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From Peace and Prosperity to Space and Sustainability

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Abstract

The concept of sustainability and its sophistication in sustainable development has become one of the EU's core policy fields with institutional meaning. European Space policy is acquiring more and more importance in EU politics. A connection between both policy fields seems far-fetched, at first glance. However, there are already some obvious examples such as earth observation for environmental protection or disaster relief. This article will go further. It will look at issues of the protection of the earth orbit from the more and more serious issue of space debris and it will look at the European Space Agency's policy towards sustainable development. Evident issues of environmental pollution resulting from space technologies, such as launchers, will be discussed asking the question of whether space technologies can continue to benefit from exceptional treatment which was conceived for a small sector mainly for scientific purposes. Today, there is a sizable space industry in Europe and the commercialisation of its services poses this question of whether the space industry is becoming a 'normal' part of European industry and therefore should adhere to normal standards of environmental protection. The article will also consider implications for the progress of the European integration process through the lens of European space policy.

Keywords

European integration; Sustainable development; European Space Policy; Integration dynamics; Space debris

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The purpose of this paper is to establish a relationship between space and sustainability in the particular context of European integration. In order to lay the foundations for this article, three founding documents will be introduced in what follows: for European integration this is the Schuman Declaration of 1950; for space in Europe this is the Convention of the European Space Agency of 1975 (European Space Agency 2010), which entered into force in 1980; for sustainable development, the founding document is the UN Report *Our Common Future* of 1987, more commonly known as the Brundtland Report in honour of its editor, Gro Harlem Brundtland, a former Norwegian Prime Minister.

The article will use the following structure. Firstly, we will look at the environmental sustainability of space activities in the current major issues of space debris, radio frequencies interference, the sustainability of the space industry on Earth and available space for satellite location in orbit. Secondly, we will look at the European Space Agency (ESA) and Sustainable Development. The ESA addressed the social, environmental and economic aspects of its space activities, primarily in its three Resolutions of December 2014 (European Space Agency 2014). Thirdly, the article will bring the evolution from sustainability to sustainable development to the analysis of the space sector, in a subsection on economic, environmental and social sustainability.

Eventually, this will lead to two research questions. The first will address the link between sustainability and space, including the analysis of the fundamental contents which constitute that

link. The second research question will set this analysis of space sustainability in the European integration process, asking what space activities have contributed and can contribute to it.

Starting with the Brundtland Report, this recognised the connection between space and sustainability on Earth and saw a utility for space, which one must call surprisingly prescient for the time when it was written, in 1987:

> In the middle of the 20th century, we saw our planet from space for the first time. Historians may eventually find that this vision had a greater impact on thought than did the Copernicus revolution of the 16th century, which upset the human self-image by revealing that Earth is not the centre of the universe. From space, we see a small and fragile ball dominated not by human activity and edifice but by patterns of clouds, oceans, greenery, and soils. Humanity's inability to fit its activities into that pattern is changing planetary systems, fundamentally. Many such changes are accompanied by life-threatening hazards. This new reality, from which there is no escape, must be recognized – and managed. (United Nations 1987, An Overview, para. 1.).

This ground-breaking definition of sustainable development is set out in the Brundtland Report to this day. The Report turned a multifarious and often chaotic discourse on sustainability (Barnes, Hoerber 2013: 245) into a structured definition of sustainable development: 'Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (United Nations 1987: Part I, Ch. 2, para. 1). Later, the document defined sustainable development as environmental, social and economic sustainability.

The connection with space came in a lucid analysis of the utility of space for sustainable development on Earth (United Nations 1987, Ch. 10, II,1, para. 58), or what later became Earth-observation technology (United Nations, 1987, Ch. 10, II, 1, para. 62). The Report, however, goes one step further. Space, it suggests, could become a 'global commons'. It reiterated the UN principle that space belongs to no one, but must be preserved by all.

> Outer space can play a vital role in ensuring the continued habitability of the Earth, largely through space technology, to monitor the vital signs of the planet and aid humans in protecting its health. According to the 1967 Outer Space Treaty, outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use of occupation, or by any other means. The UN Committee on the Peaceful Uses of Outer Space has been laboring to see that these ideals remain on the agenda. This Commission, in view of these developments, considers space as a global commons and part of the common heritage of mankind. (United Nations 1987, Ch. 10, II, para. 56.)

This concept of the global commons entails common heritage, but also common use, similar to the concept of the commons of earlier human history, where village dwellers would share part of the land and institutions with joint responsibility. The concept of the global commons has been discussed extensively, notably by Garrett Hardin's 'Tragedy of the Commons' (Hardin 1968) and, importantly, after the impetus the Brundtland Report gave to it.

For the purpose of this article, the Brundtland Report established an analytical structure for sustainability in defining it in its social, economic and environmental aspects. This structure will be used in the analysis of European space policy herein. Perhaps more importantly, the Brundtland Report established the first tangible link between sustainable development and human space activities. Therefore, it provides a framework within which both research questions can be answered,

i.e. the connection between space and sustainability and the function of space within the European integration process.

The institution that has put the idea of a shared space programme into action in Europe is the European Space Agency (ESA). The Convention of the European Space Agency was the founding document of a 'European space programme' (European Space Agency 2010: 11). The ESA was set up as an intergovernmental organisation – most notably through the key principle of *juste retour*, which guarantees each member state a return investment corresponding roughly to its own contribution to ESA. It was given technical competences only; there was no aspiration by the founding states to create another supranational community like the European Coal and Steel Community (1951) or the European Economic Community or Euratom (both 1958), which the French Gaullists particularly viewed with suspicion. They were seen in the 1960s and 70s as encroaching upon national prerogatives, well exemplified in the discourse of *L'Europe des Patries* (Samuel 1999: 244; for the application of the discourse of the Europe of Nation states to space policy, see Hoerber 2016). Nevertheless, the ESA united European space endeavours by bringing together the European Launch Development Organization (ELDO) and the European Space Research Organization (ESRO). The objective was to put Europe on the map of space technology.

Therefore, the use of the ESA Convention and corresponding ESA document should provide a structure within which the research question of this article on the function of space in the European integration process can be addressed. A good example of this is that the ESA is independent of the EU, but acts as the special interlocutor for European nations which engage in space activities. Some EU countries are not members and some non-EU countries (Switzerland and Norway as full members, Canada as an associate member) are. The ESA implements several key EU space programmes, Galileo (geo-positioning system) and Copernicus (Earth observation) as EU flagship programmes are good examples. This has led to a protracted and lively debate about the institutional relationship between ESA and the EU (Peter, Stoffl 2009; Gaubert, Lebeau 2009; Hoerber 2009; Hoerber, Stephenson 2016; Hoerber, Sigalas 2016). For some time, the ESA had been intended as the space agency of the EU, but the ESA Ministerial Council of December 2014 declared it would keep the ESA as an 'independent' organisation while making it the 'long-term partner of choice for the EU for jointly defining and implementing the European Space Policy together with their respective Member States' (European Space Agency, Resolution 3, 2014: 5).

For the purpose of this article, the ESA Convention and several other ESA documents, such as this Council Resolution, highlight the function of space policies within the European integration process: in addition, the ESA has addressed issues of sustainability (mostly the economic aspects of business sustainability and not sustainable development) in several documents. The later analysis of them here addresses the research question on the connection between space and sustainable development.

The Schuman Declaration of 9 May 1950 defined peace and prosperity as the key objectives of European integration. These would become the guiding ideals of the post-war European integration process (Harryvan, Harst 1997: 60-63). Neither space nor sustainability featured at the time as political projects. Today, both have emerged as important policy fields in the EU (European Commission 2016), for which the Schuman Declaration was the foundation. In 2012, it was suggested that the EU may have to look for new guiding ideals, because it has fulfilled the original ones of peace and prosperity. Space exploration, or rather a European space policy, was suggested as one new guiding ideal for the European integration process – see Table 1. Here, therefore, these foundations will be developed further through the argument that both policy fields have become major components of the European integration process. Their connection is thus of interest for the understanding of the process, beyond their importance as individual policy areas in the EU. This

argument will answer to the research question on the importance of space policy and sustainable development for the European integration process.

Table 1

	Old	New
Internal	Prosperity ⇨ economic integration	Consolidation ⇨ territorial ⇨ constitutional
External	Peace ⇨ politically cooperation	[Space] Exploration ⇨ outreach

Source: Hoerber (2012: 78)

This rough sketch may need some updating and indeed some more concrete policy examples in order to show the connection between space and sustainability. Therefore, the conclusion of this article will suggest a refinement.

As we have seen in this introduction, the relationship between space and sustainability has existed for a long time. It was considered in the Brundtland Report in issues such as early Earth observation initiatives to arrive at reliable data on the major changes and threats on Earth, but also in the issue of space debris. Sustainability in space has been a recurrent topic in the ESA and a good understanding of the guiding ideals of the Schuman Declaration may well be important for the formulation of new ones for the future of the European integration process. The three key documents make up a composite source base for a method which is geared towards answering the research questions on the connection between space and sustainability and the function of both policy fields in the European integration process.

ENVIRONMENTAL SUSTAINABILITY OF SPACE ACTIVITIES

Space Debris

The Brundtland Report outlined the growing problem of sustainability in space under the heading ‘Managing the Commons’.

> There are growing concerns about the management of orbital space, centring on using satellite technology for monitoring planetary systems; on making the most effective use of the limited capacity of geosynchronous orbit for communication satellites; and on limiting space debris. The orbiting and testing of weapons in space would greatly increase this debris. The international community should seek to design and implement a space regime to ensure that space remains a peaceful environment for the benefit of all. (United Nations 1987, From One Earth to One World III., 2, para. 84.)

As the US made serious steps towards an implementation of President Reagan’s Strategic Defence Initiative (SDI) the Cold War had paralysed the UN by the ideological separation of the two blocs, where no common ground, as it were, could be found for the governance of space (United Nations 1987, Ch. 10, II, para. 57). The language that was used between the two blocs was that of force, threat and deterrence through nuclear weapons. SDI was conceived to disable intercontinental nuclear missiles through satellite-based lasers. It was also a political weapon enabling the Reagan administration to put an end to the Soviet Union by sheer weight of financial resources. Weapons tests were conducted in space and the UN voiced its concerns as to the devastating effects of such a weapon system on sustainability in space.

> (…) the creation of debris is an integral and unavoidable consequence of the testing and use of space weapons. The contribution of military activity to the Earth's 'debris belt' could grow greatly if plans to place large numbers of satellite based weapons and weapon-related sensors are realized.
>
> The most important measure to minimize space debris, therefore, is to prevent the further testing and deployment of space based weapons or weapons designed to [be] use[d] against objects in space. (United Nations 1987, Ch. 10, II, 3, para. 71-72.)

In the event, there was no actual 'weaponisation' of space in the 1980s and, mercifully, no 'Star Wars'. SDI proved too costly, even for the United States, and therefore the danger of increasing space debris from that source was largely avoided. However, today, humankind is becoming more and more dependent on space based technology and this holds its own dangers in terms of the increased use of space. There are several sources of space debris, e.g. old satellites, burned up rockets stages, engines and fuel containers.

These parts become dangerous in the two main orbits. The first one is called Low-Earth-Orbit, as described in the following quotation from the Brundtland Report: 'Debris in orbit is a growing threat to human activities in space. […] This debris consists of spent fuel tanks, rocket shells, satellites that no longer function, and shrapnel from explosions in space: it is concentrated between 160 and 1760 kilometres above Earth' (United Nations, 1987, Ch. 10, II, 3, para. 70). In Low-Earth-Orbit, telecommunication satellites usually operate for 10 to 15 years; spy satellites may last only a few months, because of higher strain and wear; scientific probes can last up to 40 years.

The second trajectory where debris poses a threat to space infrastructure is called geostationary orbit, and lies at 35,786 km above sea level, which is

> the most valuable part of Earth's orbital space [, because] (…) [m]ost communication and many weather satellites – as well as many military orbits – [can be found there.] (…) To prevent signals to and from the satellites interfering with one another, satellites must be placed some distance apart, effectively limiting the number that can use this valuable band to 180. Thus the geosynchronous orbit is not only a valuable but also a scarce and limited global resource. (United Nations 1987, Ch. 10, II, 2, para. 64.)

The Brundtland Report summarises the problem of managing the Commons in space, which is, however, older than the Report.

> The first effort to devise a property regime of geosynchronous orbit was the 1976 Bogota Declaration signed by seven equatorial countries. These countries [Colombia, Ecuador, Congo, Indonesia, Kenya, Uganda, Zaire and Brazil] declared that the orbits above them were extensions of their territorial aerospace. The Bogota Declaration has been challenged by some nations that see it as contradicting the 'non-appropriation' principle of the Outer Space Treaty. (…) Another way of managing this resource and capturing its rental value for the common interest would be for an international body to own and license the slots to bidders at an auction. Such an alternative would be analogous to the Seabed Authority in the Law of the Sea Convention. (United Nations 1987, Ch. 10, II, 2, para. 65-67, see also Bogota Declaration 1976 (Equatorial Countries 1976).)

The Declaration has never won universal international recognition, neither is there a universal regime on how to manage the Commons in space. This article will address the question of the non-existence of sustainable development in space in the context of the European integration process

later. For the moment, it shall suffice to say that the absence of sustainable development in space clearly touches on the survival of humankind, the key question which sustainable development addresses.

In addition, there is no available means of clearing up space, despite several options which have been discussed in the past, e.g. a space tug (Reinke 2004: 138-140), a robotic arm, small engines fixed to debris, a towing net, or even an ion canon to force flotsam out of orbit and out of the pull of Earth's gravity. The reason why there is no 'space cleaning service' was stated in very clear terms in the Brundtland Report as the lack of political will resulting from the high cost and difficult technical feasibility (United Nations 1987, Ch. 10, II, 3, para. 73)

Another alternative to cleaning up is to reduce the generation of debris in the first place. For instance, in 2016, the US private company SpaceX successfully landed a re-usable launcher, the Falcon 9 (Grush 2016). This new technology has influenced the redesign of the European Ariane rocket which will have to include reusable components in the future. Currently, the argument at ArianeSpace is still that reusable space vehicles are heavier at lift-off, because they have to store the extra fuel needed for re-entry. Therefore, the consumption of fuel in the atmosphere is much heavier, particularly during landing back on Earth, which creates emissions, which do not exist with single-use rockets. However, reusable components have been accepted as a breakthrough in space technology and European companies, such as ArianeSpace, will have to adapt their products if they do not want to be outperformed by non-European competitors. A more sustainable use of space may result from that, too.

Radio Frequency Interference

There is another sustainability challenge that is important for all that it is invisible: radio frequency interference. Brundtland had already identified the problem in the 1980s.

> Since satellite communications involve the use of radio waves, a de facto regime for the parcelling out of slots in the geosynchronous orbit has emerged through the activities of the International Telecommunications Union (ITU) in the past several years. (United Nations 1987, Ch. 10, II, 2, para. 69.)

Any radio emission potentially causes interference, which can lead to the loss of communication and radio interference is not only generated by humans. Space weather, for example, is highly unpredictable and strongly influences the reliability of transmissions. Apart from this phenomenon, every country has the right to use radio frequencies in space, with the caveat mentioned in the above quotation. As more and more countries develop their telecommunication and TV-broadcasting networks, ever more data is released into space. Even if the issue is not as serious as space debris itself, the pollution of space by radio frequency is a sustainability challenge in the long term. To regulate radio transmission in space, common ground has to be found between all countries operating in this field. The fact that radio waves are the main means of communication adds another element exerting pressure on the Earth's surrounding space as a limited resource.

Sustainability of Space Technology on Earth

A rocket contains very harmful components, sometimes even radioactive parts, and it always needs very powerful engines to overcome Earth's gravitation. Without discussing segments left behind at a launch, or even fatal accidents of space craft, the use of space technology inevitably brings with it sustainability problems on Earth. The environmental impact of rocket launchers is most harmful up to 70 km height. Up to 7.5 km, the first stage of the launch takes place, which is the most demanding

in term of propulsion power. Two main types of propulsion are used. First, oxygen and kerosene, similar to aircraft engines; secondly a mix of rubbers, ammonium, aluminium and other solid fuels, in a container that is called a booster. The American space shuttles used the latter type of propulsion, for example. Massive exhaust emissions result from the use of such boosters. They also use Chlorofluorocarbons (CFC) in the combustion. CFCs were banned in the 1990s in all domestic products, because they are destructive of the ozone layer (see US Environmental Protection Agency 1993; see also European Commission 2000). The space sector is the only industry where their use is still allowed, but the harmful effects are the same. Arguably, the effect of current launch activity on the ozone layer is low, but this may change with a growing rocket launch market (Ross, Toohey, Peinemann, Ross 2009). For smaller rockets, such as the European Vega, solutions have been found (European Space Agency n.d.). China, too, launched 20 micro-satellites in 2015 using a rocket free of toxic fuel. It still uses kerosene, but it is as environmentally friendly as combustion in a rocket engines can get.

From 7.5km, rockets burn hydrogen and oxygen and therefore produce only steam as exhaust. The spacecraft maintains its speed without further acceleration not only for reasons of fuel and weight efficiency, but also because the vehicle could suffer damage from particles in the atmosphere if velocity were further increased. Thus, the exhausts of rocket propulsion do cause pollution, which is becoming an increasing problem in a market of growing launch activities.

The Fall-Back of Space Debris

Space debris, such as batteries, empty fuel containers, tools, old satellites and sometimes even radioactive elements can fall out of orbit back to Earth. Entry into the atmosphere destroys most elements. All debris and meteorites of less than 10cm diameter completely vaporise before reaching the ground. Debris of 10cm or more often explodes and turns to dust. Very little gets right through.

However, officially eleven satellites with radioactive components have re-entered the Earth's atmosphere and reached the ground since the 1960s. The biggest event is probably that of the Russian satellite Cosmos-954 in 1978. A substantial part of the Canadian countryside was contaminated with uranium (Galloway 1979: 407). Fall-back events remain unusual and collisions in space under the Kessler effect naturally reduce the size of space debris (Pelton 2013, Ch. 2). However, some environmental NGOs – notably 'Robin Hood' – believe that the increase of uranium and plutonium particles in the air is mainly due to the disintegration of satellites (des Bois 2011). The Brundtland Report concurred with this threat evaluation to some extent:

> Many spacecraft are nuclear-powered and threaten contamination if they fall to the Earth.[1] There are two basic approaches to the problem: Ban or regulate. […] A ban on reactors in space would be easy to monitor, because reactors produce waste heat detectable by infrared sensors at great distance.
>
> A wide variety of methods are available for regulating the use of radioactive materials in space. The most important include limiting the size of reactors permitted in orbit, requiring shielding around the radioactive material sufficient to withstand re-entry into Earth's atmosphere, and requiring deep space disposal of spacecraft that contain radioactive material. All are technologically feasible, but would add cost and complexity to missions. Nevertheless, these measures should be implemented, as a minimum step. (United Nations 1987, Ch. 10, II, 4, para. 74-75.)

As we have seen above, because of this phenomenon some serious damage has been done to the environment. However, the fall-back of radioactive parts was mainly a challenge for the early space era. Now, space agencies track space debris (see Appendix 1) and thus such events can be anticipated. Consequently, there has not been a single radioactive fall-back in the last 20 years.

However, against the backdrop of more and more activity in space, the space industry may have to adapt to sustainability standards just like any other industry on Earth. The attitude that argues that pollution from fuel exhaust and from fall-back is an acceptable price to pay in the great cause of further space exploration and the development of humankind may have to change in the interest of the sustainable development of the space industry itself. This may require a change of mindset from interpreting sustainability almost exclusively in its economic sense today, to considering environmental and social sustainable development equally, as defined in the Brundtland Report.

THE EUROPEAN SPACE AGENCY AND SUSTAINABLE DEVELOPMENT

The most important developments in the ESA's sustainable development date from the Council meeting of 2 December 2014. The Ministerial Council of 2 December 2016 added nothing more substantial in the field of sustainable development (European Space Agency 2016). Three resolutions of 2014 spelled out the directions of European space programmes for years to come, with the launch of Ariane 6, for example. Today, the question of sustainable development has to be considered in space activities too. The ESA's role in the process of introducing sustainable development into space activities is crucial.

The Three Resolutions of December 2014

The Ministerial Council of December 2014 (held in Luxembourg) brought all 20 ESA member states together (European Space Agency 2014). The first Resolution was concentrated around the new launchers the European Space Agency was developing. The Council insisted that they should be economically competitive. Here we see the industry focus on *economic* sustainability, which in a blunt reading is nothing more than having the best product for the most competitive price. That makes the Ariane launcher economically viable, with the social consequence of guaranteeing and/or growing employment in the European space industry. In this vein, we also find the ESA advocating the commercialisation of space services: the European space industry should rely less and less on public funds and try to be as efficient as possible in the market. That is important because it can serve to free up funds in the ESA, either for primary research, which has always been high risk and economically unsuitable for private actors, or, indeed, for reducing the costs of the space programmes overall. This economic sustainability was the main line reinforced by the 2016 ESA Ministerial Council Resolution (European Space Agency 2016). For Ariane, cost reduction should be achieved by improved synergy among the various actors involved in the construction of the launchers.

The second Resolution reset the objectives of the ESA. The practical objectives are important but more important was deemed to be the pursuit of a successful European space policy. One could sum this up as economic sustainability, leading to positive social spin-offs in employment in the European space industry and a growing critical awareness of the threats to the environment constituted by some of the activities of the industry. This remains a very neo-liberal attitude in which *economic* viability seems to be a prevailing consideration, while social sustainability remains only a positive by-product. The development of technologies for environmental protection is, in this reading, essentially a source of revenue for the European space industry.

The third Resolution showed how the ESA should evolve. This is the major change in comparison with the previous Ministerial Council. Agenda 2011 of the European Space Agency stated: 'the long-term and political perspective is to make ESA become an Agency of the EU by 2014' (European Space Agency 2011: 25). This is no longer the case. In fact, this Resolution reaffirmed the independence of the European Space Agency from the European Union. The ESA becoming the space agency of the EU seems no longer to be an option, a change which may well lead to difficulties, hampering efforts to unify the space policies of the European states.

SPACE AND SUSTAINABLE DEVELOPMENT

The key question here is that of the sustainability of such space programmes. Space exploration often suffers from the image of a science that costs a lot without providing returns justifying the investment. In the following, we will offer some answers using the threefold definition of sustainable development from Brundtland and in the light of a tentative neo-institutional analysis.

Economic Sustainability

The three Resolutions of the ESA Ministerial Council of 2014 concede that space programmes will probably not produce enough direct revenue to cover the investments made in them, e.g. by selling launchers or other ESA products. In a rational choice sense, this is a clear argument against the financial commitment of rational actors, such as nation states, to space programmes. However, one may well argue that the very reason why the ESA exists is that the programmes it runs do not produce sufficient return on investment to make a profit. This does not mean that space programmes can never be economically viable. The ESA has made its launchers more competitive than they were and is charged with creating competitive launchers for the market, achieving economic sustainability. It is important to remember that the Council is staffed by the member states of the ESA and not companies. These countries can benefit from indirect economic revenue. In April 2013, the National Aeronautics and Space Administration (NASA) produced a document called 'NASA socio-economic impact'. It shows the economic growth NASA helps to generate for the United States of America (NASA 2013: 11-13). NASA's efforts to demonstrate its usefulness can be connected with one of the objectives the Council gave to the ESA, i.e. economic relevance. Scientific discoveries from ESA projects can be used to stimulate innovation for European companies. Such innovation can provide competitive advantage for European companies and, with this, growth. In addition, individual ESA member states have always had their specific space research preference, e.g. solar research for Germany (Reinke 2004: 300-318), launcher development for France, or communication satellites for Britain (Hoerber 2016: 19-21). The pursuit of these longstanding research priorities is more of a well-justified habit than a rational choice for the most cost-effective space programme. However, one can also argue that spin-offs from space research will help to generate economic growth in other parts of the economy, which will yield, however indirectly, tax revenue for the states. This could be seen as a model for the *economic* sustainability of the European space sector at least.

Social Sustainability

Social sustainability may not be as visible and measurable as economic sustainability, but society is an important stakeholder in space exploration too (Cameron, Crawley, Loureiro, Rebentisch 2008: 327). Space exploration does not now enjoy the same support that it attracted during the Cold War (Vedda 2008: 24), but it is a sector that benefits society in many ways. That is why three of the four objectives defined by the Council revolve around this aspect. First, technological progress can be

extremely useful to everyday life, notably in the field of medicine. It can help us understand better the functioning of the human body when weightless, for example. It can provide sociological and psychological insights, for example through the unique experience that isolation in space represents (Dudley-Rowley, Gangale 2006: 4). It may also provide breakthroughs in transport, such as technologies for sub-orbital flight, which could well shorten travel times drastically in the future. The second objective related to social sustainability is international cooperation. Even in periods of crisis, cooperation in space has continued, notably between Russia and the West during the Crimean crisis. Many space projects, e.g. the Hubble Space Telescope and the International Space Station, were created and are maintained through international cooperation. They are an element of stability in international politics and cooperation in the space sector may spill over into other sectors and hopefully, of course, to the next generation. The final objective of the social sustainability of space is the 'inspiration' it provides. Science and space can inspire future generations to seek out ever newer horizons. By trying to answer important questions of humankind - such as what is the universe *made* of? Is there life elsewhere? How was the universe created? - space acts as an incentive for progress in science, understanding and the progress of humankind. This may well be seen as a new definition of social sustainability, taken from the space sector.

Environmental Sustainability

The only reference made to environmental sustainability in the three Resolutions is in respect of the objectives for 2030:

> […] able to respond, together with the scientific communities, to emerging demands, such as monitoring humankind's impact on the environment, climate change, the polar regions and food security. (European Space Agency 2014: Ch.1, 2a.)

Ecological considerations are mentioned as impacting on the economic viability of the European space industry, e.g. in the search for future customers, but they are not an objective in themselves. The ESA is good at Earth observation, for environmental protection on land and the seas (Carpenter 2016: 239-248), but environmental sustainability does not seem to be considered by the Council as an end in itself. Major questions regarding environmental sustainability remain unanswered, most notably the treatment of currently existing space debris and how to avoid it in the future. This finding confirms that in the space sector sustainability still follows a weak interpretation (Barnes, Hoerber 2013: 245), where profit comes first and environmental protection last.

THE WAY AHEAD

Space and Sustainability in European Integration

The Brundtland Report once more describes the problem and suggests an answer in the idealistic manner of the UN.

> Orbital space cannot be effectively managed by any one country alone. The inherently international character of space has been recognized by a majority of nations in the Outer Space Treaty. The international community should seek to design and implement a space regime to ensure that space remains a peaceful environment for the benefit of all. […] A system of space traffic control in which some [practices] were forbidden and others harmonized cuts a middle path between the extremes of a sole Space Authority and the present near anarchy. (United Nations 1987, Ch. 10, II, 5, para. 77-78.)

Space has proved itself a rare exception to the endemic disunity of humankind. Many space projects have been and could only be realised through international cooperation. The examples of the Hubble Space telescope and the ISS have been given. However, the UN seems hardly capable of bringing its member states together around sustainable development, let alone sustainability in space because of its intergovernmental nature and the consequently frequent vetoes in the Security Council and the failure to ratify treaties.

It might be more promising to look to the EU for solutions. The reasons are simple. The European Union is much larger and has more funding sources than any of its member states for major space initiatives such as Galileo or Copernicus. It has supranational characteristics and cannot be blocked. The EU acquired space competences in the Lisbon Treaty (Art. 189) and it has engaged in the two above-mentioned flagship space programmes. As already set out, in 2012, it was suggested that the EU may have to look for new guiding ideals, because it has fulfilled the original ones of peace and prosperity (Table 1, Hoerber 2012: 78). Table 2 is suggested as a refinement of those rough ideas from 2012.

Table 2: Proposal of the Authors

	Peace	Prosperity	Space	Sustainability
Internal	German Question	ECs	ESA + EU	20/20/20
External	Cold War	Liberalism *vs.* Communism	Outer Space exploration	Survival of humankind

Internally, the European integration process has always been about building institutions, be it in solving the German Question by binding (West) Germany into the nascent European institutions to guarantee peace or by building the European Communities to create prosperity from the 1950s onwards. Today the EU still follows that pattern. For space, that is reflected in the debate about the proper structure of cooperation between the ESA and the EU (as suggested at the beginning of this article). For sustainability, policies such as the 20/20/20 objectives, i.e. 20% reduction of CO_2 emissions by 2020 in comparison with 1990 standards have poised the EU as a global leader in sustainable development. Unfortunately, the European Commission has only rarely exhibited sufficient leadership capabilities, in this case for European sustainable development. The Environmental Action Programmes (EAP) are good examples of how the EU has actively taken European sustainable development forward. The Fifth EAP of 1992 has been shown as a good example, where the EU implemented the Brundtland definition of sustainable development to set concrete norms and policies of its own.

Externally, the situation has always been more conflictual. After the Cold War, peace was not only maintained, at any rate as the absence of conflict, as during the Cold War, but was firmly established from 1989 onwards with the substantial help of the EU and its corresponding good repute in the new member states. During the Cold War prosperity, relative living standards and comparative growth rates, were always a bone of contention between Liberalism and Communism. Liberalism, in its capitalist manifestation, clearly won out. This has led to an increase in, if not to the creation of, a globalised system in which the EU is itself a major actor. The objectives were to win the Cold War and demonstrate the superiority of Liberalism as an economic system. These policy objectives have been achieved, despite the fact that we see contestations of liberal market logic today and without wanting to suggest that peace and prosperity have been achieved for good and that their maintenance would not need constant attention. However, the argument at this point, which the authors would like to suggest, is that, somewhat paradoxically, because of the success of the European integration progress in achieving the initial guiding ideals, these ideals have lost their power to pull the member states together and to push the integration process further forward. The exploration of outer space and the survival of humankind on Earth are suggested as having the

potential to become new policy objectives corresponding to the internal institutionalisation of space and sustainability in the EU as described above.

All four aspects of 'Peace' and 'Prosperity' and 'Internal' and 'External' have been resolved; not only by the European integration process, but nevertheless with some help from it. This leads to the suggestion that the European integration process needs new guiding ideals, as proposed on the right of Table 2. The fundamental conviction which leads to this suggestion is that the guiding ideals of peace and prosperity have exercised a considerable motivation towards further integration of the EU member states. These ideals, which could only be achieved together, have induced the member states to accept compromises to their national sovereignty which have substantially altered the reality of European polity. They were right in doing so, because the objectives of these ideals have been fulfilled. However, as a consequence of the success of the European integration process, the guiding ideals have weakened. It stands to reason, therefore, that new ideals are needed. Just like the original ideals of peace and prosperity, the new ideals should be visionary, as yet unachieved and difficult to attain in order to draw the EU member states together in the pursuit of common targets. These do not necessarily replace the old ideals, because peace and prosperity will always be vulnerable, but new ideals ought now to be found to give the European integration process new impetus and direction and are therefore suggested here. Such large targets for the future are essential for the political integration process, which will endeavour to bring its members ever more closely together and will provide aspirations for the future, just as the European integration process did throughout the Cold War.

CONCLUSION

All of the sustainability concerns regarding space discussed above can potentially jeopardise humankind's ability to make the most of Earth's surroundings and deny us the many benefits they currently provide and the new ones that can be developed.

Sustainability in Space

The space community should be able to manage environmental challenges as outlined early in the Brundtland Report:

> A fine balance must be struck between regulating activities too late and regulating non-existent activities too soon. Regulating activities on the Moon, for example, beyond the general principle laid out in the Outer Space Treaty is clearly premature. But regulating space debris and nuclear materials in Earth orbit is clearly overdue. (United Nations 1987, Ch. 10, II, 5, para. 80.)

This becomes more important with the increasing commercialisation of space technology. There are more and more private-sector companies operating in the space industry, notably SpaceX, EADS Astrium, Sierra Nevada Corporation and Copenhagen Suborbital. For now, their operations consist mainly of supplying space components and rockets to public agencies, but one day we may well see hotels on the moon or a casino in orbit, a mining company reaching asteroids, or long-haul flight in Low-Earth-Orbit. Environmental concerns will consequently grow. The commercialisation of the geosphere can therefore have negative consequences for both our planet and its surrounding space. Space, and particularly the orbit around Earth, may become a limited resource. To make outer space activities sustainable in the long term, regulatory regimes and guidance for new actors in the space arena should be implemented.

On the positive side, space activities provide substantial benefits and greatly influence sustainability policies on Earth. Space technologies help to develop environmental monitoring, meteorological forecasting, climate modelling, resource management and disaster relief.

On 2 December 2014, the ESA Ministerial Council agreed that sustainability of space exploration is achievable. It is achievable because there are many stakeholders who do not pursue economic profit alone as an objective. It is achievable because we are able to create institutions, such as the ESA and the EU, which bring member states together. It is achievable because solutions to intractable problems can be found. The ESA has given a good example of that in its activities in space over past decades (European Space Agency 2014).

Sustainability in European Space Policy

Perhaps most importantly, sustainability and space may become new guiding ideals for the European integration process. Since its inception, the EU has been one of the most positive forces in the world, exemplified in its guiding ideals of peace and prosperity. Adding space to this canon of guiding ideals of the EU may well facilitate renewal of this remarkable organisation, while maintaining its positive impetus. The Communication on the Space Strategy for Europe (European Commission 2016) is a good example of the EU waking up to the political importance of space in the EU. It is seen as a way to push the European integration process forward. The resulting attempt to establish a single European space policy may be seen as inducing more rationality into collaboration in space affairs in Europe. The debate about the institutional relationship between the ESA and the EU is the reflection of that process, but the ways and means of how to achieve a European space policy still remain contested. The debate about the relationship between the ESA and EU shows this very well. Moreover, it has been shown that an institutional logic of economic sustainability – still dominant in the space sector – was different from environmental or social sustainability. However, in the Brundtland Report they were brought together in the concept of sustainable development. This has become the dominant rationale today, building a new institution, which has become the reference point for the EU and ESA alike. Rather than just sticking to the economic rationale, a European Space Policy will have to reflect the environmental and the social aspects of sustainable development. The current lack of those two elements leads the authors of this article to the conclusion that the formulation of a European Space Policy has only just begun. This process will most likely lead to new institutions, treaties or *modi vivendi* which will add the still lacking elements of social and environmental sustainability. The space sector in Europe will therefore become more normal in reflecting the demands asked of all other policy fields in the EU, i.e. the transversal nature of sustainable development. This will most likely be done in a step-by-step approach during which the still diverging logics of space and sustainability will become aligned. Therefore, the important contribution of the paper is to further an understanding of how different constructions of sustainable development – economic, social and environmental – can be found in existing European space policies and where they are still missing. It has been suggested that the coherent application of sustainable development in *a* European space policy and particularly the connection of both policy fields should make them both more influential in the EU and should foster the European integration process as a whole.

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ENDNOTES

[1] 'The United States has launched 23 spacecraft that relied at least in part upon nuclear power sources: one source was a reactor; the rest were radioactive materials the decay heat of which is converted into electricity (thermoelectric generators). By the end of 1986, the Soviet Union had launched 31 nuclear-powered spacecraft, almost all of which contained fission reactors, and it currently operates all of the reactor-powered satellites.'

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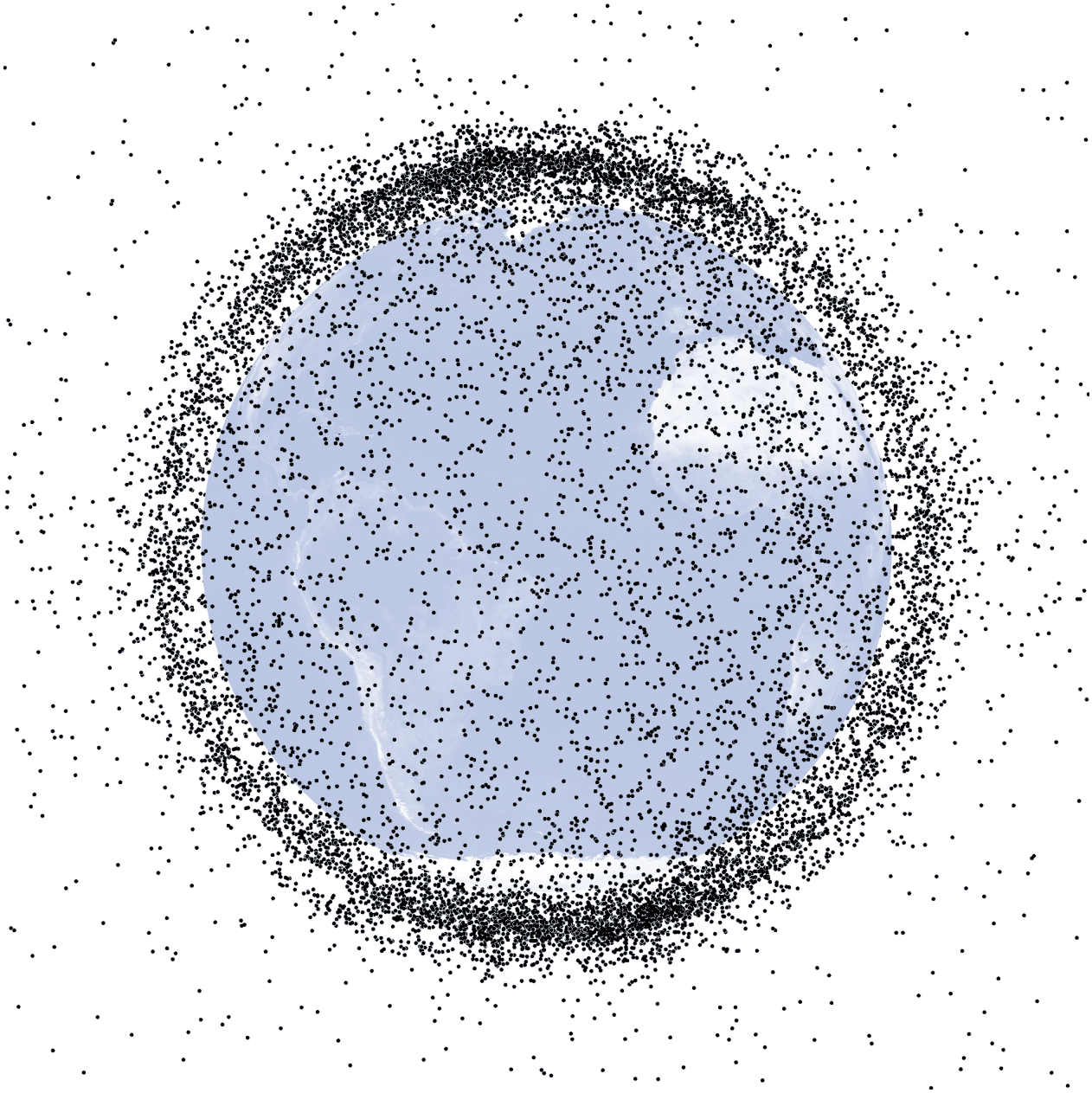
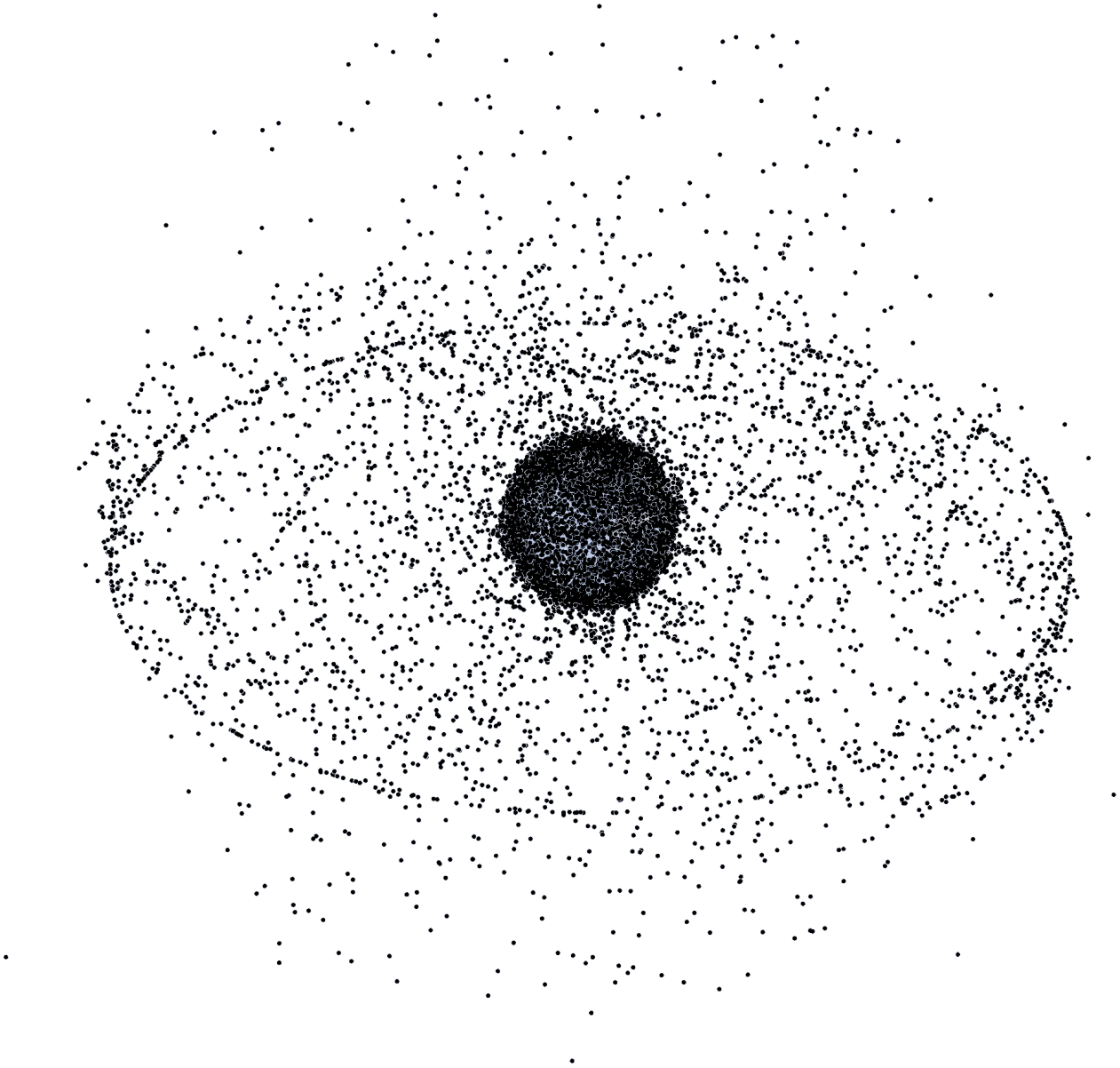
Appendix 1: Map of space debris in Low-Earth-Orbit tracked by NASA



Source: NASA (2009)

Appendix 2: Map of space debris in High-Earth-Orbit tracked by NASA



Source: NASA (2009)