weapons tests «or any other nuclear explosion» in the atmosphere, in outer space and underwater. Since 1957 when the Soviet Union launched a satellite, the exploration of outer space has raised many questions crucial to the peace and security of the world. President Kennedy and Chruščëv accepted these limitations on nuclear testing on behalf of their countries because of the fear of mutual destruction required for Mutual assured destruction (MAD), the military strategy and national security policy.

In the late 1960s, Vikram Sarabhai became the scientific chairperson of the UN Committee on Peaceful Uses of Outer Space. The Indian physicist and astronomer was considered as the father of India's space program since he was the person who began space research and developed nuclear power in India. In 1962, the astronomer established the Indian National Committee for Space Research, now renamed as the Indian Space Research Organization (ISRO). He was also known as a guru for world peace and disarmament. Sarabhai met national leaders, such as Mahatma Gandhi, Jawaharlal Nehru and Nehru's daughter Indira Gandhi[54]. He was also elected President of the fourteenth general Conference of the International Atomic Energy Agency (IAEA), promoting pacific use and space application. So, he naturally became the ambassador for NASA's peaceful programs in developing countries across the world. The distinguished Indian nuclear physicist Homi J. Bhabha presided over the twelve-day meeting. It was attended by more than 1,400 delegates from seventy-three countries, by almost as many observers, and by more than 900 journalists[55].

The relations between United States and India in the civilian aspects of space started in 1957, in Northern India, when it started a collaboration in the field of optical tracking of satellites. The technical equipment provided was a highly specialized

[54] NASA, https://history.nasa.gov (consulted on 27/09/2021).

[55] KRIGE J., 2006, *Atoms for Peace, Scientific Internationalism, and Scientific Intelligence*, in *Osiris, Science and Technology in International Affairs*, 21, p.174.

satellite tracking camera and a quartz clock. On November 1963, the launch of a Nike Apache sounding rocket donated by NASA was the starting point of the Indian space program. In 1970, the Satellite Instructional Television Experiment (SITE), another impressive international project to bring educational television, produced locally and dealing with local needs in rural areas. For the United States it served a variety of political and economic needs. It promoted the modernization of India as an alternative model to China for developing countries[56].

Since the establishment of a communist regime in China, the first visit of a US president to the People's Republic of China took place in 1972. This was a highly significant event diplomatically[57]. During their meeting in Shanghai, Richard Nixon and Mao Zedong agreed to make science an area of cooperation. In the same year, during the US-Soviet summit, Richard Nixon and Leonid Bréžnev signed five major agreements for cooperation in science and technology.

1.7. INSTITUTIONS

NATO (1949)

According to the first Secretary General Lord Hastings Ismay, the aim of **NATO** was «to keep the Russians out, the Americans in, and the Germans down» and emphasized the importance of trans-Atlantic relations between the U.S. and Europe.[58] NATO was established by President Truman in 1949, through the North Atlantic Treaty, because of the need for collective defence against URSS. While in the far East, also in the year 1949, Mao Zedong took power and proclaimed the People's Republic of China.

At the beginning of NATO's Science Diplomacy, it was Howard Percy Robertson, Isidor Isaac Rabi, Norman Ramsey and Solly Zuckerman who took responsibility for generating consensus on NATO's science program. Their convergence in thinking and planning echoed the improvement in political relations between their representative states[59]. US and British science diplomats worked together toward a

[56] KRIGE J. - LONG CALLAHAN A. - MAHARAJ A., 2013, *NASA in the world. 50 years of international collaboration in space*, London, Palgrave MacMillan p. 237.

[57] RUFFINI P. B., 2017, *Science and Diplomacy. A New Dimension of International Relations*, Berlin, Springer, p. 87.

[58] UNC Center for European Studies, https://europe.unc.edu (consulted on 12/10/2021).

[59] TURCHETTI S., 2018, *Greening the alliance. The diplomacy of NATO's science and environmental initiatives*, Chicago, University of Chicago Press p. 32.

NATO agenda that priorities defence needs. The four scientists together worked to promote **American values in scientific cooperation**: «Anti-Communist but not populist, nationalistic but not jingoist, firmly convinced that the US, whatever it flaws, had its key roles in defending the Free World».

In the first period, the focus was on radio pulses, oceanography, meteorology, due to its urgent surveillance ambitions. Military was the leading customer for the product of scientific R&D.

The race for the **dominion of Earth from space** began when Sputnik started to send **radio pulses** from space. Established in 1947, **signal propagation** has a tradition started with Guglielmo Marconi. US physicist Jules Aarons of the Geophysicist Research Directorate made the Spacetrack the focus of international collaboration for the navigation of aircrafts and satellites, the identification and tracking of enemy forces and missiles.

Sharing information on the physical properties of the **atmosphere** became vital to build a NATO-wide detection system. Rainmaking, hail busting, fog lifting, snowpack enhancing, lightning suppressing, hurricane snuffing…**weather control**[60]. The VKC environmental warfare panel met in 1962, when the nuclear scientist Edward Teller argued the merits of generating perturbations on enemy's communications and defence. In 1962, the U.S. military launched Project *Stormfury*, an attempt by researchers at the Naval Ordinance Test Station (NOTS) to test weather control by seeding the clouds of tropical cyclones[61].

A thalassocracy is a maritime supremacy. After the British Maritime Empire, United States replaced its role as the first world power to inhabit between two oceans - the Atlantic and the Pacific. During the Cold War, **oceanography** was intended as global ocean surveillance. For much of the 1950s and 1960s the direct role of the National Institute of Oceanography was to assist the Royal Navy in designing improved technologies and methodologies for anti-submarine warfare, especially after the Cuban missile crisis. Naval power cannot be improvised: you

[60] HARPER K. C., 2008, *Climate Control. United States Weather Modification in the Cold War and Beyond*, in *Endeavour*, 32, 1, pp. 20–26.

[61] DENTON A., 2018, *Ecological Militarism. The Unusual History of the Military's Relationship with Climate Change*, in *Historical Climatology*, https://www.historicalclimatology.com/features/category/weather-modification (consulted in October 2021).

must think long term, technology is useful but that is not all, and above all it takes a maritime population. Gary Weir's book, *A Ocean in common, American Naval Officers, Scientists, and the Ocean environment* provides the history of how, during the period 1914-60, the U.S. Navy evolved from a craft knowledge of the ocean, derived from experience and tradition to measurements, tracings and scientists' advice. But the Ocean Model attributes worth to all cultures insofar as they are all constitutive of one human civilisation encapsulating a common human story[62].

In 1956, the North Atlantic Council endorsed a report to enhance non-military cooperation and coordination within NATO. It addressed political, economic and cultural aspects and encompassed questions directed at scientific cooperation[63]. Three Ministers were therefore appointed to submit a report and advise the Council on ways to improve NATO cooperation in non-military fields. The three ministers selected were Lester B. Pearson, Foreign Minister of Canada, Gaetano Martino, Foreign Minister of Italy, and Halvard Lange, Foreign Minister of Norway. They were also called as the *Three Wise Men*.

Fig. 3 - Lester B. Pearson, Foreign Minister of Canada, Gaetano Martino, Foreign Minister of Italy, and Halvard Lange, Foreign Minister of Norway. They soon became known as the Three Wise Men. (NATO)

This Keynote, addressed by NATO Secretary General Jens Stoltenberg, celebrated the 60th anniversary of the Three Wise Men Report:

> The report helped to change NATO from being almost entirely a military alliance into a political-military alliance. That might sound like a subtle difference. But it has made a

[62] OxPol, University of Oxford, https://blog.politics.ox.ac.uk (consulted on 13/10/2021).
[63] NATO, https://www.nato.int (consulted on 13/10/2021).

> profound difference. The Three Wise Men helped to ensure that NATO is what it is today. That our Alliance has continued to adapt. And remains as important as ever. […] Consensus is not always easy. And sometimes it may take a lot of time; And I can see a lot of people in the room that knows everything about that. But consensus is the basis for the strength of the Alliance and when 28 democracies come to consensus, we can move forward and take action as a strong Alliance. So consensus and unity are two sides of the same coin.

NASA (1959)

International scientific collaboration goes hand in hand with foreign policy. NASA's foundation was related to the pressures of national defense and at the same time an arm of American diplomacy. In reaction to the launch of Sputnik, the National Aeronautics and Space Act of 1958, signed by President Dwight Eisenhower, established the National Aeronautics and Space Administration (NASA), an independent agency that is not part of any executive departments, but report directly to the President[64]. Eisenhower signed the *National Aeronautics and Space Act*, giving birth to «an Act to provide for research into the problems of flight within and outside the Earth's atmosphere, and for other purposes».

The Congress and the President of the United States established the National Aeronautics and Space Administration (NASA) on October 1, 1958.

In 1959, Arnold **Frutkin** joined NASA from National Academy of Science (NAS), where he had been the deputy director of the US National Committee for the International Geophysical Year and advisor for the first meeting of Committee on Space Research (COSPAR). He served eighteen years as director of NASA’s Office of International Programs.

Frutkin laid down the basic principles that guided **NASA’s international collaboration projects** for two decades in which the US was the leading space power in the free world, for example, the principle of «clean technological and managerial interfaces» – **to secure American pre-eminence while sharing knowledge and skills** that foreign partners still valued[65]. NASA- India relations began with the establishment of satellite tracking stations and space science. NASA’s cooperation with Japan began during the late 1970’s, in human space flight and participation in the International Space Station[66].

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[64] TANTARDINI M., 2021, *One Word, Multiple Identities*, in *Longitude* (the Italian Monthly on World Affairs), 118, pp. 26–27.

[65] KRIGE J. - LONG CALLAHAN A. - MAHARAJ A., 2013, *NASA in the world. 50 years of international collaboration in space*, London, Palgrave MacMillan, p. 185.

[66] *Ibidem*.

John Krige distinguished in Western Europe collaboration in space from technological collaboration. Clean interface and no exchange of funds are relatively easy to respect in space science; the management of knowledge and dollar flows is far more contentious in advanced technological collaboration. Four are the major Western European countries: Britain, France, Italy and West Germany. In the 1960s, Helios was one of the most ambitious joint projects agreed to between NASA and a foreign partner, Germany, to send two probes built in West Germany to within 45 million kilometres of the Sun. Long negotiations initiated by NASA administrator Tom Paine in 1969 to engage European allies in the post-Apollo program, after the President Nixon speech to the United Nations calling for an internationalization of space missions. This process is important in the light of reducing the conflict due to the **technological gap**, the blame for European supposed «backwardness». Two barriers to collaboration: French ambitions on national strategic nuclear delivery capability by President de Gaulle and Intelsat's mission. The negotiations over the Intelsat agreement emphasized the European vulnerability. President Kennedy proposed the establishment of a single, global communication system. The *Communication Satellite Act* authorized Comsat, a private corporation that deals with the US portion, to plan and construct with foreign governments a commercial communication satellite system. The Europeans were concerned of the American dominance in Comsat through the Comsat's dual role in defining policies and monitoring the system. Italian Ambassador Edigio Ortona suggested that the global Comsat system should be managed by a world organization, but the Unites Stated refused this proposal. However, in terms of economic budget, the Europeans had little choice but accept it. In the late 1960s, the debate was dominated by technological gap issues, so NASA was convinced to favor technological sharing with European industries. In 1971, the anomaly that Comsat was both the arm of US national interests and the manager of the space sector was removed.

The *San Marco* project was one of the most important international NASA programs. Luigi Broglio discussed the *San Marco* project at the COSPAR meeting in Florence in 1961. NASA provided to Italy technical and support in all aspects of satellite construction and integration, tracking and data analysis. The birth of a technical and scientific school for space applications is tied to a single name, that of Luigi Broglio, a brilliant and competent scientist and engineer, who ensured the collaboration of the Aeronautica Militare (AM) thanks to his double role as Lieutenant Colonel of the AM and Dean of the Scuola di Ingegneria Aerospaziale of the University of Rome, founded in 1952 at the Aeroporto dell'Urbe[67]. The beginning of the Italian national space programme was an initiative of Edoardo Amaldi and Luigi Broglio, of the Commissione per le Ricerche Spaziali (CRS), in 1959.

There is a solid tradition of bilateral agreements with the NASA, the American space agency, which was established already in the 1960's[68].

Important relationships and agreements were concluded not only with Italy, but also with other national agencies and governments, such as Roscosmos (Russian Federation), JAXA (Japan), CONAE (Argentina), ISA (Israel), Kenya (through the *Luigi Broglio* space station in Malindi), ISRO (India), CNSA, CAS and CMSA (China), EAU (United Arab Emirates), CSA (Canada), BSA (Brazil), AMS (Mexico), KARI (Korea), GISDTA (Thailand).

The legal and diplomatic architecture of bilateral and multilateral, inter-governmental and inter-institutional partnerships that constitute the coordination of the International Space Station (ISS), is the most successful example in practice of science diplomacy.

COPUOS (1959)

A commitment to **the peaceful use of outer space** was essential to the exploitation of space for civilian scientific programs on both a national and international level. The Committee on the Peaceful Uses of Outer Space constitutes one of the first international public forum to exchange information in the field of space cooperation.

Eilene Galloway, who was involved in the Space Act, stated that «the emphasis on peaceful use was intended to preserve space as a dependable orderly place for

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[67] DE MARIA M. - ORLANDO L. - PIGLIACELLI F., 2003, *HSR-30, Italy in Space 1946–1988*, R.A. Harris. ESA. p. 2. https://www.esa.int/esapub/hsr/HSR_30.pdf.

[68] Italian Space Agency, https://www.asi.it/en/the-agency/asi-in-the-world/the-asi-and-its-international-relationships/ (consulted in October 2021).

beneficial pursuits»[69]. No clear definition of peaceful use of outer space was laid by COPUOS. This is because of the immense importance of military space programs and, above all, the role of intelligence satellites. The term *peaceful* concerning outer space was interpreted by the US to mean «non-aggressive» rather than «non-military».

At the time, there was a growing concern in the international community that space might become yet another field for intense rivalries between the superpowers or would be left for exploitation by a limited number of countries with the necessary resources.

The United States moved rapidly to set up an international regime forbidding the militarization of space, with the *ad hoc* committee becoming a regular committee in 1959. COPUOS was set up by the General Assembly of the United Nations to govern the exploration and use of space for the benefit of all humanity: for peace, security and development[70].

The **United Nations Office for Outer Space Affairs (UNOOSA)** was formed as a small team to support the COPUOS and was established by the General Assembly in 1958[71].

Since the beginning of the space age, triggered by the launch of Sputnik I in 1957, the United Nations has accorded significant importance to the promotion of greater international collaboration in outer space[72], in terms of peaceful use and exploration of space. The Office assists any United Nations Member States to establish legal and regulatory frameworks to legislate on space activities, helping to integrate space capabilities into national development programmes.

UNOOSA listed 45 national and 3 regional space agencies. According to the Collins dictionary, an agency is a government organization responsible for a certain area of administration. Founded at different historical times and answering specific needs in a peculiar environment and institutional framework, each space agency has its

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[69] *Ibidem*, p. 7.

[70] UNOOSA, http://www.unoosa.org (consulted on 27/09/2021).

[71] The unit was moved to support the Department of Political and Security Council Affairs in 1962 and was transformed into the Outer Space Affairs Division of that Department in 1968.

[72] CHIRIATTI A. - HEDMAN N., 2021, *Spring School in Diplomazia Tecno-Scientifica ExPoST Italian Diplomacy Esperti e Politici in Scienza e Tecnologia in Italia per Una Diplomazia Multilaterale Preventiva*, Università degli Studi di Padova (4-8 aprile 2022) e Università degli Studi Roma Tre (26-29 aprile 2022).

own statute, which impacts on its values and the organization and, ultimately, on the objectives it is tasked to achieve[73].

THE SOVIET SPACE PROGRAM (1955- 1991)

The Soviet Union had not a space agency, but several competing experimental design bureaux and the council of designers[74]. The space program was tied with Five-Year Plans and the Soviet military. In 1992, President Boris Yeltsin signed a decree that let the creation of *Roscosmos*, the first agency of the Russian Federation. In the meanwhile, in 1993, the People's Republic of China formed the China National Space Administration (CNSA) and the China Manned Space Agency (CMSA).

During the Stalin era, more precisely on the night of October 22, 1946, after having assembled about thirty V2, 7000 scientists, engineers, technicians of different backgrounds with their families were deported on 92 trains to the Soviet Union, where they were forced to work in various fields of technology: aviation, nuclear, rocket, communications, chemical and electrical engineering[75]. 150 of these deportees were rocket specialists and they were confined in a small island for six years.

Sergej Pavlovič Korolëv was born in Ukraine and was arrested in 1938 after Stalin's Great Purge. According to NASA, Korolëv was identified by Sergej Tupolev, a famous aircraft designer who was in *gulag*[76] too, who requested for his collaboration in his projects. Now, Sergej Korolëv was the chief builder of the Soviet Union's space program. During his tenure, Korolëv was the man responsible for the first satellite, *Sputnik* (1957), the first human in space, Jurij Gagarin (1961), and *Luna 9*, the first spacecraft to achieve a soft landing on the moon (1966)[77].

While the world assisted to his technological achievements, Korolëv remained in total mystery until his death. His identity was kept secret as were many activities of

[73] TANTARDINI M., 2021, *One Word, Multiple Identities*, in *Longitude* (the Italian Monthly on World Affairs), 118, pp. 26–27.
[74] *Ibidem.*
[75] CAPRARA G., 2021, *Breve storia dello spazio*, Milano, Adriano Salani Editore, p. 63.
[76] In USSR, from the 1937 to 1952, the best intelligences were locked up in the gulags, as a prisoner-of-war job-detention.
[77] https://www.space.com (consulted February/2022).

the Soviet space program. This contrasted with NASA and the United States, which publicly report its achievements and failures to the world.

1.8. THE SPACE RACE – 1969 AS A TURNING POINT

The launch of *Sputnik I* shocked many Americans, who had assumed that their country was technologically ahead of the Soviet Union and led to the «space race» between the two countries. The *Sputnik*, which means «fellow traveller» and «satellite» in Russian, marked the Soviet entry in the scientific and technological race. After the *missile* race, it started a *satellite* race between the two superpowers, that ended in the *space* race.

Tab. 2 – Key moments of the space race.

August 2, 1955	The USSR intended to challenge the US government's announcement that they set the objective to launch the first satellite into space.
October 4, 1957	The USSR launched Sputnik I, the first Earth-orbiting satellite in history.
November 3, 1957	The USSR launched Sputnik II, this was the first mission sending a dog, Laika, into orbit.
January 31, 1958	The US launched Explorer 1, representing the first US satellite to reach orbit. the most important experiment on board measured the level of cosmic radiation along the orbit and was prepared by physicist James Van Allen, with his student Wei Ching Lin. Explorer 1 was designed to investigate the cosmic environment.
October 1, 1958	The National Aeronautics and Space Administration (NASA) replaced the National Advisory Committee on Aeronautics (NACA).
December 18, 1958	The US launch SCORE, the first communication satellite in the world.
January 2, 1959	The USSR launches Luna 1, known as the first «cosmic rocket», the first object made by humans to leave the orbit of the Earth and orbit the sun instead.

August 2, 1959	The US launches Explorer 6, the world's first weather satellite, taking the first images of Earth from space.
September 12, 1959	The USSR launches Luna 2, considered the first spacecraft to the Moon.
January 31, 1961	Ham, a chimpanzee, becomes the first hominid in space sent by US.
April 12, 1961	The Soviet Union achieved a relevant success in the Space Race, when Gagarin makes a single orbit around the Earth and becomes the first man to reach space.
September 12, 1962	The 35th U.S. President John F. Kennedy delivered a speech before a joint session of Congress. This speech is also known as the «Moon speech».

Fig. 4 - President John F. Kennedy with second Soviet cosmonaut German Titov (right) and the first American astronaut to orbit Earth, John Glenn (left), May 1962. Photo illustration by Angela Church for Supercluster.

President Kennedy challenged the nation to land astronauts on the moon by the end of the decade. 1960s represent the Golden years for space investments and research. The history of formalized Soviet-American cooperation in space might well be traced to letters and public pronouncements between President John F. Kennedy and Soviet premier Nikita Chruščëv[78]. Kennedy proposed a joint lunar mission to President Chruščëv, as a sort of «benign hypocrisy». Moreover, the agreement to cooperate was «for the benefit of humankind». This proposal represented a request for coordination, not an integration of effort.

In 1969, NASA met that challenge with the Apollo program. It resulted in American astronauts' making a total of eleven spaceflights. NASA Administrators involved James Webb (1961 – 1968) and Thomas Paine (1969 – 1970).

APOLLO'S GOALS

1. Establishing the technology to meet other national interests in space;
2. Achieving pre-eminence in space for the United States;
3. Carrying out a program of scientific exploration of the Moon;
4. Developing human capability to work in the lunar environment.

On *July 20, 1969*, the Apollo 11 crew successfully completed the goal set by President Kennedy.

On *July 16*, 1969, Apollo 11 Commander Neil Armstrong and lunar module pilot Buzz Aldrin left on the Moon this writing: «We came in peace for all mankind».

[78] KRIGE J. - LONG CALLAHAN A. - MAHARAJ A., 2013, *NASA in the world: 50 years of international collaboration in space*, London, Palgrave MacMillan, p. 128.

2. EXPLORING NEW SPACE APPLICATIONS

2.1. NEW ACTORS IN SCIENCE AND POLITICS

Apollo 11 represented one of the most celebrated scientific and technological missions in history. The 1960s were the «Golden Age» where the present has been perceived in a linear process in the line of achievements based on a positivist point of view. On the contrary, on 20th July 1969, when man landed on the Moon, humankind never felt so small as in front of the vastity of the universe. Then the decade finished, and the 1970s took a «wind of change» and humanity rediscovered a new present laid on a new political awareness, based on decolonization, development, democratization, de-monopolization, disarmament.

The shifts were profound and concerned many fields: motivation, actors, contents, roles, technologies, space environment, commercialisation, market development, global setup, national activities.

To identify the different science diplomacy stakeholders (Fig. 5)[79]:

- *Governmental stakeholders*: nation states and subnational governments in science diplomacy;
- *Intergovernmental and supranational stakeholders*: multilateral international and supranational organisations that transcend national boundaries, engaging in global governance;
- *Research and academic stakeholders*: from research councils to universities, research centres, national academies, learned societies, and also, individual researchers;
- *Private sector stakeholders*: private companies, which can be trans- or multi-national companies as well as Small and Medium Enterprises (SMEs);
- *Civil society stakeholders*: national and transnational NGOs, civil society organisations, private charities, and even individuals.

[79] MELCHOR L. - LACUNZA I. - ELORZA A. - MCGRATH P. - RUNGIUS C. - FLINK T. - AUKES E., 2021, *What is Science Diplomacy?*, S4D4C European Science Diplomacy Online Course, https://www.s4d4c.eu/courses/s4d4c-european-science-diplomacy-online-course/ (consulted in October 2021).

Fig. 5 - The different Science Diplomacy stakeholders (Horizon 2020-funded project «Using science for/in diplomacy for addressing global challenges» (S4D4C))

This actors' constellation forms the scientific collaboration world, how the scientific system works, and the dynamics of international relations. Science diplomacy includes not only scientists, engineers, and epistemic communities, but also politics, diplomats, businessmen.

❖ *Top-down approach*

In 1972, the United Nations Conference on the Environment in Stockholm was the first international conference to make the environment a primary issue. Since Stockholm, numerous multilateral agreements have developed a range of operational guidelines, targets, and standards. Since the 1970s, the impact of international environmental agreements into which states have entered seemed to start a process of erosion of the institution of state sovereignty. Recent evidence, however, suggests that the trend toward international cooperation in the face of «the seamless web of nature» has resulted in something more subtle but perhaps equally profound: a shift in the practices and norms of sovereignty[80].

A vast array of norms, institutions, and actors influence decisions on natural resources, constitute in natural resource governance. A plethora of national legislation, intergovernmental agreements, regional organizations, certification

[80] LIFTIN K. T., 1997, *Sovereignty in World Ecopolitics*, in *Mershon International Studies Review*, 41, 2, https://doi.org/10.2307/222667 (consulted in October 2021), pp. 167–204.

mechanisms, corporate codes of conduct, and multistakeholder partnerships create a complex web of rules affecting how natural resources are used and benefits thereof are distributed[81].

UN ENVIRONMENT PROGRAM (UNEP)

The United Nations Environment Programme (UNEP) was established after the United Nations Conference on the Human Environment in Stockholm in 1972. It is responsible for environmental issues within the United Nations system. Its mandate is to provide leadership, deliver science and develop solutions on a wide range of issues, including climate change, the management of marine and terrestrial ecosystems, and green economic development. The organization also develops international environmental agreements.

UNEP hosts the secretariats of 15 multilateral environmental agreements and research bodies, regional framework, and other entities including:

❖ **Multilateral environmental agreements**

Such as:

- Convention on Biological Diversity (CBD)
- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal
- Stockholm Convention on Persistent Organic Pollutants

❖ **Regional Conventions**

Ex. Bamako Convention on the Ban of the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa

❖ **Regional Seas Conventions and Action Plans**

Ex. Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (*Barcelona Convention*)

[81] BANSARD J. - SCHRÖDER M., 2021, *BRIEF #16 The Sustainable Use of Natural Resources. The Governance Challenge*, International Institute for Sustainable Development, p. 4. https://www.iisd.org/system/files/2021-04/still-one-earth-natural-resources.pdf (consulted in October 2021).

In 1988, the World Meteorological Organization and UNEP established the Intergovernmental Panel on Climate Change (IPCC). UNEP is also one of several Implementing Agencies for the Global Environment Facility (GEF) and the Multilateral Fund for the Implementation of the Montreal Protocol.

❖ *Bottom-up approach*

GREENPEACE

In the 70s, not only top-down environmental policies were developed, but also grassroots groups exploded. An episode solicited public opinion: in 1971, a small team sailed from Vancouver, Canada, on board an old fishing boat to protest underground nuclear testing by the US military at Amchitka, an island off western Alaska. These environmental activists with a pacificist imprinting created a non-governmental organization called *Greenpeace*, with the belief that non-violent action can positively change. Nuclear testing on Amchitka was banned and later this territory was protected as a bird sanctuary. In 1979, Greenpeace International was constituted precisely with the dream of a *green peace*.

Permanent sovereignty over natural resources vs Indigenous People

The use of natural resources has long been considered an element of both human rights and economic development, leading the United Nations, amid its work on advancing decolonization in the 1960s, to declare that «the right of peoples and nations to permanent sovereignty over their natural wealth and resources must be exercised in the interest of their national development and of the well-being of the people of the State concerned» (UN General Assembly Resolution 1803 (XVII)[82].
Indigenous peoples have deep spiritual, cultural, social and economic connections with their lands, territories, but their rights have been recognised only recently and partially.
Since the XIX century in the Russian Empire and the United States, large movements of migrants have settled in their territories, causing the displacement of the indigenous peoples. In both the steppes and the Great Plains, the colonizing

[82] BANSARD J. - SCHRÖDER M., 2021, *BRIEF #16 The Sustainable Use of Natural Resources. The Governance Challenge*, International Institute for Sustainable Development, p. 2. https://www.iisd.org/system/files/2021-04/still-one-earth-natural -resources.pdf (consulted in October 2021).

powers – the Russian Empire and the United States – constructed similar, negative stereotypes of the indigenous populations as «backward, uncivilized, wandering, primitive»[83]. This cultural prejudice has been used as a pretext to reduce Indigenous land rights and resources.
The discovery of gold changed the sorts of Siberia through the construction of the Trans-Siberian Railway. Mining, processing, and energy industries started to develop in the region. The spatial changes in Siberia had a negative impact on the cultural and linguistic diversity of the indigenous population.

2.2. WOMEN OF CHANGE

The cultural prejudices and discriminations affect particularly women in almost every part of the world. In 1962, the Russian delegation visited the United States with the first Soviet female trainees. Linda Halpern asked President Kennedy how she could become an astronaut. «We have no present plans to employ women on space flights», NASA responded[84].
However, precisely in the sixties, two powerful women had an impact on science and policymaking: Rachel Carson for the scientific world and Barbara Ward for economic and sustainable development.

- **Rachel Carson**

Her book *Silent Spring* (published in 1962) became **the catalyst** for the development of **environmental consciousness in the United States**. According to her insight based on nature observation, Rachel noticed a «spring without voice», indeed «no bees droned among the blossoms, so there was no pollination and there would be no fruit»[85]. In this book, Carson affirmed «the obligation to endure» because of the alarming contamination of air, earth, rivers and sea with lethal materials.

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83 MOON D., 2020, *The American steppes. The Unexpected Russian Roots of Great Plains Agriculture, 1870s–1930s*, Cambridge, Cambridge University Press, p. 6.
84 MALASHENKO U., *The First Group of Female Cosmonauts Were Trained to Conquer the Final Frontier - Two Decades before the First American Woman Flew to Space, a Group of Female Cosmonauts Trained in Star City of the Soviet Union*, Supercluster, https://www.smithsonianmag.com/science-nature/first-group-female-cosmonauts-trained-conquer-final-frontier-180971900/ (consulted on 11/04/2021).
85 CARSON R., 1962, *Silent Spring*, London, Penguins p. 22.

With the launch of I and II Sputnik by the USSR and the space race's development, Rachel Carson became extremely afraid of the potential for evil and destruction. Carson promoted nuclear non-proliferation, dedicating Silent Spring to Albert Schweitzer, the winner of the 1952 Nobel Peace Prize for his contribution against the atomic arms race. She called «twin evils» the nuclear weapons and widespread chemical contamination. Strontium 90, released through nuclear explosions into the air, and the DDT released for civilian use. She attacked the widespread and unregulated use of chemicals sprayed indiscriminately from airplanes over vast areas.

By 1963, atmospheric tests had been banned. However, the Toxic Substances Control Act of 1976 represents Rachel Carson's greatest legal vindication: EPA acted to ban or severely restrict all six toxic chemicals cited in Silent Spring (DDT, chlordane, heptachlor, dieldrin, aldrin, and endrin) and control tests on new chemicals.

- **Barbara Ward**

Barbara Ward was a political scientist of world-wide stature. She was a public speaker, especially at UN global conferences. Ward advised British Prime Ministers (Harold Wilson and James Callaghan), US Presidents (John F. Kennedy and Lyndon B. Johnson), and Canadian Prime Ministers (Lester B. Pearson and Pierre Trudeau).

On a conceptual side, Rachel Carson has considered the main scientist who leads a shift from anthropocentric to «biocentric» understanding of our world.

Barbara Ward, influenced by Carson's work, in her «Spaceship Earth» (1966), describes human beings as both the Earth's crew and its passengers. Barbara Ward discusses about how modern science and technology forces the society toward a more coordinated world community. Science and technology developed a close network of communication, transport, and economic interdependence. However, the economic inequalities are so great that run into hostility and envy.

Barbara wrote: «the gaps in power, the gaps in wealth, the gaps in ideology which hold the nations apart also make up the abyss into which mankind can fall to annihilation»[86]. She also added:

> Scarcity has driven them to competition and enmity. It has required great vision, great holiness, great wisdom to keep alive and vivid the sense of unity of man. It is precisely the saints, the poets, the philosophers, and the great men of science who have borne witness to the underlying unity which daily life has denied.

2.3. WINDOW OPPORTUNITY

Since at least the 1970s, a wide scientific, political and public consensus has emerged about **the crucial necessity of «protecting nature»**[87]. Since early scientists such as Rachel Carson to the theorization of «conservation biology», the conservation of nature has matured both wide popular concern and scientific maturity. Debates, thinkers and scientific advances have made this field one of the most important ones socially speaking in contemporary science, having a strong influence on national and international politics. New technical words have been born in the same lexical field, such as «ecosystem», «biodiversity», «biosphere», and even «Gaia», but none of them ever really supplanted «nature».[88] Studying the concept of «nature» itself and its relationship with practical implications is crucial for conservation sciences and policies.

Two nuclear accidents favoured a rise of **environmental awareness** and **public health** concerning about **man-made environmental disasters.**

Firstly, the Three Mile Island accident occurred when a nuclear-generating station widespread radioactive pollution in Pennsylvania. Secondly, the Černobyl' disaster (1986) in Ukraine - then part of Russia - contaminates a vast area in the skies of Europe (and over).

The Convention on Early Notification of a Nuclear Accident was adopted in 1986 immediately following the Černobyl' nuclear plant accident. It establishes a notification system for nuclear accidents from which a release of radioactive

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[86] WARD B., 1966, *Spaceship Earth*, p. viii, New York, Columbia University Press.

[87] WORSTER D., 1994, *Wealth of Nature. Environmental History and the Ecological Imagination*, Oxford Scholarship Online, (consulted in October 2021).

[88] DUCARME F. – COUVET D., 2020, *What does «Nature» mean?*, London, Palgrave Macmillan & Palgrave Communications, https://doi.org/10.1057/s41599-020-0390-y (consulted in October 2021).

material occurs or is likely to occur and which has resulted or may result in an international transboundary release that could be of radiological safety significance for another State[89]. Notification is to be made to States directly affected or through the International Atomic Energy Agency.

The Japanese government started a collaboration through the Ministry of Foreign Affairs along with financial cooperation from the World Health Organization (WHO)'s preliminary research project on health consequences. The Chernobyl Sasakawa Health and Medical Cooperation Project began with the objective of conducting health screenings for thyroid cancer and leukemia among children. For Japan, Hiroshima was indeed a vivid trauma memory. 90% of the city was destroyed and 80,000 people died immediately. Thousands more died later. The survivors included 170 trees in 55 locations[90]. The trees that survived the bomb were called *Hibakujumoku* (survivor trees or A-Bombed trees).

In 1951, the President of Hiroshima University sent a letter to universities in Europe, the United States and Asia asking to send tree seeds and seedlings to replant their campus. He said that «Green is the color of vividness, the color of hope, the color of peace».

2.4. CLIMATE CHANGE

IPCC well establishes the science of climate change:

- Climate change is real and human activities are the main cause.
- The concentration of greenhouse gases in the Earth's atmosphere is directly linked to the average global temperature on Earth.
- The concentration has been rising steadily, and mean global temperatures along with it, since the time of the Industrial Revolution.
- The most abundant greenhouse gas, accounting for about two-thirds of greenhouse gases, CO_2 is largely the product of burning fossil fuels.

[89] Convention on Early Notification of a Nuclear Accident, https://www.iaea.org/topics/nuclear-safety-conventions/convention-early-notification-nuclear-accident (consulted in October 2021).
[90] GLASSCOCK R. C., 1945, *Hiroshima Trees of Peace*, College of Agriculture, Food and Environment, Urban Forest Initiative, https://ufi.ca.uky.edu/tree-stories/hiroshima-trees (consulted in October 2021).

- Methane, the primary component of natural gas, is responsible for more than 25% of the warming we are experiencing today.

To define a safe environment for human conditions on a stable planet, it is necessary to start identifying the most important Earth processes. By using the **Holocene** as a reference point for our future on Earth, we can scientifically quantify the boundaries we need to avoid pushing our planet out if its, for us, desired state[91]. If we push systems too far, they can break. If the tipping points occur in too many systems in too many places, it can cause an irreversible melting of ice or the release of methane in steppe regions. However, we are crossing that equilibrium in Earth climate between 350 to 450 ppm of CO_2 that ensure Holocene conditions.

Earth is a complex and a self-regulating system, in which everything is connected. When the climate is stable, it rains adequately, **biodiversity** is rich, and ecosystems thrive. That's why we need to respect planetary boundaries[92].

Rockström and Klum identify nine **planetary boundaries**, quantifying safe boundary levels:

1. climate change;
2. stratospheric ozone depletion;
3. rate of biodiversity loss;
4. chemical pollution;
5. ocean acidification;
6. freshwater consumption;
7. land-use change;
8. nitrogen and phosphorus pollution;
9. air pollution or aerosol loading.

We must protect the biosphere with its boundaries on land, water, biodiversity, by reducing global warming, keeping methane below ground and preserving grasslands, savannahs, rainforests and wetlands.

The discovery of the ozone layer

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[91] ROCKSTRÖM J. – KLUM M., 2015, *Big World, Small Planet. Abundance Within Planetary Boundaries*, United States of America, Yale University Press, p. 60.
[92] *Ibidem*.

In 1985, Joe Farman, Brian Gardiner and Jonathan Shanklin reported unanticipated and large decreases in stratospheric ozone levels over the Antarctic stations of Halley and Faraday[93]. Their data revealed that, after about 20 years of constant values, ozone levels began dropping in the austral spring months around the late 1970s (Fig. 6). By 1984, the stratospheric ozone layer was called the *Antarctic ozone hole*.

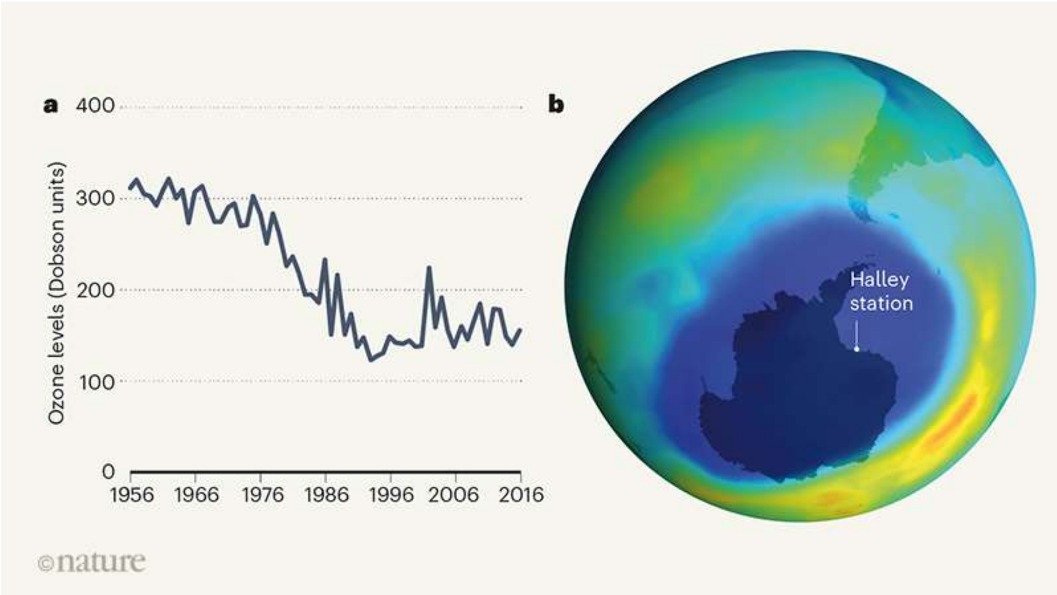

Fig. 6 - the Antarctic ozone hole (Nature)

Ozone over Antarctica[94]:

a) In 1985, Farman, Gardiner and Shanklin reported that stratospheric ozone levels over the Halley and Faraday stations in Antarctica during the austral spring had declined greatly from previously steady values. The graph shows the Halley times series, extended to 2016.
b) Subsequent satellite monitoring revealed that the area of ozone depletion - the ozone hole - extended over a vast region. This map shows a satellite ozone map for 10 September 2000, when ozone depletion was close to its maximum: blue indicates low ozone levels; red indicates high levels. The position of the Halley station is indicated.

[93] SOLOMON S., 2019, *The Discovery of the Antarctic Ozone Hole*, in *Nature*, https://www.nature.com/articles/d41586-019-02837-5 (consulted in October 2021).
[94] *Ibidem*

NASA and NOAA monitor the ozone hole via complementary instrumental methods. NASA's Aura satellite, the NASA-NOAA Suomi National Polar-orbiting Partnership satellite and NOAA's Joint Polar Satellite System NOAA-20 satellite measure ozone from space. The Aura satellite's Microwave Limb Sounder also estimates levels of ozone-destroying chlorine in the stratosphere. At the South Pole, NOAA staff launch weather balloons carrying ozone-measuring «sondes» which directly sample ozone levels vertically through the atmosphere (Fig. 7).

Fig. 7 - The flight path of an ozone sonde (Robert Schwarz/University of Minnesota)

This time-lapse photo from September 9, 2019, shows the flight path of an ozone sonde as it rises into the atmosphere over the South Pole from the Amundsen-Scott South Pole Station. Scientists release these balloon-borne sensors to measure the thickness of the protective ozone layer high up in the atmosphere (NASA).

The more we learn about how the Earth's system works, the higher the concern is. The level of risk has risen, from the assessments of the Intergovernmental Panel on Climate Change (IPCC). Many ecosystems, from lakes to forests and coral reefs, have tipping points. Under the pressure of deforestation and climate change, a rainforest can turn into steppes. One of the most crucial factors in contributing to the resilience of an ecosystem, is biodiversity. When top predators like sharks, wolves, lions are not present in an ecosystem, the entire food web is out of balance. The stability of the Earth relies on a equilibrium of stable ecosystems. If we want to know if oceans are healthy, we must pay close attention to the coral reefs, often called «rainforests of the sea», as they offer a wealth of biologically rich and productive ecosystems[95].

2.5. FUTURE RISKS AND SOLUTIONS

As we know, the impact of humanity on the planet is producing devastating effects. The geographical reality that we identify with Italy, for example, has been extremely mobile over the millennia. The philosopher and evolutionist Telmo Pievani and the geographer Mauro Varotto imagined how Italy will transform by projecting us, in a dystopian way, into the year 2786, in their book *Italian journey in Anthropocene*[96].

Considered this unprecedented acceleration, we cannot help but ask ourselves how the appearance of the world will change in the near future. The visionary geography of our future begins exactly 1000 years after the start of Goethe's trip to Italy: the Po Valley in Northern Italy will be almost completely flooded, the Rialto Bridge and San Marco Basilica in Venice will be accessible only by scuba diving, Rome will be a tropical metropolitan and Sicily will turn into a rock desert. Another concern is linked to waste: will the future be waste filled? *WALL-E*, directed by Andrew Stanton, is an animated Pixar film about a trash-compactor robot with the function of cleaning up the planet. One day, WALL-E discovers a plant growing among the trash. Does this mean Earth can sustain life once again? To find out an answer, WALL-E embarks on a journey through space. In *Interstellar*, the fifth-dimensional communication through gravity enables Murph to communicate with their father in the space. Subsequently, translating that coded data gives Murph the information she needs to advance humanity's understanding of space and time.

Also in real word, sea level rise, the huge amount of waste (also nuclear waste) and natural disasters concern public opinion. A transition to sustainability can only be achieved through combining technology with deep systems innovations and

[95] ROCKSTRÖM J. – KLUM M., 2015, *Big World, Small Planet. Abundance Within Planetary Boundaries*, United States of America, Yale University Press p. 91.
[96] PIEVANI T. – VAROTTO M., 2021, *Viaggio nell'Italia dell'Antropocene*, Città di Castello (PG), Italy.

lifestyle changes. Technology cannot do it all, but can have an essential role in five global transformations[97]:

- Cost of restoration;
- Innovation;
- Renewable and sustainable energy system;
- Sustainable food system;
- Circular economic model for business, societies, and communities.

We will touch two features: renewable and sustainable energy system and sustainable food system.

1. Renewable and sustainable energy system

From a historical perspective, the falls in energy demand and carbon emissions are obviously dramatic[98]. Some of great turmoil in global energy in the history of the global energy system: the Suez Canal crisis in 1956, the oil embargo of 1973, the Iranian revolution in 1979, and the Fukushima disaster in 2011.

Statistical Review of World Energy (2021) refers that 2020, the year of COVID-19 pandemic, had a dramatic impact on energy markets, with both primary energy and carbon emissions falling at their fastest rates since the Second World War. How should we see these reductions? Primary energy consumption fell by 4.5% in 2020 – the largest decline since 1945. The drop in energy consumption was driven mainly by oil, although natural gas and coal also saw significant declines. While wind, solar and hydroelectricity all grew, by country, the US, India, and Russia witnessed the largest declines in energy consumption. The challenge is to maintain growth as the overall size of renewable energy expands. China was the largest contributor to renewables growth (1.0 EJ), followed by the US (0.4 EJ). Europe, as a region, contributed 0.7 EJ. ESA stated that a solution from space is given by the technologies for space missions – including power supply and management systems

[97] ROCKSTRÖM J. – KLUM M., 2015, *Big World, Small Planet. Abundance Within Planetary Boundaries*, United States of America, Yale University Press, p. 133.
[98] Centre for Energy Economics Research and Policy, *Bp Statistical Review of World Energy*, BP p.l.c, London, https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2021-full-report.pdf (consulted in October 2021).

– that are helping the terrestrial energy sector as it works to serve its customers and are contributing to reduce carbon emissions and other environmental impacts[99].

2. Sustainable food system

Michael Pollan introduces a very interesting issue connected with lifestyle changes: food. «What should I eat? » could no longer be answered without first addressing two other even more straightforward questions: «What am I eating? And where in the world did it come from? »[100]. His questions investigate the industrial food chain in the United States. In the post-war period, the focus was on economic growth under a modernization model. The natural environment was considered as a resource to exploit for human advancement. The key turning point in the modern history of corn, and in the industrialisation of our food[101]. Why corn and not something else? Corn is the most efficient way to produce energy, while soybeans are the most efficient way to produce protein.

The Food and Agriculture Organization (FAO) affirms that the food supply chain in many countries is on course to overtake farming and land use as the largest contributor to greenhouse gases (GHGs) from the agri-food system[102]. Now, the trend should be different: the biggest effort to cut food emissions is to stop producing more food than we need[103].

A FAO study, *Global Food Losses and Food Waste*, highlights the losses occurring along the entire food chain and makes assessments of their magnitude[104]. Furthermore, it identifies causes of food losses and possible solutions for preventing them. Food waste represents a huge level of inefficiency with economic, social and environmental impacts. It has consequences on food insecurity, malnutrition and

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[99] ESA, https://www.esa.int/ (consulted in October 2021).

[100] POLLAN M., 2006, *The Omnivore's Dilemma. The Search for a Perfect Meal in a Fast-Food World*, 2011th ed, London, Penguins, p. 17.

[101] *Ibidem.*

[102] Climate and Environment, 8 November 2021, *New FAO Analysis Reveals Carbon Footprint of Agri-Food Supply Chain*, UN News edition, https://news.un.org/en/story/2021/11/1105172 (consulted in October 2021).

[103] ASCHWANDEN C., 2020, *What Lifestyle Changes Will Shrink Your Carbon Footprint the Most? How to Take Steps That Will Make a Difference*, in *Science News*, https://www.sciencenews.org/article/climate-change-actions-reduce-carbon-footprint (consulted in October 2021).

[104] FAO, 2011, *Global Food Losses and Food Waste. Extent, Causes and Prevention*, Rome.

water consumption used by agriculture. Reductions can save money for farmers, business and citizens.

FAO is the custodian agency of **Target 12.3**:

> By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses.

FAO also manages the Food Loss and Waste Database to help monitor the state of food loss and gathers information from almost 500 publications, reports and studies from organizations.

In the European Union context, the EU Commission's Communication on «A Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system» is the first EU strategy with the goal of dealing with the whole food chain. It is a key component of the European Green Deal. It aims at contributing to Europe's climate change agenda, protecting the environment and preserving biodiversity, ensuring farmers' and fishers' position in the value chain, encouraging sustainable food consumption and promoting affordable and healthy food for all without compromising the safety, quality and affordability of food[105].

However, the COVID-19 crisis has made it urgent to increase the resilience of EU and global food systems by future shocks. What it is necessary to create a new paradigm in which innovation, technology and international cooperation, is calling for decision makers to act to prevent a future climate catastrophe.

2.6. ENVIRONMENTAL TREATIES AND POLICIES

International law tends to safeguard what is now referred to as «environmental heritage», a synthesis of conscience ecology actually matured in civil society and expressed by public opinion, the world of science, and the application of legal rules that, with a progressive erosion of competence state, in an increasingly exclusive way are oriented to the protection of different people ecosystems.[106] This approach began in the seventies of the last century in the face of the need to protect the

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[105] European Union, 2020, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions A From Farm to Fork Strategy for a Fair, Healthy and Environmentally-Friendly Food System COM (2020) 381 Rapporteur: Peter SCHMIDT (DE)*, Bruxelles, https://effat.org/wp-content/uploads/2021/02/PS-A-From-Farm-to-Fork-Strategy-for-a-fair-healthy-and-environmentally-friendly-food-system.pdf (consulted in October 2021).

[106] BUONOMO V., 2017, *La tutela dell'ambiente nelle fonti internazionali*, Rome, Aracne Editrice, p. 131 (consulted in October 2021).

environment or at least of minimize the risks deriving from economic, production or resource exploitation choices.

The role is played by natural resources in visibly strategic key - as in the case of energy sources -, therefore possible reasons for conflicts, including of a military nature, directly capable of threatening security and peace.

The number of multilateral environmental agreements in the international community has proliferated greatly since 1972. In 1989, UNEP listed a total of 139 treaties. Today, there are more than 900 international legal instruments, including treaties and binding or non-binding agreements. This massive proliferation led to a well-known phenomenon called «treaty congestion» in international environmental law, causing the need for international coordination, in terms of effectiveness, efficacy and efficiency. Effectiveness is the extent to which planned outcomes, goals, or objectives are achieved because of an intervention. Efficacy is the ability to reach the desired effect. Efficiency is to carry out activities in the most economical way.

These are some **key environmental treaties and policies**:

- **UN Conference of Rio on Environment and Development (1992)**

In June 1992, at the *Earth Summit* in Rio de Janeiro, 178 countries adopted Agenda 21, a comprehensive plan of action to build a global partnership for sustainable development to improve human lives and protect the environment. One of the most relevant outcomes of this summit was that **United Nations Framework Convention on Climate Change** committed signatories' governments to reduce atmospheric concentrations of greenhouse gases. «Preventing dangerous anthropogenic interference with Earth's climate system» is the motto. The **precautionary principle** is expressed in this Declaration, which stipulates that, where there are «threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation». Introducing the precautionary approach, Principle 15 of the 1992 Rio Declaration states that «where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation»[107]. When there is reasonable suspicion of harm, decision-makers need to apply precaution and consider the degree of uncertainty that appears from scientific evaluation. Precaution involves the systematic application of risk assessment, risk management and risk communication. One of the firsts scientists to promote the precautionary principle in policymaking was Rachel Carson, supporting an idea of prevention rather than remediation.

- **UNFCCC**

The UNFCCC entered into force on March 21, 1994. The 197 countries that have ratified the Convention are called *Parties to the Convention*. The UNFCCC strengthened more the bounding effect than the Montreal Protocol (1987): it bounds Member States to act in the interests of human safety even in the situation of scientific uncertainty. R&D involves uncertainty, which has multiple dimensions. At the outset of an R&D project, the kind of outcome and the cost (including time allocation) cannot be precisely determined relatively to the goals.
A system of grants and loans has been set up through the Convention and is managed by the GEF. Industrialized countries agree to share technology with less-developed countries.

- **The COP**

The first COP meeting was held in Berlin, in March 1995. The COP is the decision-making body of the Convention. All States that are Parties to the Convention are represented at the Conference of Parties. A key role of the COP is to review the national communications and emission inventories submitted by Parties. Based on this information, the COP evaluate the effects of the measures taken by Parties and the progress made in achieving the objectives of the Convention. The COP Presidency rotates among the five UN regions.

- **The Kyoto Protocol (1997)**

The Kyoto Protocol was adopted on December 11, 1997, but it entered into force on February 16, 2005. Currently, there are 192 Parties to the Kyoto Protocol. The Kyoto Protocol operationalizes the United Nations Framework Convention on

[107] The ten principles of the UN global compact, https://www.unglobalcompact.org (consulted in October 2021).

Climate Change by committing industrialized countries in transition to limit and reduce **greenhouse gases (GHG) emissions** in accordance with agreed individual targets[108]. The Kyoto Protocol is based on the principles and provisions of the Convention. It only binds developed countries, under the principle of «common but differentiated responsibility and respective capabilities», recognizing that they are largely responsible for high levels of GHG emissions in the atmosphere.

- **Millennium Summit of the United Nations in New York (2000)**

In September 2000, the Member States unanimously adopted the Millennium Declaration at the Millennium Summit at UN Headquarters. The Summit led to the elaboration of eight **Millennium Development Goals (MDGs)** to reduce extreme poverty by 2015.

At the United Nations Conference on Sustainable Development (Rio+20) in Rio de Janeiro, Brazil, in June 2012, Member States adopted the outcome document «The Future We Want» in which they decided to start a process to develop a set of SDGs to improve the MDGs.

Fig. 8 Sustainable Development Goals (SDGs), the 2030 Agenda for Sustainable Development

[108] UNFCCC, https://unfccc.int/ (consulted on 02.02.22).

❖ The 2030 Agenda for Sustainable Development (2015)

The General Assembly Resolution A/RES/70/1, titled «Transforming our world: the 2030 Agenda for Sustainable Development», adopted by all United Nations Member States, provides a universal direction for peace and prosperity for people and the planet. At its heart, there are the 17 Sustainable Development Goals (SDGs), with 169 associated specific targets. They recognize that ending poverty must be connected to strategies that improve health and education, reduce inequality and gender gap and ensure economic growth. The 2030 Agenda for Sustainable Development highlights also that «sustainable development cannot be realized without peace and security; and peace and security will be at risk without sustainable development».

It is remarked the key role of Earth Observation (EO) and geolocation (provided by GNSS) is in support of the achievement of sustainability. Space-based services and technologies are key in understanding climate change and disaster risk management.

Although much of the attention of the Paris Agreement is to tackle climate change, the Agreement affirmed that: «the context of sustainable development and efforts to eradicate poverty». The UN SDGs, which were adopted around the same time as the Paris COP, provide a natural benchmark for monitoring progress on this aspect of the Paris Agreement[109]. Since the COVID-19 crisis has amplified the impact on the economic inequalities towards women and young people, it exacerbated these disparities also in the Global South. The pandemic has also aggravated the threats to progress raised by conflict and climate change. Estimates suggest that 2020 saw an increase of between 119 million and 124 million global poor, 60% of whom are in Southern Asia[110].

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[109] Centre for Energy Economics Research and Policy, *Bp Statistical Review of World Energy*, BP p.l.c, London, https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2021-full-report.pdf (consulted in October 2021).

[110] UNSTATS, United Nations Department of Economic and Social Affairs Statistics Division, https://unstats.un.org/sdgs/report/2021/goal-01/ (consulted in November 2021).

❖ Paris Agreement on Climate Change (2015)

The adoption of the Paris Agreement at the 2015 Conference of the Parties to the UNFCCC marks the urgence of a climate change action. The long-term goal of the Paris Agreement on climate change, as agreed at the COP in 2015, is to keep global temperature rise this century to well below 2 degrees Celsius above pre-industrial levels.

Why is 1.5°C so important? The world will suffer serious climate impacts at 1.5°C. The difference between 1.5°C and 2°C implies:

- 70% or 99% of coral reefs dying,
- double the likelihood that insects, vital pollinators, lose half their habitat,
- ice-less summers in the Arctic Ocean once per century or once per decade,
- 1 meter added in sea-level rise.
- 6 million or 16 million affected by sea-level rise in coastal areas by the end of this century[111].

Article 4 of the Paris Agreement specifies that «each Party shall communicate a nationally determined contribution every five years».

In 2015, also these agreements were adopted:

- **Sendai Framework for Disaster Risk Reduction** (March 2015): Disasters and their immediate impacts threaten to slow poverty and hunger reduction. Based on the latest reporting under the Sendai Framework monitoring process, direct economic losses of $70.4 billion due to disasters were reported by 53 countries for 2019, 60% of which ($42.5 billion) were recorded in the agricultural sector[112].
- **Addis Ababa Action Agenda on Financing for Development** (July 2015).

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[111] Intergovernmental Panel on Climate Change (IPCC).

[112] UNSTATS, United Nations Department of Economic and Social Affairs Statistics Division, https://unstats.un.org/sdgs/report/2021/goal-01/ (consulted in November 2021).

While 2015 was an intense year for multilateralism, it is notable the absence of the United States of America in engaging in international treaties that have been ratified by most of the world's countries, such as[113]:

1. **United Nations Convention on the Law of the Sea** (1982)
2. **Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal** (1989): The United States has signed but not ratified the Basel Convention, which took effect in 1992.
3. **Convention on Biological Diversity at the Rio Earth Summit** (1992): The United States does still participate in the Conference of Parties but relegated to a observer status.
4. **Stockholm Convention on Persistent Organic Pollutants** (2001): The treaty identifies «persistent» chemicals that stay in the environment for a long-term and can bioaccumulate up the food chain. 184 countries have ratified the agreement. The United States signed it in 2001, but the treaty has yet to be ratified by the Senate.

- **Policy paths for tackling climate change** (2015)

«Countries are running out of time to make the policy adjustments needed to meet their targets and keep alive the long-term goal of limiting the temperature rise to 2°C», according to OECD Environment Director Simon Upton. What should policy makers do? They should improve carbon pricing and cut GHG emissions, but it is a very complex challenge. Another important climate change mitigation policy includes reducing the destruction of forests, further reducing the emissions intensity of agriculture; and reducing GHG emissions from industrial processes and waste. In this latter area, there is significant potential for mitigation through measures covering the entire life cycle of materials – from production to consumption.[114]

[113] LOHAN T., 2021, *4 Major Environmental Treaties the U.S. Never Ratified - But Should*, in *The Revelator*, https://therevelator.org/environmental-treaties/ (consulted in November 2021).
[114] OECD, Organisation for Economic Co-Operation and Development, 2015, *Policy Paths for Tackling Climate Change. STRONGER ACTION NEEDED TO MEET MITIGATION GOALS*, www.oecd.org (consulted in November 2021).

❖ The UN Environment Emissions Gap Report (2017)

The alarming number and intensity of extreme weather events in 2017 stress the urgency of early action and the window opportunity of the Paris Agreement. The UN Environment Emissions Gap Report (2017), the 8th edition, presents an assessment of current national mitigation efforts, which form the foundation of the Paris Agreement[115]. It focuses on the gap between the emissions reductions necessary to achieve these agreed targets at lowest cost and the likely emissions reductions from full implementation of the Nationally Determined Contributions (NDCs).

President Donald Trump announced on June 1, 2017, that the US would make a withdrawal from the Paris Agreement, including NDCs and financial contributions. Zhang et al. (2017) wrote referring to it that the withdrawal undercuts the foundation of global climate governance and upsets the process of climate cooperation, undermines the universality of the Paris Agreement; it also aggravates the leadership deficit in addressing global climate issues and sets a bad precedent for international climate cooperation; furthermore, it reduces other countries' emission space and raises their emission costs and refusal to contribute to climate aid makes it more difficult for developing countries to mitigate and adapt to climate change. Moreover, cutting climate research funding will compromise the quality of future IPCC reports and will ultimately undermine the scientific authority of future climate negotiations[116]. The position of China suggested by these analysts is that China should facilitate the rebuilding of shared climate leadership. Meanwhile, China needs to keep the US engaged in climate cooperation.

❖ UN Declaration on the Rights of Peasants and other People Working in Rural Areas (2018)

The Resolution adopted by the General Assembly in 2018 adopted the United Nations Declaration on the Rights of Peasants and Other People Working in Rural

[115] UNEP, United Nations Environment Programme, 2017, *The Emissions Gap Report*, Nairobi, www.unenvironment.org/resources/emissions-gap-report (consulted in November 2021).
[116] HAIBIN Z. - HANCHENG D. - HUAXIA L. - WENTAO W., 2017, *U.S. Withdrawal from the Paris Agreement. Reasons, Impacts, and China's Response*, in *ScienceDirect*, pp. 220–25, https://www.sciencedirect.com/science/article/pii/S1674927817301028 (consulted in November 2021).

Areas (UNDROP). The Declaration highlights the importance of small-scale sustainable practices and the need to strengthen the protection and recognition of groups who have experienced historical marginalization and violent conflict over resource use. Similarly, the UN Declaration on the Rights of Indigenous Peoples (UNDRIP) and ILO Convention 169 protect individual and collective rights of Indigenous Peoples. To protect the right to live in a healthy environment, governments must adopt robust reforms across national policies, laws, programmes and institutions that prompt shifts in country priorities and ensure the mainstreaming of environmental and social concerns across sectors, focusing especially on empowering marginalized groups[117]. To ensure that decisions connect ecological with social vulnerability to end poverty, decision-makers should choose human rights-based approaches to natural resource governance. From historical legacies, structural inequalities exist across the resource. These issues disproportionately impact women, rural communities and Indigenous Peoples.

- **IPCC report (2022)**

The Intergovernmental Panel on Climate Change is the United Nations body with the role of assessing the science related to climate change. The IPCC elaborates an Assessment Reports about the state of scientific, technical and socio-economic knowledge on climate change, its impacts and future risks. In 2022, IPCC published the Sixth Assessment Report, with three Working Group contributions and a Synthesis Report. Chapter VII deals with Agriculture, Forestry and Other Land Uses (AFOLU). This sector offers mitigation opportunities while delivering food, wood and vibrant biodiversity. Land-based mitigation measures can both deliver carbon dioxide removal (CDR) and substitute for fossil fuels. The rapid deployment of AFOLU measures is essential in all pathways.

[117] BANSARD J. - SCHRÖDER M., 2021, *BRIEF #16: The Sustainable Use of Natural Resources. The Governance Challenge*, p. 6, International Institute for Sustainable Development, https://www.iisd.org/system/files/2021-04/still-one-earth-natural-resources.pdf (consulted in October 2021).

2.7. THE CIVILIAN USE OF SPACE

Thanks to the amplification of possibilities offered by new technologies, today science can be spread and reported better than in the past[118]. At the basis of this transformation is the time diffusion of the news. Information networks have profound effects on the organization of time and space, as well as on other relations, allowing real-time communication on a planetary scale[119].

From 1990s to 2020s, the world assisted in a ICTs boom, so we can say we live in an **Information Society** in a Digital Age. This change is technological, economic, occupational, spatial and cultural.

Digital ICTs are implicated also in policymaking as tools such as PC, TV, telecommunication or other digital devices. Recent technological advances in ground stations, antennas, satellites and space launch capabilities are associated with new telecommunications business models and high demand for low latency high bandwidth internet. Together have driven rapid growth in the space-based internet industry, forming a complex, multi-level and highly politicized system.

Convergence of governments, non-governmental organisation and multi-stakeholders meet different interests in public or private or public-private partnerships. They operate at different levels - **national, regional, global** - with different goals and processes. By discovering actors' positions, we can analyse their influence, the use of power, the conflictual interplay and the level of cooperation in International Relations. Formal and informal political processes, by actors with different degrees of power, can lead to the creation of a policy.

Globalization, multi-level Governance and technological convergence process led to multi-layered communication systems and regulation, whose key elements are:

- Connectivity;
- Human capital;
- Use of the internet and integration of digital technology: business digitalisation and e-commerce;
- Digital public services: e-Government.

[118] CAPRARA G., 2015, *Science Journalism in a Changing World*, in *IFOM Review*, https://review.ifom.eu/2013/caprara-ugi.php (consulted in November 2021).
[119] Oxford Reference, www.oxfordreference.com (consulted in November 2021).

The inter-operation of infrastructures connects media platforms, institutional forms of the media system, media contents, cultural industries and the global market.

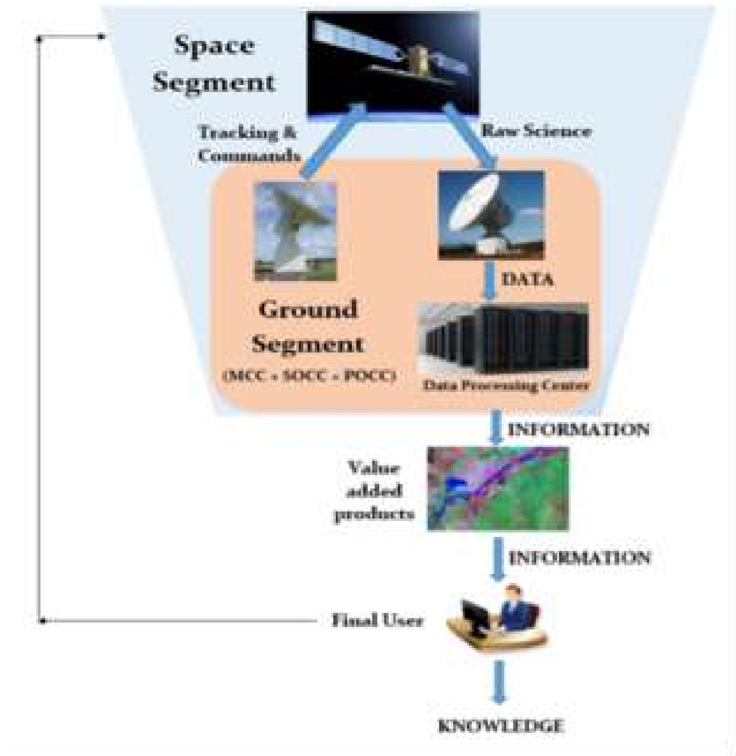

Fig. 9: The functional relationship between the space segment, ground segment and final user for a small satellite mission (NASA)

This figure shows the functional relationship between space segment, ground segment and final user for a small satellite mission. The ground system is responsible for collecting and distributing the most asset of the mission: the data. A typical mission is comprised of three operational components: space, ground and user segments.

The space segment consists of the payload and spacecraft bus system, maintaining operational stability to receive and transmit information. The ground segment includes all the ground-based elements that are used to collect and disseminate information from the satellite to the user. All small satellites use some forms of a ground segment to communicate with the spacecraft.

NASA explains that a typical small satellite mission is developed within the ground system structure:

- Spacecraft Terminal
- Ground Station Terminal

- Mission Operations Center (MOC):
    - Controls the spacecraft;
    - Monitor spacecraft performance;
    - Requests and retrieves data.
- Science Operations Center (SOC):
    - Produces and shares science data products.
- Ground Station Data Storage and Network:
    - Provides live connectivity;
    - Temporarily stores data.

The spacecraft transceiver and ground station must be in a coordinated frequency to communicate. Selecting **transmit and receive frequencies** are a central issue of the spacecraft communications system design process.

Satellite communication frequencies are protected. The signals from satellites in space are very weak. Within each frequency band there are government and non-government designations amongst the frequencies, and some are shared. All national bodies must coordinate with the International Telecommunications Union (ITU), which is the international governing body.

Among the various applications of the commercial space, satellite telecommunications more than any other have found an outlet in every commercial space, generating a market and services in continuous growth. Satellites also play a fundamental role in the dissemination of culture and information thanks to the Internet.

A variety of **companies** are implementing **communications** numbering in hundreds to tens of thousands of satellites, particularly in nongeosynchronous Low Earth Orbit (LEO). On one hand, these satellite constellations provide technological advancements, but, on the other, they will change the view of the dark sky on the planet, introducing new challenges in space sustainability and space traffic management. This change to the pristine night sky has impacts on dark sky reserves, astrophotography, religious and cultural practices, animal life and scientific inquiry[120]. All-sky (or A-kind) simulations consider the spacecraft orbits and give them a position on Earth; they predict satellites at any given instant in time. This implies computing several satellites which are above a certain elevation, then choosing which ones of them are truly detectable because they are illuminated by direct sunlight. Only satellites illuminated by the Sun will be detectable.

Another global issue is how to reduce **space debris**. Inter-Agency Space Debris Coordination Committee stated that, typically, spacecraft operators perform re-entry manoeuvres to comply with space debris mitigation guidelines. The Inter-Agency Space Debris Coordination Committee (IADC) has issued a special statement in this regard (Inter-Agency Space Debris Coordination Committee, 2007), as the number of debris is growing and the probability of collisions that could lead to potential damage will consequently increase. The Satellite Constellations 1 (SATCON1) Mitigations Working Group Report proposed some recommendations to mitigate the effects of proposed LEOsats on optical astronomy research:

- Fewer satellites
- Darken satellites in all phases of the orbit
- Darken satellites to at minimum fainter than 7th visual mag when at 550 km altitude, and preferably > 8th mag
- LEO satellites on orbits as low as possible

An increasing number of private actors are being authorized by States to launch tens of thousands of satellites in the next years, so it becomes essential to develop guidelines to determine international standards. In 2007, the COPUOS adopted the Space Debris Mitigation Guidelines, endorsed by the General Assembly in its resolution 62/217 of 22 December 2007. The guidelines reflected existing practices developed by national and international organizations invited voluntarily Member States to implement those standards through national mechanisms.

The European Space Agency (ESA) develops communications satellites since 1968. The Agency launched an Orbital Test Satellite (OTS-2), which paved the way to new services, such as broadcasting to cable feeds and direct-to-home television.

[120] COPUOS, UNOOSA, the International Astronomical Union and Spain, 2020, *On-Line Workshop. Dark and Quiet Skies for Science and Society - Report and Recommendations*, https://www.iau.org/static/publications/dqskies-book-29-12-20.pdf (consulted in November 2021).

The success of OTS-2 inspired the creation of many other satellites for civilian use in Europe.

3. EARTH OBSERVATION PROGRAMMES

3.1. EARTH OBSERVATION

An orbit is the curved path that an object in space - a star, Moon, spacecraft - takes around another object due to gravity. When rockets launch satellites, they put them into orbits in space. **Gravity** keeps the satellite on its required orbit. Europe's family of rockets launch from Europe's Spaceport in Kourou, in French Guiana.

Ariane 5 is Europe's most powerful launch vehicle, and, depending on which orbit Ariane 5 is going to, it can launch between approximately 10 to 20 tonnes into space. While Vega is smaller than Ariane 5, it can launch roughly 1.5 tonnes at a time. This characteristic makes it an ideal launch vehicle for many scientific and Earth observation missions. Both Ariane 5 and Vega can deploy multiple satellites at a time.

Depending on what kind of functions the satellite is designed to achieve, there are many features that decide which orbit would be best for a satellite to use:

- **Geostationary orbit (GEO)**: for instance, telecommunication satellites. This way, an antenna on Earth can be fixed to always stay pointed towards that satellite without moving.
- **Low Earth orbit (LEO)**: used for satellite imaging, because of the proximity with the surface that allows it to take images of higher resolution. It is also the orbit used for the International Space Station (ISS).
- **Medium Earth orbit (MEO)**: useful for navigation satellites, like the European Galileo system (pictured) for navigation communications across Europe and for many types of navigation.
- **Polar orbit and Sun-synchronous orbit (SSO)**: Sun-synchronous orbit (SSO) is a particular kind of polar orbit: the satellite will always observe a point on the Earth as if constantly at the same time of the day. This point of observation serves a number of applications: discover how weather patterns emerge, help to predict weather or storms and to monitor emergencies like fires and flooding or phenomenon like deforestation and rising sea levels.
- **Transfer orbits and geostationary transfer orbits (GTO):** Transfer orbits are used to get from one orbit to another. When satellites are launched from

Earth and carried to space with launch vehicles, the satellites are not always placed directly on their final orbit.

- **Lagrange points (L-points):** These are specific points in space where the gravitational fields of Earth and the Sun combine in such a way that the spacecraft that orbit them remain stable.

The difference between remote sensing and earth observation is that **remote sensing** is gathering information about an object or a phenomenon, without making any physical contact, while **Earth observation (EO)** consists in gathering information about Earth's physical, chemical and biological systems via remote sensing technologies.

Earth observation is collecting information about our planet physical, chemical and biological systems. It involves monitoring and evaluating the status, the variations, the natural and artificial environment. There are many kinds of Earth observations, such as radar and sonar images and processed maps or forecasts, etc. **Earth observation (EO)** is used in a dual use, both for civilian and military activities. It involves public and private actors and it is at the crossroads of scientific and commercial endeavours. Earth observation satellites allow numerous **practical applications**, useful for the life of **citizens**; in fact, they can keep under control the effects of natural disasters, such as floods, earthquakes and volcanic eruptions, but they also give the possibility to detect changes in agricultural areas, forests and marine areas, monitoring their eventual degradation[121].

Earth observation has become more advanced with the development of remote-sensing satellites and high-tech *in-situ* instruments. Today's Earth observation instruments include floating buoys for monitoring ocean currents, temperature and salinity; land stations that record air quality and rainwater trends; sonar and radar for estimating fish and bird populations; seismic and Global Positioning System (GPS) stations; and over 60 high-tech environmental satellites that scan the Earth from space[122].

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[121] CAPRARA G. – CHELI S., 2003, *Dallo Spazio per la Terra. Tutte le applicazioni utili all'uomo*, Novara, Istituto Geografico De Agostini Spa p. 141.

[122] Group on Earth Observation, https://www.earthobservations.org/index.php (consulted in November 2021).

Why are Earth observations crucial? Earth observations are essential for monitoring and mitigating the negative impacts on our planet. They can be used also for the sustainable management of natural resources. The importance of the contribution of satellite data to implement environmental policies and the strategic value of space has been confirmed by numerous ESA initiatives. **Environmental policymaking** depends on timely, accurate information about the state of our planet and predictions about its future[123]. In combination with ground-level observations, Earth observation from space by satellites can provide a huge amount of data relating to the land, oceans and atmosphere. The resulting information offers greater detail of observation and an opportunity to monitor variations and impact in the environment. Many applications require the integration and merging of data originating from different satellites and the comparison with the information collected on the ground.

3.2 EUROPEAN EARTH OBSERVATION PROGRAMMES

The European Space Agency (ESA) is an international organisation composed by 22 member states. There are four Associate Member States: Latvia, Lithuania, Slovenia, and Slovakia. In addition, Canada participates in ESA's work as a Cooperating State. Cooperation agreements are also in force with the states of Bulgaria, Cyprus, Croatia, and Malta.

ESA has ten founding members: Belgium, Denmark, France, Germany, Italy, the Netherlands, Sweden, Switzerland, Spain and the United Kingdom. In 1975, in Paris, the Convention for the Establishment of a European Space Agency was signed letting the fusion of the European Launcher Development Organisation (ELDO) and the European Space Research Organisation (ESRO) in ESA.

The European Space Research Organisation (ESRO) was an international organisation established with the objective of scientific research in outer space. The origins of a joint European space effort are generally traced back to a series of initiatives carried out in the 1960s by a small group of scientists and science

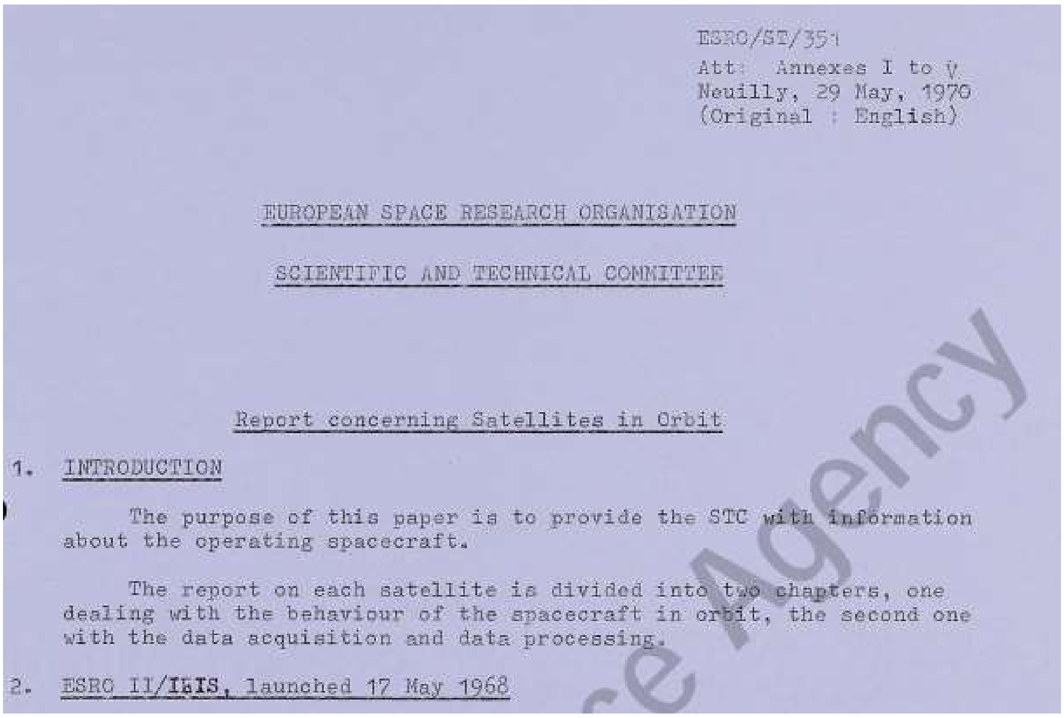
[123] Science Communication Unit, University of the West of England, Bristol (2012). Science for Environment Policy Future Brief: Earth Observation's Potential for the EU Environment. Report produced for the European Commission DG Environment, February 2013, http://ec.europa.eu/science-environment-policy (consulted in November 2021).

administrators, led by the Italian Edoardo Amaldi and the French Pierre Victor Auger.

ESRO-1A (Aurorae) and ESRO-1B (Boreas), the first European satellites, were designed to study how the auroral zones responded to geomagnetic and solar activity[124]. ESRO-1A was launched on 3 October 1968 and reentered 26 June 1970; ESRO-1B was launched on 1 October 1969 and reentered 23 November 1969[125]. ESRO-1B was launched into a lower, circular orbit - meaning that reentry was inevitable after a few weeks - to provide complementary measurements.

ESRO-l/Aurorae launched carried eight experiments to study the auroral zones, the polar cap and low latitude ionosphere.

Results from these satellites have been outlined in the Annual General Reports of 1968 and 1969 and have been presented in more detail in the following ESRO Report (fig. 10 and 11).



ESRO/ST/351
Att: Annexes I to V
Neuilly, 29 May, 1970
(Original : English)

EUROPEAN SPACE RESEARCH ORGANISATION

SCIENTIFIC AND TECHNICAL COMMITTEE

Report concerning Satellites in Orbit

1. INTRODUCTION

The purpose of this paper is to provide the STC with information about the operating spacecraft.

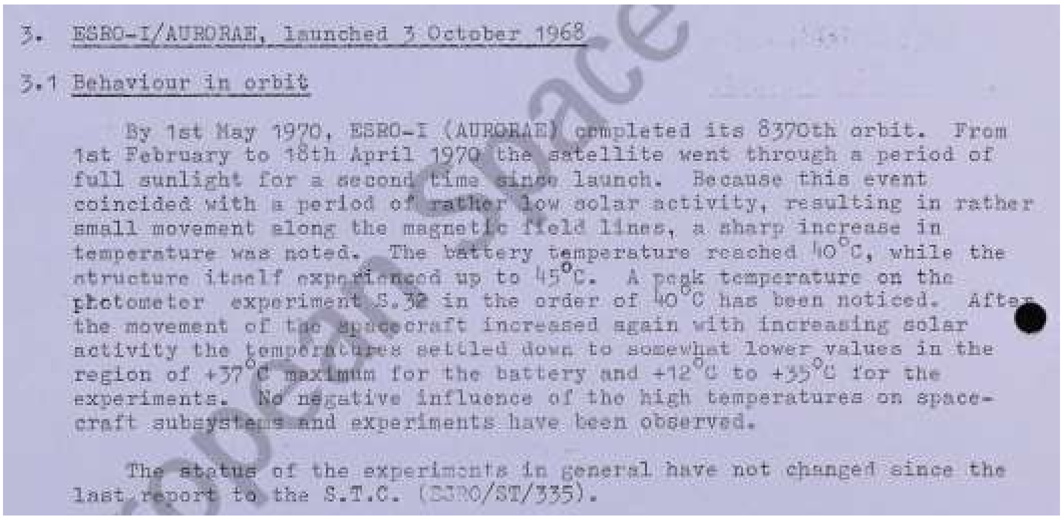
The report on each satellite is divided into two chapters, one dealing with the behaviour of the spacecraft in orbit, the second one with the data acquisition and data processing.

2. ESRO II/IRIS, launched 17 May 1968

Fig. 10: *Satellites in orbit*, ESRO-4411 (Historical Archives of the European Union (HAEU), Florence, Italy).

124 DE GOUYON MATIGNON L., 2019, *The first European satellites*, https://www.spacelegalissues.com/the-first-european-satellites/ (consulted in November 2021).

125 www.esa.int


3. ESRO-I/AURORAE, launched 3 October 1968

3.1 Behaviour in orbit

By 1st May 1970, ESRO-I (AURORAE) completed its 8370th orbit. From 1st February to 18th April 1970 the satellite went through a period of full sunlight for a second time since launch. Because this event coincided with a period of rather low solar activity, resulting in rather small movement along the magnetic field lines, a sharp increase in temperature was noted. The battery temperature reached 40°C, while the structure itself experienced up to 45°C. A peak temperature on the photometer experiment S.32 in the order of 40°C has been noticed. After the movement of the spacecraft increased again with increasing solar activity the temperatures settled down to somewhat lower values in the region of +37°C maximum for the battery and +12°C to +35°C for the experiments. No negative influence of the high temperatures on spacecraft subsystems and experiments have been observed.

The status of the experiments in general have not changed since the last report to the S.T.C. (ESRO/ST/335).

Fig. 11: *Satellites in orbit*, ESRO-4411 (Historical Archives of the European Union (HAEU), Florence, Italy).

Under the pressure of the awareness that independence from non-European interests would be indispensable, and thanks to French contribution, ESA built the Ariane spacecraft which, from 1979, would guarantee autonomy in the launch of satellites. It is specialised in:

- Space science;
- Human spaceflight;
- Exploration;
- Earth observation;
- Launchers.

The **Council** is the organ representing the Member States, and it appointed the **Director General** represents the Agency in all its acts. ESA's Director General is assisted by 11 Directors, each of whom is responsible for one of ESA's programmes or for the administration of part of the Agency[126]. Delegates are often supported by experts.

The Council has established subordinate bodies to specific duties. Each of the **Committees and Boards** can take decisions and make recommendations. Each Member States nominates its representation to the Boards and Committees.

The **Committees** are the following ones:

[126] ESA, https://www.esa.int/About_Us/Corporate_news/ESA_top_management (consulted in November 2021).

❖ **Administrative and Finance Committee (AFC)**

The AFC makes recommendations to the Council, the Programme Boards and the Director General on matters of an administrative, staff, financial or legal nature.

❖ **Industrial Policy Committee (IPC)**

The IPC's task is to define, implement and monitor ESA's industrial policy. It also approves the procurement and contract proposals submitted to it for the conduct of ESA's activities. IPC is also competent for the authorisation of transfer of technology outside ESA Member States.

❖ **International Relations Committee (IRC)**

On one hand, it assists the Council in coordinating the space policies of the Member States with respect to other national and international organisations and institutions, with the aim of achieving at a common position in international bodies. On the other side, it submits recommendations regarding cooperation with Governments, organisations, and institutions of non-member States.

❖ **Oversight Committee (OC)**

Experts with technical capacity, appointed by Council, provide independent and objective advice on the effectiveness, efficiency and accountability of the Agency's internal control framework and functions.

❖ **Security Committee (SEC)**

It advises the Director General and the Council on issues ranging from the physical security of the installation of the Agency, with such as the protection of classified information or material and to industrial security policy.

The **boards** have been created by the Council, and each Boards has its own field of action, with various level of decision power. They can be consulted by any bodies on specific matters and have a duty to report to the Council when necessary:

❖ **Science Programme Committee (SPC)**

The SPC is the only committee established by ESA Convention itself. The Council shall refer to SPC for any mandatory scientific programme. It follows both scientific projects from their selection to their execution, and the preparation and selection of future projects.

❖ **Joint Board on Communication Satellite Programme (JCB)**

The JCB is a fusion of the Communication Satellite Programme Board and the Maritime Satellite Programme Board. This board is competent for programmes such as Artemis and Artes. It deals with the preparation and development of activities in fixed, mobile, broadcasting and multimedia services.

❖ **Launchers Programme Board (PB-LAU)**

Originally, the PB-LAU was set-up to follow up the Ariane Programme. New programmes such as VEGA, Soyuz at CSG have been initiated by this board.

❖ **Programme Board for Earth Observation (PB-EO)**

The PB-EO coordinates the European and national Earth observation activities and makes recommendations to the Council about future programme and decisions.

❖ **Programme Board for Human Spaceflight, Microgravity and Exploration (PB-HME)**

The PB-HME is entrusted with the responsibility of coordinating and monitoring the execution of the various activities related to human spaceflight development and exploitation. It coordinates Europe's contribution to the International Space Station.

❖ **Programme Board on Satellite Navigation (PB-NAV)**

The PB-NAV is competent on satellite navigation programmes carried out in the frame of the Agency, which presently include EGNOS and Galileo.

❖ **Programme Board on Space Situational Awareness (PB-SSA)**

The PB-SSA's role is to coordinate and monitor the execution of the Agency's preparatory and development activities for a Space Situational Awareness (SSA) programme.

The organisation is separated from the European Union. However, some 20% of the funds managed by ESA in the recent past have originated from the EU budget. ESA and the EU are indeed increasingly working together towards common objectives, through the EU's flagship programmes, such as Galileo, Copernicus, and Horizon 2020.

Article II states the purpose of the Convention of establishment of a European Space Agency:

> ESA's purpose is to provide for, and to promote, for **exclusively peaceful purposes**, cooperation among European State in space research and technology and their space applications, with a view to being used for scientific purposes and for operational space applications system.

One of the key issues for ESA is how to tackle climate change, not only as always on the top of the Member States' agendas. A coordinated global response on climate change is made difficult by the structural opposition between developed and developing economies and by the lack of consensus within the US on climate change policies. Despite some partial successes, however, the Conferences of the Parties often fell short their objectives. On the contrary, ESA soon became **one of the first arenas** for the civilian use of satellites for the environment. In 1977, the launch of its first Meteosat meteorological satellite marked the beginning of ESA's engagement in observing Earth from space. Then Meteosat satellites, ERS-1, ERS-2 and Envisat provided a great quantity of valuable data about Earth, its climate and changing environment.

A history of Earth Observation in Europe

TIMELINE

1986 – First European earth observation satellite (SPOT-1) launched
1998 – Initial idea for GMES at Baveno meeting
1999 – Resolution on shaping the future of Europe in space, supported by ESA
1999 – Resolution on developing a coherent European space strategy
2000 – GMES conference, Lille, France
2001 – Implementation strategy outlined in joint EC-ESA document
2002 – Launch of ENVISAT
2002 – 2006 Funding under 6th Framework programme (€230 million)
2004 – ESA releases funds for socioeconomic assessment (€80 million)
2005 – GMES established flagship programme within European Space Policy
2006 – Graz dialogue addressed marketing of GMES services
2007 – 2013 Funding under Seventh Framework programme (€1.4 billion)
2008 – Launch of pre-operational phase
2009 – EC proposal for initial operations
2011-2013 – Initial operations
2012 – ENVISAT finally stopped transmitting
2012 – GMES renamed Copernicus
2013 – Planned launch of first Sentinel satellite by ESA
2014 – Full operations

Fig. 12 - Earth observation in Europe 1986- 2014 ('Science for Environment Policy - Earth Observation's Potential for the EU Environment'[127], European Commission)

However, for the climate issues, we must wait for Copernicus, previously known as **Global Monitoring for Environment and Security (GMES)**, a flagship programme of the European Union in partnership with the European Space Agency. For the EU, Copernicus is a tool of economic development and a driver of innovation.

[127] Science Communication Unit, University of the West of England, Bristol (2012). Science for Environment Policy Future Brief: Earth Observation's Potential for the EU Environment. Report produced for the European Commission DG Environment, February 2013, http://ec.europa.eu/science-environment-policy (consulted in November 2021).

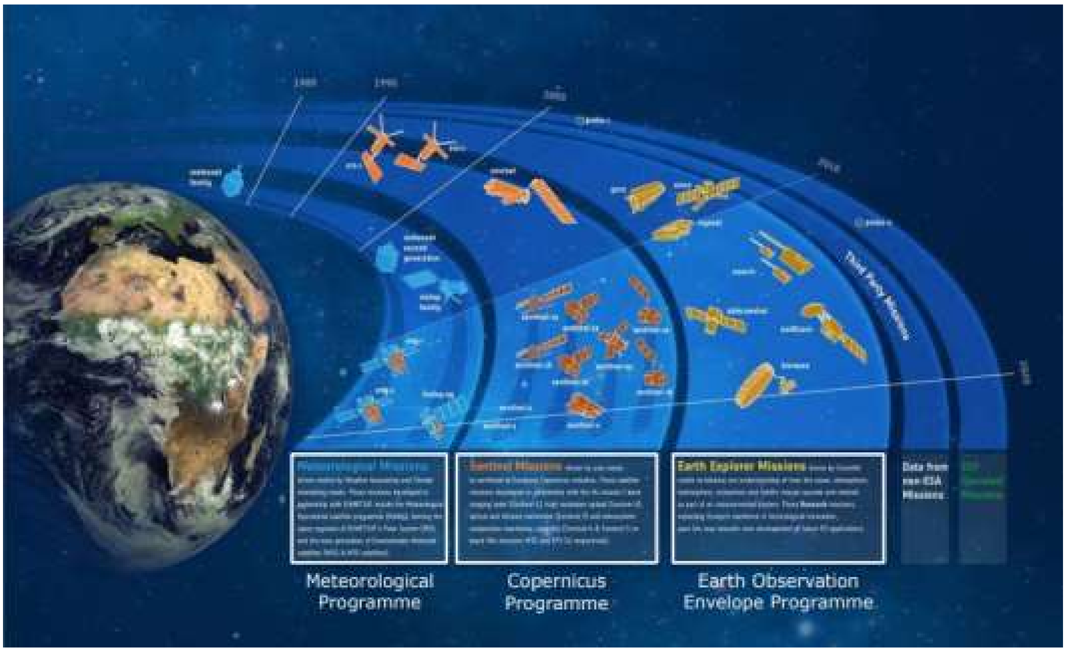


Fig. 13 - European Earth Observation Programmes
Sarti, Francesco. 'ESA Earth Observation Programme and Related Educational Programme. Data Access 8th ESA Training Course on Radar and Optical Remote Sensing'. ESA, 2016.

Copernicus provides the necessary data for operational monitoring of the environment and for civil security:

- It monitors the environment and its ecosystems;
- It prepares crisis, security risks, and natural disasters;
- It strengthens the EU's soft power.

Data is full, free and open, and the combined data with other satellites archives are used for climate monitoring, modelling and prediction. The real value would emerge from space-based to be combined with data collected on the ground («*in situ* data»). Copernicus indeed need to integrate satellite and *in situ* observations to obtain useful analysis of huge amount of not only environmental data, but also security applications such as borders surveillance, maritime surveillance and support to EU External Action. In the case, data is strictly restricted to authorised users.

Fig. 14 – Copernicus
Sarti, Francesco. 'ESA Earth Observation Programme and Related Educational Programme. Data Access 8th ESA Training Course on Radar and Optical Remote Sensing'. ESA, 2016.

The **Copernicus Sentinel missions**, part of the Copernicus Space Component, collect long-term datasets.

Tab. 3 – ESA's Sentinel Missions.

Name	Functions	Launch
Sentinel-1	Land and ocean services.	Sentinel-1A was launched in 2014 and Sentinel-1B in 2016. Soyuz rocket from Europe's Spaceport in French Guiana.
Sentinel-2	Land monitoring to provide, for imagery of vegetation, soil and water cover, inland waterways, and coastal areas.	Sentinel-2A was launched on 23 June 2015 and Sentinel-2B followed on 7 March 2017.
Sentinel-3	Sea-surface topography, sea- and land-surface temperature, ocean colour and land colour with high-end accuracy and reliability. The mission supports ocean forecasting systems, as well as environmental and climate monitoring.	Sentinel-3A was launched on 16 February 2016 and Sentinel-3B joined its twin in orbit on 25 April 2018.
Sentinel-5 Precursor	To provide timely data on a multitude of trace gases and aerosols affecting air quality and climate.	Sentinel-5P was taken into orbit on 13 October 2017 on a Rockot launcher from the Plesetsk Cosmodrome in northern Russia.
Sentinel-4	To monitor atmosphere, embarking upon a Meteosat Third Generation-Sounder	

	(MTG-S) satellite in geostationary orbit.	
Sentinel-5	To monitor the atmosphere from polar orbit aboard a MetOp Second Generation satellite.	
Sentinel-6	To measure global sea-surface height, primarily for operational oceanography and for climate studies.	The first satellite was launched into orbit on 21 November 2020 on a SpaceX Falcon 9 rocket from the Vandenberg Air Force Base in California, US.

The overall **programme coordination** is divided in **components** and **competences**:

- *Space* component: coordinated by ESA with industry, private companies, national space agencies, Eumetsat as partners.
- *Services* component: coordinated by European components with the support of services operators.
- *In-Situ* component: coordinated by EEA with the contribution of national environmental agencies.

The main features of Sentinel data policy:

- Open access to Sentinel data.
- Free of charge data licenses.
- Restrictions possible due to technical limitations or security issues.

The Earth Explorers are research missions designed to address key scientific challenges identified by the science community. Europeans saw the opportunity for international cooperation, to boost the scientific domain and the technological development of new missions.
The demand for satellite data for many practical applications to constantly monitor the environment’s variations grew. In response, the **ESA's Living Planet Programme** was formed by a science and research element, which includes the *Earth Explorer missions* and an *Earth Watch element*, designed to facilitate the delivery of Earth observation data for use in operational services. By time, the ESA

Living Planet Symposium became of the biggest Earth observation conferences in the world. It takes place every three years, by bringing together scientists and researchers from all over the world to discuss the latest findings on advances in Earth observation technologies. The Living Planet Symposium 2022 will be at the forefront of sustainability for international conferences, and a certified sustainable event [ISO20121][128]. The LPS22 sustainability objectives are conceived in the context of the three principal factors causing climate change:

- Greenhouse gas emissions from the burning of fossil fuels;
- Deforestation;
- Intensive agriculture.

Furthermore, LPS22 tends to achieve a zero-waste strategy avoiding single-use plastics and keeping to a minimum printed material.
Some examples of satellites from the family of Earth Explorer missions are the result of this strategy to try to limit climate change to underline the process, to anticipate when and where phenomena will happen, to develop mitigation and prevention strategies, and at the end, to formulate policies:

- **CryoSat: ESA's ice mission**
- **FLEX: ESA's plant health mission**

Copernicus can be considered as a pillar along with other EU initiatives, such as SEIS (Shared Environmental Information System) and INSPIRE (Infrastructure for Spatial Information in the European Union). In 2007, the Space Council – ESA and members of the European Commission – adopted the Resolution on the European Space Policy, inviting proposals from the Commission for financing and operating what was then GMES (EU 4th Space Council, 2007)[129]. The INSPIRE Directive came into force in 2007 and will be implemented in various stages, with full implementation required by 2021[130]. The **INSPIRE Directive** aims to create a European Union **spatial data infrastructure** for the purposes of EU environmental

[128] https://lps22.esa.int.
[129] 4th Space Council of the European Union, Resolution on the European Space Policy, https://www.copernicus.eu/sites/default/files/2018-10/Resolution_EU_Space_Policy.pdf (consulted in November 2021).
[130] Infrastructure for Spatial Information in the European Community, http://inspire.ec.europa.eu/ (consulted in November 2021).

policies and activities. The programmes and measures laid down in thematic environmental legislation and policies having an impact on the environment (such as agriculture, transport, energy, spatial development, etc.) generally entail **the mitigation of risks** arising from societal pressures on the environment or those related to **natural or man-made hazards** potentially leading to disasters (with climate change as a driving factor)[131].

Public consultations, undertaken during the preparation of the INSPIRE directive, agreed that at all levels, from local to European:

- Spatial data is often missing or incomplete.
- Spatial datasets can often not be combined with other spatial datasets.
- Cultural, institutional, financial, and legal barriers prevent or delay the sharing and re-use of existing spatial data.

As a member of the Group on Earth Observations (GEO), the European Commission is also collaborating with 88 participating governments to build a worldwide network of EO systems – a Global Earth Observation System of Systems (GEOSS)[132].

If we look at ESA budget by domain, we can notice that EO's budget allocation is 22%, so the highest expenditure item (fig. 15 and 16).

[131] *Ibidem.*

[132] Science Communication Unit, University of the West of England, Bristol (2012). Science for Environment Policy "FUTURE BRIEF: Earth Observation's potential for the EU environment". Report produced for the European Commission DG Environment, February 2013, ://ec.europa.eu/science-environment-policy (consulted in November 2021).

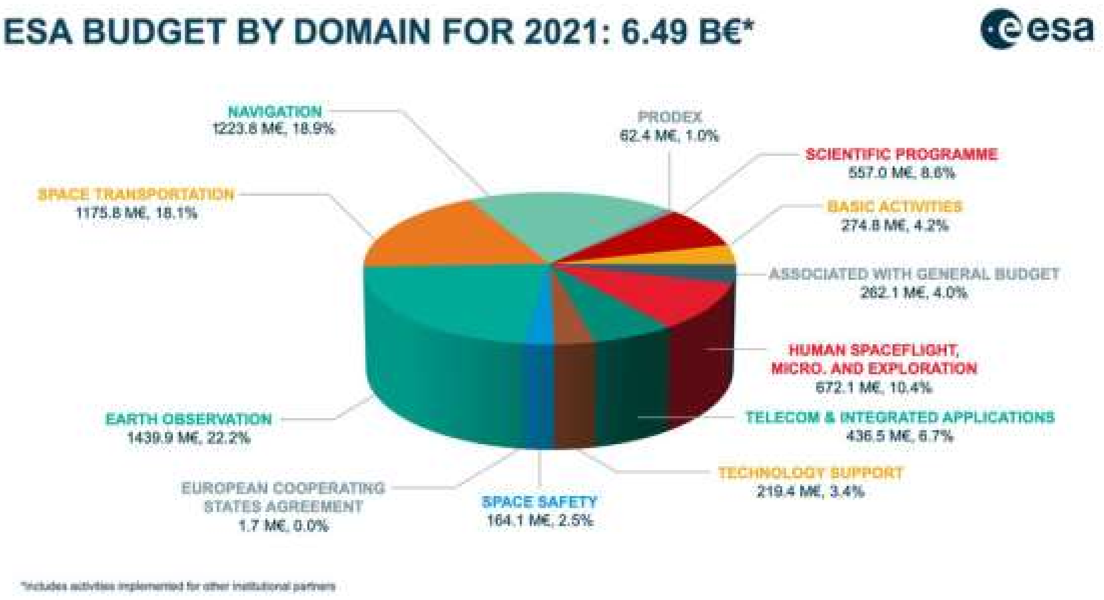


Fig. 15 – ESA budget by domain for 2021

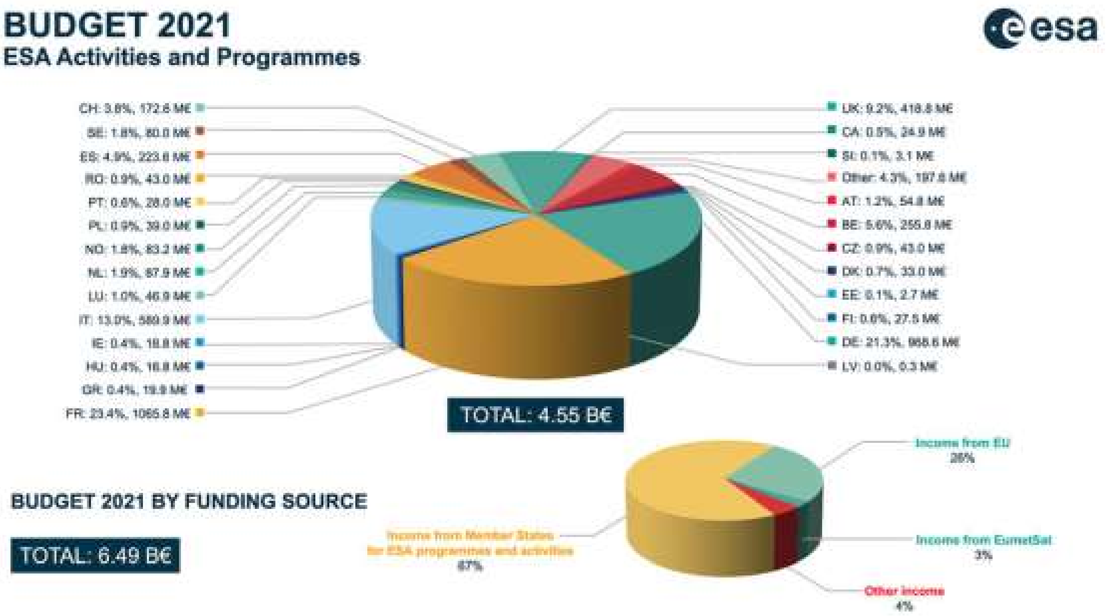


Fig. 16 – ESA budget 2021 by funding source

The *Compulsory* Program includes the activities of the scientific program, infrastructure costs and general basic activities. This program is funded with the contribution of all the member states of the Agency. For *optional* programs, the choice of the level of contribution for each program is left to the individual Participating Countries.

ESA operates on the basis of **geographical distribution criteria** (the so-called fair return), and it guarantees that the investments made in each Member State, through industrial contracts for space programs, are proportional to its contribution. This feature has allowed ESA to increase the number of its member states, and consequently also to obtain a gradually increasing budget over the years.

In 2022, the Member States of the European Space Agency have adopted a budget of €7.2 billion, as announced Director General Josef Aschbacher. This is an increase of 10% compared to 2021, with €2 billion came from the European Union and about €500 million from third parties[133].

3.3. SATELLITE - BASED OBSERVATION FOR CLIMATE CHANGE

why: 1) underlying the process 2) when and where phenomena happen 3) mitigation 4) prevention 5) policy

- **CryoSat: ESA's ice mission**

Tab. 4 – CryoSat: ESA's ice mission.

ROLE	Earth observation (EO)
LAUNCH DATE	8 April 2010
LAUNCHER/LOCATION	Dnepr/Baikonur Cosmodrome, Kazakhstan
LAUNCH MASS	720 kg
ORBIT	Low-Earth, non-Sun-synchronous; 717 km
PERIOD	100 minutes
NOMINAL MISSION	3.5 years

https://www.esa.int/Enabling_Support/Operations/CryoSat-2_operations

One of the biggest challenges in polar science is measuring the thickness of the floating sea ice that blankets the Arctic and Southern Oceans[134]. However, there is a strong link between Arctic Sea ice and climate: changes in ocean circulation patterns and weather are associated with changes in sea-ice cover, while melting of this ice has no direct effect on sea level because it is already floating[135].

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[133] AGENCE EUROPE, https://agenceurope.eu/en/bulletin/article/12856/8 (consulted in November 2021).

[134] NASA, https://svs.gsfc.nasa.gov/4841(consulted in September 2021).

[135] ESA, 2010, *ESA Communications BR-199. ESA's Ice Mission CRYOSAT*, https://esamultimedia.esa.int/multimedia/publications/BR199_LR.pdf (consulted in November 2021).

CryoSat (also called CryoSat-2) is the European Space Agency satellite mission monitoring the effect of climate change on ice in Earth's polar regions: the centimetre-scale changes in the thickness of ice floating in the oceans and in Greenland and Antarctica. These measurements show how the ice extent and volume of Earth's ice is varying to better understanding the relationship between ice and climate. The satellite can also be used to study water levels in lakes and rivers.

The story of this satellite started with a failure: the first CryoSat mission, launched in 2005 on a Rockot launcher, was destroyed during a launch malfunction. Then, CryoSat was totally lost just a few minutes after launch and before the ESOC Mission Control Team even had the chance to acquire the satellite.

The satellite was launched from the Baikonur Cosmodrome in Kazakhstan on April 8, 2010, on a Russian launch vehicle, to circle Earth in a polar orbit.

The features facing the CryoSat mission falls into two areas:

1. To acquire accurate measurements of the thickness of floating sea ice so that annual variations can be detected.
2. To survey the surface of the ice sheets accurately enough to detect small changes.

Its principal instrument on board is the SAR Interferometric Radar Altimeter (SIRAL), which is designed to measure changes of less than 1 cm per year in the height of ice. SAR (Synthetic Aperture Radar) is a technique that uses short radar bursts to make an image.

The satellite does not have any deployable solar panels. This choice had a very significant cost saving, but, at the same time, it poses some problems for the provision of adequate solar power in CryoSat-2's unusual orbit. The solar panels are fixed to the satellite body, forming a «roof» at a carefully optimised angle, which provides adequate power under all orbital conditions and still fits within the launch vehicle[136].

A Commissioning Phase lasted six months, consisting in verifying the performance of all elements of the system: satellite platform and payload, orbit, ground segment

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[136] ESA, CryoSat-2 operations, https://www.esa.int/Enabling_Support/Operations/CryoSat-2_operations (consulted in November 2021).

and science data processing facilities. The Commissioning Phase was successfully concluded, allowing the mission to formally transition into the routine phase. In this period, the teams were supported under flights by NASA's Icebridge team, which allowed parallel aberrations from CryoSat and a radar flown in an aeroplane by NASA over the Antarctic and later over the Arctic. Aberrations cause the image through a lens to be blurred or distorted. NASA’s ICESat-2 satellite measures the Earth’s surface height by firing green laser pulses towards Earth and timing how long it takes for those laser pulses to reflect to the satellite. The laser light reflects off the top of the snow layer on top of the sea ice. In contrast, the European Space Agency’s CryoSat-2 mission uses radar waves to measure height. These radar waves penetrate the overlying snow and are reflected off the sea ice, rather than the overlying snow.

The single routine ground station for CryoSat is at the ESA/ESTRACK station in Kiruna (Sweden). The Kiruna S- and X-band station supports 18 satellites, including many of ESA's flagship missions such as Aeolus, CryoSat, Integral, the Swarm trio, the Sentinel series of Earth Observation spacecraft, Cluster and CHEOPS[137]. The CryoSat-2 ground segment at ESOC is using the SCOS-2000 mission control system. Mission planning is organised at ESOC while the payload is coordinated by ESA/ESRIN centre in Frascati (Italy). The large amount of data received from the payload and from the altimeter, is being pre-processed at Kiruna, before being sent to ESA/ESRIN for the final data processing.

CryoSat has also revealed how the world’s 200,000 mountain glaciers have succumbed to climate change, thanks to advanced swath processing of its radar measurements, which allows small regions to be mapped in fine detail[138].

Through its new synthetic aperture radar and interferometric capabilities, it has the foundation for the Copernicus Polar Ice and Snow Topography Altimeter (CRISTAL) operational mission. CRISTAL will serve to fill the gap in sustaining

[137] ESA, Kiruna station, https://www.esa.int/Enabling_Support/Operations/ESA_Ground_Stations/Kiruna_station (consulted in November 2021).

[138] ESA, Cryosat launch, https://www.esa.int/Applications/Observing_the_Earth/FutureEO/CryoSat/CryoSat_still_cool_at_10#:~:text=CryoSat%20has%20also%20revealed%20how,to%20study%20polar%20ice%20alone (consulted in November 2021).

long-term monitoring of polar ice variability for the Copernicus Climate Change Service and Copernicus Marine Environment Monitoring Service, and in support of the EU Integrated Arctic Policy and commitments to the Paris Agreement and Green New Deal.

NASA's ICESat-2 satellite measures the Earth's surface height by firing green laser pulses towards Earth and timing how long it takes for those laser pulses to reflect to the satellite. The laser light reflects off the top of the snow layer on top of the sea ice. In contrast, the European Space Agency's CryoSat-2 mission uses radar waves to measure height. These radar waves penetrate the overlying snow and are reflected off the sea ice, rather than the overlying snow.

In July 2020, ESA elected to slightly perturb the orbit of CryoSat-2 to increase the overlap with ICESat-2. Given their different orbit altitudes, the result is a ~3000km stretch of sea ice that is measured by both ICESat-2 and CryoSat-2. By combining data from these two sensors, scientists can measure the snow layer thickness, and produce substantially improved sea ice thickness estimates. Tom Neumann, ICESat-2 project scientist at NASA Goddard stated:

> This opens up new science possibilities that weren't possible with either mission independently, especially for sea ice science […]. It's a grassroots effort, promoted by the scientists and engineers asking if there was a way, we can make this happen[139].

Since 2015, European polar research institutions have been collaborating thanks to «EU-PolarNet», funded by the European Commission. This initiative represents the world's largest consortium of expertise and infrastructure for polar research, by the support of 22 research institutions across 17 European countries involved. Coordinated by the Alfred Wegener Institute for Polar and Marine Research (AWI) in Germany, the goal of the project is to create a close collaboration between Europe's institutions that conduct research in the Arctic and the Antarctic.

AWI director, Professor Karin Lochte, explains why a need was there to establish a network of European polar research institutions. Polar research is very relevant for policymakers. Researchers can inform decision-makers about what changes to expect and be prepared for, but polar research is a very expensive undertaking at

[139] RAMSAYER K., 2020, *Syncing NASA Laser, ESA Radar for a New Look at Sea Ice*, https://www.nasa.gov/feature/goddard/2020/syncing-nasa-laser-esa-radar-for-a-new-look-at-sea-ice (consulted in November 2021).

the national level. To save costs, EU-PolarNet has started to investigate how to make better use of each European country's polar logistical support and infrastructure.

EU has published its new Arctic Strategy, the EU has a particular interest in what is happening in the Arctic, so EU-PolarNet is trying to find synergies between the different national polar research programmes in Europe. IASC (International Arctic Science Committee) and SCAR (Scientific Committee on Antarctic Research) usually defined research priorities in the world of polar research - in both the Arctic and the Antarctic – at the international level.

Once IASC and SCAR identify research priorities, then the national research institutes in each country pick up on these priorities and design their individual national research programmes around them.

Supporting a robust, inclusive and sustainable development of the Arctic to the benefit of its inhabitants and future generations, the EU has the possibility to[140]:

1. Invest in the people: better education, sustainable growth and jobs, including in the blue economy increase the involvement of young, women and Indigenous Peoples in Arctic decision-making.
2. Stimulate an innovative green transition in Arctic regions.
3. Increase the involvement of young, women and Indigenous Peoples in Arctic decision-making.

3.4. SATELLITE - BASED OBSERVATION FOR AGRICOLTURE

- **FLEX: ESA's plant health mission**

A new mission - FLEX - is expected to be launched in 2025. A launch of the FLEX and ALTIUS missions is scheduled from Kourou on ESA's Vega-C launcher of Arianespace[141]. The mission was selected as the 8th Earth Explorer in ESA's Living Planet Programme in 2015. Thales Alenia Space will be leading a consortium for the FLEX program that includes its own subsidiaries[142] and partners from the space

[140] European Commission, 2021, *A Stronger EU Engagement for a Peaceful, Sustainable and Prosperous Arctic*, doi:10.2771/352540 (consulted in November 2021).

[141] Sharing Earth Observation Resources, https://directory.eoportal.org/web/eoportal/satellite-missions/f/flex (consulted in November 2021).

[142] The company's Spanish subsidiary will supply the satellite's radio-frequency subsystem, while Swiss technology company RUAG will design and produce the platform.

industry[143]. Thales' UK-based unit will be responsible for the satellite propulsion system, assembly, integration and testing (AIT) of the satellite[144]. European Earth observation activities help a data-driven transformation in agriculture to adapt to the challenges of climate change and global population increase.

High-resolution data generated by ESA missions are enabling scientists to build detailed pictures of the planet's environment, such as vegetation density, soil characteristics, seasonal conditions and possible changes in the long-term. This facilitates the development of sustainable technologies and strategies to enhance crop yields, to meet growing global food demands while constantly monitor adverse environmental impacts.

The FLuorescence EXplorer (FLEX) mission will provide global maps of vegetation fluorescence that can quantify photosynthetic activity and the status of plants' health and/or stress level. It is the fundamental mechanism underlying plant growth and productivity. These data help to understand how energy and mass exchange happen – when carbon moves between plants and the atmosphere - and how photosynthesis affects the carbon and water cycles, understanding the global carbon cycle, agricultural management and food security. This is relevant for the impact on the food production.

FLEX is a novel instrument capable of measuring photosynthetic activity from space, but it will fly in tandem with the Copernicus Sentinel-3 mission. FLEX will carry the high-resolution Fluorescence Imaging Spectrometer (FLORIS), which will acquire data in the 500 - 780 nm spectral range[145]. Leonardo will provide the spectrometer for the FLEX Space mission, which will study the actual photosynthetic activity of vegetation on a global scale[146]. Leonardo will lead a consortium of European companies, marking a leadership in the market of electro-optical instruments for the Space sector. In Campi Bisenzio site near Florence,

[143] Thales Alenia Space, 2019, *ESA chooses Thales Alenia space to lead the FLEX mission*, https://www.thalesgroup.com/en/worldwide/space/press-release/esa-chooses-thales-alenia-space-lead-flex-mission (consulted in November 2021).

[144] Aerospace Technology, 2019, *Thales and ESA sign €150m deal for FLEX satellite mission*, https://www.aerospace-technology.com/news/thales-esa-flex-satellite/ (consulted in November 2021).

[145] ESA, https://earth.esa.int/eogateway/missions/flex (consulted in September 2021).

[146] LEONARDO, 2016*, Leonardo will monitor the health of the Earth from Space Climate change. 74 million contracts from ESA*, https://www.leonardo.com/en/press-release-detail/-/detail/leonardo-will-monitor-the-health-of-the-earth-from-space (consulted in November 2021).

Leonardo, together with the Italian Space Agency and the scientific community, built numerous high-tech tools for international Space missions. These missions include Copernicus, Galileo, BepiColombo and Cassini.
A series of ground facilities will support the mission[147]:

- *Mission control*: ESA's European Space Operations Centre (ESOC) in Darmstadt, Germany. Additionally, the tandem operations with Copernicus Sentinel-3 will be coordinated with EUMETSAT.
- *Communication links*: X-band science data via Svalbard and Norway, and S-band telemetry via Kiruna in Sweden.
- *Data*: ESA's Centre for Earth Observation (ESRIN) in Frascati, Italy.

Environmental information generated by ESA's Earth observation activities has several applications for the agriculture sector, including predicting crop yields, monitoring crop damage, assessing the risk of water scarcity[148]. This kind of information can help governments to implement strategies that support sustainable food production, as well as facilitating rural innovations such as a targeted, flexible approach to agriculture.
The drivers of climate change and biodiversity loss are global and are not limited by national borders. The EU can use its influence, expertise and financial resources to mobilise its neighbours and partners to join it on a sustainable path.
On the other part of the Atlantic, to monitor agricultural systems, NASA utilizes satellite observations to assess a wide variety of geophysical and biophysical parameters, including precipitation, temperature, evapotranspiration, soil moisture and vegetation health. HARVEST is NASA's food security and agriculture program with the mission to enable adoption of satellite Earth observations by public and private organizations to benefit food security, agriculture and human and environmental resiliency[149]. In these programs, projects are co-developed with very different end-users, ranging from:

- Agricultural industry;

[147] ESA, https://earth.esa.int/eogateway/missions/flex/description (consulted in November 2021).
[148] ESA, https://earth.esa.int/eogateway/news/how-space-data-are-transforming-the-global-food-system (consulted in November 2021).
[149] NASA HARVEST, https://nasaharvest.org/about (consulted in November 2021).

- The food security early warning community;
- Global trade organizations/associations;
- The major national, regional and global policy frameworks, such as G20 Agriculture, UN Sustainable Development Goals, UNFCCC, Sendai Disaster Risk Reduction.

FAO findings indicate that the world is not going to meet most of the food and agriculture-related SDG targets by 2030[150]. Food insecurity is still rising, affecting currently around 26% of the global population. It results in an increase in food demand that highlights the need for sustainable agricultural models. The exponential growth in food demand is amplified by the following factors[151]:

1. Dietary changes leading to the consumption of processed, meat and dairy products;
2. Changes in lands due to desertification caused by global warming as well as increasing water scarcity;
3. Reduction of farmer populations due to urbanisation, as well as over-farming and soil degradation practices.

If cows were a country, they would be among the top greenhouse-gas emitters: current Agriculture and Livestock practices are responsible for generating around 20% of total GHG emissions, mainly due to methane, which is much more potent than CO2 in contributing to global warming[152].
A 1.5-degree pathway would require multiple changes to our food systems:

- Reduce the share of beef and lamb in global protein consumption;
- Adopt new rice-cultivation methods;
- Curb food loss and waste.

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[150] FAO, 2021, *Tracking Progress on Food and Agriculture-Related SDG Indicators 2021. A Report on the Indicators under FAO Custodianship*, https://doi.org/10.4060/cb6872en (consulted in December 2021).
[151] BROOM D. - BREENE K., 2020, *This Is Why Food Security Matters Now More than Ever*, https://www.weforum.org/agenda/2020/11/food-security-why-it-matters/ (consulted in December 2021).
[152] HENDERSON K., 2020, *Climate Math. What a 1.5-Degree Pathway Would Take. Decarbonizing Global Business at Scale Is Achievable, but the Math Is Daunting*, Chicago, McKinsey Quarterly, https://www.mckinsey.com (consulted in December 2021).

The Think20 (T20) is the official engagement group of the G20, bringing together leading think tanks and research centres worldwide[153]. It serves as a ideas collector for the G20 and aims to provide policy recommendations to the G20 political leaders. ISPI (Italian Institute for International Political Studies) was the National Coordinator and Chair of the T20 Italy, with IAI (Istituto Affari Internazionali) as the T20 Co-Chair and Bocconi University as the T20 Summit Co-Chair. The Task Force called «TF2: Climate Change, Sustainable Energy & Environment» suggest some policy briefs recommendations. One of these policy briefs regards «repurposing agricultural policy support for climate change mitigation and adaptation». The premise is that agricultural production is both a victim of climate change and a major contributor to it. The agriculture and land-use change account for total global greenhouse gas emissions is more than for transport or industry. The 2021 G20 brief summarises that simple elimination of all existing support measures would do little to reduce global emissions from agriculture, but the latter could be cut by as much as 40% by «smart repurposing», which would shift resources towards R&D and generate incentives for the widespread adoption of productivity-enhancing and climate-resilient production practices[154]. To support international coordination of the smart repurposing of agricultural subsidies, the first step is monitoring and evidence for informed policy decisions, then strengthening of the AgIncentives Consortium established by several international organisations (FAO, IADB, IFPRI, OECD and The World Bank) to monitor agricultural policies. This let the AgIncentives Consortium provide comprehensive scenario analyses to improve effective and smart repurposing of existing agricultural support measures in line with objectives of sustainability of food systems, poverty reduction, food security and affordability of healthy and cultural diets.

Food security represents one of the world's greatest challenges. Not only it is the second ranked among the 17 Sustainable Goals in the United Nations 2030 Development Agenda, but also other SDGs are directly related to the agriculture impact on health, poverty, water and climate. To effectively address this challenge,

[153] Think20 (T20), https://www.t20italy.org/about/think20/ (consulted in December 2021).

[154] LABORDE DEBUCQUET D. (IFPRI), 2021, *TF2 – Climate Change, Sustainable Energy & Environment «Repurposing agricultural policy support for climate change mitigation and adaptation»*, https://www.t20italy.org/2021/09/21/repurposing-agricultural-policy-support-for-climate-change-mitigation-and-adaptation-2/ (consulted in December 2021).

timely data and information on food production, agricultural practices and natural resources is required to be available, analysed and understood by scientists and policymakers.

India is the current chair of BRICS 2021. Among BRICS, China accounts for 21.4% of global agricultural production, but, at the same time, virtually all its output is consumed domestically. Despite these impressive indicators, prevalence of undernourishment remains high compared to the rest of the BRICS countries, except India[155]. China's losses of agricultural lands at 37% of the nation's entire territory. Soil degradation, drought and expanding disaster-prone areas pose a serious threat both to the agricultural sector and the economy. Agriculture is the foundation of the Indian economy: indeed, India's agro-industrial sector accounts for nearly 50% of the working population, while 70% of Indian families depend on agriculture for their income. The BRICS Remote Sensing Satellite Agreement, that has been signed between the partner nations, will help accelerate cooperation between BRICS nations in the peaceful use of outer space with use of data and applications across an array of sectors, such as research in global climate change, agriculture and food security, disaster management and water resource management[156]. The Secretary Sanjay Bhattacharyya underlines the willing of BRICS to significantly contribute towards the 2030 Sustainable Development Agenda targets and goals.

In 2021, ESA, a world leader of Earth observation data, and FAO signed a «Memorandum of Understanding», an agreement covering several thematic areas, including food security, water-related SDGs and forestry statistics, by taking advantage of the digital transformation in agriculture. Satellites can provide data to fill information gaps and contribute to improving national statistics, as well as support innovative data analytics based on synergies between field survey

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[155] BELOTOSTOTSKAYA A. - ZAITSEVA N., *Can BRICS Feed the World?*, in *BRICS Business Magazine*, https://www.bricsmagazine.com/en/articles/can-brics-feed-the-world (consulted in November 2021).

[156] *BRICS remote sensing satellite agreement will accelerate peaceful use of outer space. MEA Secretary,* 2021, in *India News Network*, https://www.indianewsnetwork.com/20210818/brics-remote-sensing-satellite-agreement-will-accelerate-peaceful-use-of-outer-space-mea-secretary (consulted in November 2021).

information and satellite observations[157]. In 2011, the G20 agricultural ministers further identified the transparency of agricultural markets as essential for food security and launched the GEOGLAM initiative to «strengthen global agricultural monitoring by improving the use of remote sensing tools for crop production projections and weather forecasting»[158]. National agricultural monitoring data is in general collected by farm and household surveys, but recently the potential of satellite Earth Observation (EO) for agricultural statistics has been recognized as well.

The Copernicus program and its observations collected by its Sentinel satellites provide open and free data relevant for agricultural monitoring. In particular, the Sentinel-1 and -2 missions can provide geospatial information on crop area estimates, crop type and status as well as on agricultural practices in a timely fashion. The potential of Sentinel-2 observations for national scale agricultural monitoring was successfully demonstrated by the Sen2Agri project in Mali, South Africa, and Ukraine.

3.5. ITALIAN EARTH OBSERVATION PROGRAMMES

ESA-ESRIN is the European centre of excellence for exploitation of Earth observation missions in Frascati, near Rome. ESRIN acts as an interface between ESA and those who use its services. The centre has close links with European industry, the European Union and the civil protection, agriculture and environment ministries within ESA Member States[159].

The most directly observation programme related to the Common Agricultural Policy, was the generation of crop statistics - the MARS programme - for the entire territory of the European Union solely from satellite-based optical imagery (both Landsat and SPOT). The European Community started to invest directly in space-based observation through the VEGETATION instrument carried on the SPOT-4 and SPOT-5 satellites.

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[157] ESA, 2021, *ESA and FAO unite to tackle food security and more*, https://www.esa.int/Applications/Observing_the_Earth/ESA_and_FAO_unite_to_tackle_food_security_and_more (consulted in December 2021).

[158] Sen4Stat Concept Paper Satellite Earth Observation for Agricultural Statistics, https://esa-sen4stat.org/ (consulted in December 2021).

[159] ESA, https://www.esa.int/About_Us/ESRIN/ESRIN_overview (consulted in November 2021).

The origins of the Copernicus programme, that can be traced back to a series of meetings involving the European Commission and European space industry representatives in Baveno, Italy, in 1998. The result was the Baveno Manifesto, which called for a «long-term commitment to the development of space-based environmental monitoring services» in Europe[160]. This represented a call for Europe to act together for enhancing environmental monitoring from space and to define a well-articulated strategy in climate change. The *Baveno initiative* was an attempt to develop a «European Strategy for Space», which requires a closer ESA and the European Union's cooperation.

The recognition of the complementarity of space and *in-situ* observations led to the introduction of the concept of an «Integrated Global Observation Strategy» (IGOS). This allowed the creation in 1998 of the IGOS Partnership (IGOS-P). IGOS-P was an attempt to put together the space-based, *in situ* and other observation networks in a coherent manner, to let the members integrate and share information with the user and scientific research communities, as equal partners, organised at the global level through programmes and international organisations sponsoring these programmes. European participation in the discussions was extended to representatives from the European Commission research directorate, from ESA, Eumetsat and the national space agencies of France, Germany, Italy and the UK. It was recognized that Europe had difficulty transforming R&D-driven space-based observations into operational systems at the service of concrete needs of society. This situation encouraged the different stakeholders to join a series of meetings to develop a plan for the creation of a European strategy in Earth observation. It emerged the idea that a global environment information service would represent a relevant solution to the implementation of the Kyoto Protocol. Through its Joint Research Centre and its Space Applications Institute (SAI) in Ispra, Italy, developing several research topics and applications from remote sensing data.

Currently, Simonetta Cheli is the Director of Earth Observation (D/EOP) and Head of ESRIN, in Frascati, Italy. Born in Siena, Italy, she studied law and economics at Yale University in the United States, before gaining a degree in political sciences

[160] BRACHET G., 2004, *From initial ideas to a European plan. GMES as an exemplar of European space strategy. Space Policy*, DOI: 10.1016/j.spacepol.2003.11.002 (consulted in December 2021), pp. 7–15.

with a thesis on international satellite telecommunication law at the University Cesare Alfieri in Florence, Italy. She joined ESA in 1988, working in International Relations, Programme and Strategy, then moved to ESRIN in 1999.

We must go back to about fifty years ago, to discover the creation of ESA/ESRIN centre. ESRO had to face the choice of location for the new organisation's three main establishments (a headquarters, a technical centre and data processing centre), determined by political and considerations formalized in an agreement. Luigi Broglio, the chief figure in the Italian national space programme and Vice-Chairman of the European Preparatory Commission for Space Research (COPERS), proposed an additional facility for Italy with a different focus. In 1962, delegations recommended to COPERS that a laboratory should be established in Italy. When the signature of the ESRO convention took place on 14 June 1962, the Broglio's proposal was accepted. It was supported by Amaldi, to build the European Space Laboratory for Advanced Research (ESLAR), later called the European Space Research Institute (ESRIN). The proposal made by the Italian delegation at first raised a lot of criticism because of its distance from the European Space Research and Technology Centre (ESTEC) in Noordwjik, Holland. In formulating his proposal Broglio did however stress that, for the activities proposed for ESLAR, it did not really need to be close to ESTEC[161].

Then, another part of the Italian story in space – and, in particular, the creation of the Italian Space Plan - is taken by a speech by the Italian Ambassador Umberto Vattani, during the «Diplomacy and Space seminar», organised by prof. David Burigana (University of Padua) on December 14, 2021, and «ExPoSTID ExPost Italian Diplomacy» Spring School 2022 organised by prof. David Burigana, Lucia Coppolaro (University of Padua) and Marilena Gala (Roma Tre University), in Rome.

The birth of Tethered satellite, invented by Grossi and Colombo, was not linear. Although the idea was conceived in 1972, only in 1979 was a serious project proposed to NASA built and this happened for reasons very different from pure scientific research. It was a way to innovate the Italian Space Agency and to get

[161] DE MARIA M. - ORLANDO L. - PIGLIACELLI F., 2003, *HSR-30, Italy in Space 1946–1988*. p. 9, R.A. Harris. ESA. https://www.esa.int/esapub/hsr/HSR_30.pdf.

back from the European Space Agency the investments paid and never returned in the form of projects. In 1979, the President of the Council of Ministers was Francesco Cossiga, in his first government experience. Vito Scalia, a minister without portfolio of scientific and technological development, was appointed. A Minister without both a plan and organigram and in a critical economic situation. Scalia let his Ministry, even without funding, became the operational arm of the newly founded CNR (National Research Council). The Head of Cabinet of Minister Scalia, Umberto Vattani, presented himself to the ESA Council for the approval of the 1979 budget, with the directives to try to fix the *just retourn* of Italian investments. Since 1974, Roy Gibson was Acting Director General of ESRO, to the transition of ESRO and ELDO to form ESA in 1975. He was the first Director General of ESA, from 1975 until 1980. Since 1987, he has worked on the establishment of the European Environmental Agency.

In a meeting with Roy Gibson and other European functionaries, Vattani had analyzed the Italian problem, for which European partners showed absolute indifference. Vattani then threatened to not take part in the annual budget, depriving ESA of Italian economic support, but even this did not upset its foreign counterparts, which did not feel threatened by Italy.

Scalia and Vattani went to the Budget Minister Andreatta, asking for money and resources and the request of the two was accepted. The basic idea for the next project was to show European colleagues what Italians can do. The Italian Space Agency (ASI) was reformed in its organization chart, selecting excellent human resources, and in two months the space plan was ready. It was detailed and accurate, reporting cost items for launchers, remote sensing and new satellites. At the end, it was approved by Parliament. Italy went to NASA instead of them, offering to collaborate. The meeting between Vattani, Colombo and Broglio, father of the Italian astronautics, and Captain Freitag took place in Orlando, Florida. Freitag congratulated himself on the punctuality of the spatial plan.

The Italian relaunch consisted in the request to satisfy at least three requirements:

- A complete project;
- Visible and evident;
- One thing that only Italian can know how to do, technologically advanced.

Freitag asked if such a thing already existed, so Bepi Colombo proposed the first satellite Tethered prototype. Upon approval by NASA, the Italian requests for the European budget were also accepted. It was a remarkable scientific success that Bepi Colombo could not see because he passed away in 1984. His work at NASA was carried out by Silvio Bergamaschi, his student and founder of CISAS (Interdepartmental Center for Space Studies) in Padua.

In 2013, coinciding with the celebration of the first 50 years of space collaboration between Italy and the United States, the two countries signed a framework agreement in Washington on cooperation in the use of space for peaceful purposes by fostering cooperation between respective space agencies and procedures for conducting scientific projects. The agreement was signed by Italian Ambassador Claudio Bisogniero and Director General for Scientific Affairs of the U.S. Department of State Kerri-Ann Jones, in the presence of Director General of the Italian Space Agency (ASI) Enrico Saggese and Deputy Director of NASA Lori Beth Garver[162]. The agreement paved the way to new scientific, technological, and economic opportunities. In 2017, at the Italian Embassy in Washington DC, NASA Planetary Science Division Director Director Jim Green and Enrico Flamini, Scientific Coordinator of the Italian Space Agency (ASI) signed the NASA's Solar System Exploration Research Virtual Institute SSERVI Associate partnership agreement[163].

[162] *ITALY-USA. Italian Space Agency-NASA collaboration agreement signed*, March 19, 2013, https://www.esteri.it/en/sala_stampa/archivionotizie/comunicati/2013/03/20130319_italia_usa_accordo_agenzia_spaziale/ (consulted in December 2021).

[163] *NASA, Italy to Collaborate on Planetary Science and Space Exploration*, https://sservi.nasa.gov/articles/nasa-italy-to-collaborate-on-planetary-science-and-space exploration/ (consulted in December 2021).

3.5.1. INTERVIEW WITH GIOVANNI CAPRARA

Giovanni Caprara is a scientific editorialist for the *Corriere della Sera.* In 1984 he published his first essay, *The Book of Space Flights*, which was followed by other thirty books, distributed throughout Europe and the USA. He is President of UGIS, Unione Giornalisti Italiani Scientifici (Union of Italian Scientific Journalists). Among Caprara's numerous interviews, there are those with astronauts as Neil Armstrong as well as the British astrophysicist Stephen Hawking. He wrote a book with Italian astrophysicist Margherita Hack. In 2014, he was declared Knight Order of Merit of the Italian Republic and in 2016 he awarded the Prize for scientific communication of the Italian Physical Society.

Your book "From space for the Earth" written with Simonetta Cheli expresses the idea that space services and their applications from space to Earth are essential to protect the environment, so I wanted to ask if this could contribute to space being peacefully developed, also taking into consideration the wider context of the Cold War.

I think so, even though sometimes it is difficult to believe and prove. In the West we have government agencies that work towards the objective of protecting the environment and all their efforts are made public. In other countries, such as in China and Russia, the scope and objective of space launches is not always clear. Satellites today are designed with a dual purpose, both civilian and military. Data gathered since the earliest days of Earth observation has always been used by Defense agencies. The USA studied Soviet agricultural cultivation to establish what their economic conditions were. This was critical information that influenced the relationship between the two superpowers. There are satellites that carry out observation for civilian purposes, but often these observations are also used by the military.

With this in mind, the civilian use of satellites for the environment can certainly help to improve nations' conditions and allow the most appropriate management and assessment of nations' territory.

An exchange between countries of their respective handling of climate change research is paramount. But applications are variable and diverse. If developing countries are given the possibility to study the environment – this happens for example in the partnership between Italy and Kenya at the Italian station in Malindi where satellites transmit Earth observations. Facilities like this one are very helpful in countries' development, both rich and poor.

Environmental policy decisions are based on accurate information regarding the planet's current state and future predictions. Environmental data provided by satellites offer us a unique opportunity to assess environmental policy effects and impact. In your opinion is this process proportionately effective to the amount of feedback received?

Without extra-terrestrial activity in the form of satellite observation environmental policies are not possible, simply because the Earth is a complex system that needs to be observed as a whole from space. We should remind ourselves that the first satellite launched in space was supposed to be American and the objective was to observe the Earth from orbit. Then the Soviets, just to beat the Americans launched Sputnik which however did not make any observations. At the beginning of 1958 the Americans launched their first satellite: the Explorer, with which they discovered the Van Allen belts that shielded the Earth from cosmic and solar radiation thus allowing the birth of life on Earth. It was a fundamental discovery that demonstrated how important it was to see the Earth from space in order to see it as a planetary object. Since then, it has been a race to different kinds of satellites made to gather specific data. In the 1980s, to give another example, the hole in the ozone layer was discovered above Antarctica by American and then Soviet satellites. Before this there were only generic observations gathered on Earth, but it was not possible to understand the entity of the phenomenon. Final confirmation was only possible by going above the atmosphere. Throughout the decades different generations and types of satellites have been developed. Today for example there are various "space eyes" that study the atmosphere and the earth's surface in different ways. There are satellites that examine winds, the surface, ice sheets and the oceans. The latter gather particularly important data seen as the oceans interact continuously with the atmosphere influencing it greatly. Other satellites check sea conditions from variations in temperature to wave heights. Others measure evaporation. All together they allow us to assess the evolution of our planet. The Earth is a dynamic system which is continuously changing, and this is why it is necessary to send a great number of satellites in orbit and furthermore correctly employ new technology ad aim for integration of data collection methods. Only in this way is it possible to obtain reliable information. For example, in the case of the hole in the ozone layer, until the 1990s of the last century satellite's observation technology was not up to the task and it was difficult to confront data. Today this problem has been resolved, although it still requires global effort. This is the only way to provide politicians with accurate data in order to elaborate environmental policy decisions which influence the economy as well. To this end satellites launched are more and more specialised, for example they detect variations in CO2 levels, a fundamental piece of information in environmental policies.

How do we preserve and reconcile the inherent complexity of scientific knowledge with the necessity to make it more accessible to everyone? The mediatory role of communication and the political implications.

I would say scientific literature today is essential due to the fact we live in a more and more scientific and technological social dimension. Just think about what has been happening for the last few years: from the arrival of artificial intelligence to climate change. They are all daily discussion points which are not limited to scientists and people to work in technology, these arguments are discussed in Parliament. Consequently, I would say its paramount that media confronts itself with these issues in order to provide specific scientific information, taking into account on one had the urgency and on the other the need to inform. Furthermore to educate people through precise, constant and thorough information. Today we have several means of communication at our disposal that have to be used correctly to guarantee forma mentis which is able to pick up the values of continuously evolving knowledge. In order to report on the world, on the journalistic side its necessary first of all to interpret concepts rather than simply transmit technical information. A science journalist must highlight, through constant training, core conclusions and result and be able to relay the meaning of the continuous evolution of scientific knowledge in its fundamental principles. Science journalism is a magnificent adventure in which I am immersed: science is made of discoveries, adventures and navigating these aspects you can pick up the elements that can excite those who are involved in them directly or occasionally. Chance involvements can become a habit, and a habit can itself lead to passion.

What advice could be useful for a young person wanting to follow in your footsteps and start a career in the field of scientific journalism?

Firstly, we must be aware that this field totally encompasses life, work and one must be passionate. Then a passion can becomes an opportunity. One must start writing without worrying about where one's works might be published. The important thing is to begin in this field, where one can start to build a professional profile. One must be determined and identify contacts and with which relationships can be established. One must just dive in! You must write, be very rigorous and be involved with the facts you want to write about. You must be respectful in relaying what you listen to and verify with different sources. Only in this way is it possible to write pieces that deserve to be read. Articles do not have to be novels, they only must present facts and people with humility, conscientiousness and competence.

CONCLUSIONS

Research and development (R&D) have profoundly transformed people's lives in multiple ways, as well as the natural environment. The Frascati Manual (2015) remarked that through research, policy analysts and decision makers can collect information about the level and nature of both human and financial resources that different countries, regions, firms, and institutions, as a first step towards favouring and improving actions to achieve the desired objectives[164].

This research focuses on a people-centered approach, through different point of view from multiple stakeholders to try to capture the negotiation/conflict interactions, the global vision, interdisciplinary issues, and the role of institutions.

Science diplomacy broadly identifies interactions between scientific and foreign policy connected to the promotion of international scientific exchanges, to establish constructive relations between countries, and the provision of scientific advice on global issues[165].

Globalisation had strong impact on science, technology, and innovation. Politicians increasingly need scientists to offer solutions to complex global challenges, such as climate change, food security, poverty, energy consumption, nuclear disarmament, and more recently the Covid-19 pandemic. The rise of new scientific powers - China, India, Brazil - partly explain the shift to an increasingly multipolar scientific world, challenging the Western nations hegemony in the field. Profound transformations took place during the dissolution phase of the Soviet Union and the end of the Cold War. With a new balance of power, the world has also witnessed a growth of networks of interdependence that transcend national and regional boundaries.

Today's diplomacy is very different from traditional diplomacy. However, the definition of 'science diplomacy' is still fluid. On one hand, national interests are crucial for science diplomacy, but, on the other hand, diplomacy was needed to

[164] OECD, 2015, *Frascati Manual 2015. Guidelines for Collecting and Reporting Data on Research and Experimental Development. The Measurement of Scientific, Technological and Innovation Activities*, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264239012-en (consulted in December 2021).

[165] TURCHETTI S. - LALLI R., 2021, *Envisioning a «Science Diplomacy 2.0». On Data, Global Challenges, and Multi-Layered Networks*, https://doi.org/10.1057/s41599-020-00636-2 (consulted in December 2021).

establish and sustain the process associated with the Intergovernmental Panel on Climate Change (IPCC) (i.e., diplomacy for science), international scientific cooperation was needed to advance our understandings of the global climate system and facilitate international agreements (science for diplomacy), and scientific measurement will be used to monitor progress against various agreements (science in diplomacy) . Science diplomacy taxonomy does not easily categorize each of these activities[166].

At the EU level, science diplomacy has gained a lot of prominence in recent years, and through it, EU develops a European Science Diplomacy Agenda. In fact, the term «science diplomacy» appeared for the first time already in the 2012. The Commission Communication published «Enhancing and focusing EU international cooperation in research and innovation: a strategic approach»[167], which stated that science diplomacy will «use international cooperation in research and innovation as an instrument of soft power and a mechanism for improving relations with key countries and regions. Good international relations may, in turn, facilitate effective cooperation in research and innovation». This concept was further developed in the Communication «Open Innovation, Open Science, Open to the World: A Vision for Europe» (2016)[168], which stated: «International research and innovation cooperation leading to common standards, scientific exchange and mobility, the sharing of resources and facilities, and scientific advice to diplomats»[169]. Open Science is the idea that scientific knowledge should be openly shared in the practical research process. It helps to define a set of priorities to make Europe a stronger global actor through science and collaboration. An international science policy arena emerged around 2012, driven by the European Union, but also pushed by the

[166] GLUCKMAN P. D. - TUREKIAN V. C. - GRIMES R. W. - KISHI T., 2018, *Science Diplomacy. A Pragmatic Perspective from the Inside*, in *Science & Diplomacy*, 6, 4, https://www.sciencediplomacy.org/article/2018/pragmatic-perspective (consulted in November 2021).

[167] European Commission, 2012, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the regions, *Enhancing and focusing EU international cooperation in research and innovation: a strategic approach*, Brussels COM/2012/0497 final.

[168] European Commission, 2016, *Open Innovation, Open Science, Open to the World - a Vision for Europe*, Directorate-General for Research and Innovation Directorate A – Policy Development and Coordination Unit A1 – Internal and external communication, https://digital-strategy.ec.europa.eu/bg/node/10395 (consulted in December 2021).

[169] Science Diplomacy at EU level, EEAS website, https://www.eeas.europa.eu/eeas/science-diplomacy- eu-level_en (consulted in December 2021).

OECD and the G7. However, it is important to bear in mind that science diplomacy goes beyond international science collaboration, because it concerns interests that go beyond the scientific ones and may directly or indirectly serve to advance diplomatic goals. Horizon 2020 was a flagship for the EU's research and innovation funding programme from 2014-2020, funding three dedicated research projects under the Horizon 2020 programme, namely Using Science for/in Diplomacy for Addressing Global Challenges (S4D4C), Inventing a Shared Science Diplomacy for Europe (InsSciDE), and European Leadership in Cultural, Science and Innovation Diplomacy (EL-CSID).

The Madrid Conference on Science Diplomacy in 2019 highlighted the growing importance of science diplomacy on a global level and often not fully exploited at all levels of governance. Science diplomacy strategies at national and supranational levels would allow for a more efficient coordination of resources.

The best way to deal with environmental issues is to ensure the participation of all interested citizens, at different levels. This is how the Rio Declaration on the Environment and Development (1992) establishes the inextricable relationship between transparency, awareness, effective access to judicial proceedings and participation in decision-making processes. Public participation and active citizenship thus become the key to ensuring environmental protection and sustainable development. The Aarhus Convention on access to information, public participation in decision-making processes and access to justice in environmental matters is the first and only international instrument, legally binding, which acknowledges and puts into practice this principle, giving concreteness and effectiveness to the concept of environmental democracy.

However, communication is one of the great bridge or walls between people, starting by communication obstacles as cultural barriers, cognitive bias, misinformation, fake news, hate speech, green washing, etc. The spread of both disinformation and misinformation can have a range of consequences, such as threatening our democracies, polarising debates, and putting the health, security, and environment of EU citizens at risk[170]. In the social environment, confirmation

[170] *Tacking online disinformation*, https://digital-strategy.ec.europa.eu/en/policies/online-disinformation (consulted in December 2021).

bias hinders the public evaluation of opinions and arguments, favoring political propaganda, the low credibility of the mass media, contempt for the opinion of experts, the polarization and manipulation of opinions, social conformity. Deliberately misleading or biased information manipulating narrative or facts, leading to propaganda, that is disinformation.

A transition to a sustainable society both environmentally and socially is possible not only combining technology with systems innovations, but also with lifestyle changes, environmental and cultural awareness, and international cooperation. The deep transformation of a society takes time. Furthermore, as we can witness after the Ukraine conflict in 2022, frozen conflicts thaw very quickly, impacting for example economy, energy, and food systems at a global level. A wise and prudent policy climate- and people-oriented led to a good governance and stable institutions that can reduce the risk of inner and external conflict. Risk communication is an essential tool for risk management to protect the environment and save lives. It serves to facilitate the exchange and sharing of information on risk to encourage conscious choices to protect individual and collective safety.

Satellite images offer us a clear and accurate picture of the state of the ozone hole, the melting of ice in the Arctic, deforestation, fires in Siberia, California, Australia. The Explorer satellite in orbit around the Moon gave us the first image through which human eyes see the entire planet for the first time. Only science can accurately grasp the scale of risks; therefore, the only solution is to listen to the scientists who have come to clear conclusions. However, effective communication is essential that brings out the benefits of new technologies and the benefits of Earth observation from space to understand the scale of events:

1. Underlying the process
2. When and where phenomena happen
3. Mitigation
4. Prevention
5. Policy

Yet, all this knowledge given by technological and innovative advancement cannot save anyone if it is not shared with other people, able to involve other people and inspire change.

The problem of global warming is very serious: CryoSat satellite data maps precise changes in sea-ice thickness year to year. The Arctic Ocean is warming up faster, and with it the melting of the layers of permanent ice. The ecological crisis poses predictable and unpredictable risks, which leaves us with a suspended ending at the end of the century. Even if all countries respected the commitments made in Paris, forecasts tell us that the hypothetical temperature rise will be 1.5 °. In the face of the risks of modernity we are not reacting strongly, because it is not a personal and imminent danger in the short term.

Politics is strongly affected by the lack of trust of citizens, which erodes political legitimacy and consensus. The national interest is no longer able to manage the complexity of global challenges, to serve a global vision, capable of absorbing requests from very different actors, from the point of view of gender, ethnicity, religion, age, with different situations economic and social. People who suffer from fame and poverty will all be less destined for the sustainable use of resources, but they also need less practical and understanding means and tools to defend themselves from the effects of climate change in, which induce crucial implications also on the social level, such as for example food security. The first goal of the SDGs is to eradicate poverty, and, by 2030, SDG should ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, control over land and other forms of property, natural resources, appropriate new technology and financial services, including microfinance. The second goal is to end hunger, by ensuring sustainable food production systems and implement resilient agricultural practices that help maintain ecosystems, that strengthen prevention, mitigation, adaptation to climate change. To limit global warming would require multiple changes to our food systems, such as reduce the consumption of meat, adopt new rice-cultivation methods, and to curb food loss and waste.

However, the world is not on track to achieve Zero Hunger by 2030: if recent trends continue, the number of people affected by hunger would surpass 840 million by 2030. EO brings new possibilities for the methodologies of 34 of the SDG indicators, as well as in national target setting for a least 29 SDG targets. There is huge potential for satellite EO to support the aim of the 2030 Agenda in «leaving no one behind» as, by nature, space-borne observations are borderless, impartial and inclusive of all. ESA is a world leader of Earth observation data, as well as NASA. Data continuity has improved with the emergence of the Sentinel satellite constellations from the European Copernicus Programme. EO missions are supported by open and free data policies. The FLEX mission in ESA's Living Planet Program aims to provide global maps of vegetation fluorescence that can reflect photosynthetic activity and plant health and stress. This is relevant for a deeper understanding not only of the global carbon cycle, but also for agriculture and food security.

Satellite EO provides:

1. A synoptic view of the Earth’s surface: polar-orbiting, sun synchronous EO sensors observe wide swathes of the Earth in one pass, acquiring and storing large amounts of Earth surface imagery under constant conditions of solar illumination. Geostationary satellites observe hemispherical-scale patterns and can produce imagery up to every 15 minutes.
2. Regular and repeatable observations: the continuity of observations in the long term is now guaranteed through dedicated, operational missions such as those of the Copernicus programme.
3. Multi-annual time series of observations.
4. Cost-effectiveness for monitoring remote and inaccessible areas.

The drivers of climate change and biodiversity loss are global and are not limited by national borders. To fully realize the benefits of space, the international community need to consider how to intentionally maintain space as an arena of collaboration. The space race between the USA and the USSR was primarily a military-technological competition, to be the first to launch satellites or land on the Moon. In that era, technological development was driven primarily by national security interests. Today, space-based technologies are part of our daily lives, for example telecommunications, GPS, financial transactions, weather predictions, etc. If we are determined to ensure that people can enjoy prosperity and decent standard of lives, consequently economic, social and technological progress should occur in harmony with the environment and natural resources. Although as regards the situation relating to the natives who inhabited, for example, the Arctic, Siberia, the

Amazon rainforest, prior to colonization, they are now reduced to national minorities. Indigenous communities found themselves in conditions of non-recognition of their rights as a community. Yet these peoples retain a high ability to manage the environment in a sustainable manner using traditional techniques. They have the right not to be deprived of their lands and from which they derive sustenance and to be involved in making decisions that affect the lives of these communities. Peasants and other people working in rural areas have a critical role in managing natural resources for ensuring food security. However, an invisible barrier significantly puts women in many parts of the world at a disadvantage, all things like competence and skills being equal. Also, the meaning of «women's rights» has transformed through time and across cultures, and also creeping discriminations as Glass ceiling - not an explicit practice of discriminating against women, because it is not often a visible barrier, until a woman «hits» the barrier. To foster peaceful and inclusive societies, democracy, dialogue with different stakeholders, and to develop partnerships, is possible only by the respect of the human rights.

The right to food, the right to health, the cultural rights… all of these are human rights. But also, the right to the benefits of scientific progress. It was first recognized internationally in the Universal Declaration of Human Rights (UDHR) (1948) and later as Article 15 in the legally binding International Covenant on Economic, Social and Cultural Rights (ICESCR) (1966). This right important because it requires that national states act for «the conservation, the development and the diffusion of science», that they «respect the freedom indispensable for scientific research» and encourage «international contacts and cooperation». This right is a prerequisite for the realization of other human rights that depend on application of science and technology, including the right to have a safe, clean, healthy and sustainable environment. Without a healthy environment, we are unable to realise all our aspirations.

To pursue the idea of preserving and improving the conditions that allow life on the planet, a dose of utopia is necessary. If policymakers set ambitious and inspiring goals, «not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which are intend to win»[171], those n-bodies will move, together, towards a configuration that could be labelled as progress.

To serve the Earth not as slaves but as architects of our destiny, to guarantee a future for the future generations.

[171] TANTARDINI M., 2021, *The N-Body Problem*, in *Longitude* (the Italian Monthly on World Affairs), 119, pp. 26–27.

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