Application of Sustainability Concept to Near-Earth Space as an Integral Part of Earth-system in the Context of Sustainable Development Goals (SDGs)

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ABSTRAK - Makalah ini memberikan analisis pada penerapan konsep keberlanjutan terhadap tata kelola kegiatan keantariksaan dan Tujuan Pembangunan Berkelanjutan secara keseluruhan. Metode analisisnya meliputi analisis deskriptif dan preskriptif. Hasil analisis data menunjukkan bahwa ada putusnya hubungan antara tindakan yang ada untuk menerapkan konsep keberlanjutan di permukaan Bumi dan di antariksa dekat-Bumi. Dikatakan bahwa lingkungan antariksa dekat-Bumi sebagai tempat untuk teknologi-teknologi yang memungkinkan pencapaian Tujuan Pembangunan Berkelanjutan adalah bagian yang tidak terpisahkan dari sistem Bumi yang terkait dengan Tujuan Pembangunan Berkelanjutan itu sendiri. Dengan demikian, lingkungan antariksa dekat-Bumi perlu dimasukkan secara eksplisit ke dalam agenda Tujuan Pembangunan Berkelanjutan.

***Kata kunci**: Keberlanjutan, Antariksa dekat-Bumi, TPB*

ABSTRACT – This paper provides analysis to an application of sustainability concept on the governance of outer space activities and the Sustainable Development Goals as a whole. Its methods of analysis is descriptive. Results of data analysis show that there is a missing link between the existing measures to apply sustainability concept on terrestrial Earth and in near-Earth outer space. It is argued that near-Earth outer space environment as the medium for the enabling technologies to achieve Sustainable Development Goals is inseparable part of Earth-system concerned by the Sustainable Development Goals itself. As such, the near-Earth space environment should be explicitly included in the Sustainable Development Goals agenda.

Keywords: Sustainability, Near-Earth Space, SDGs

1. INTRODUCTION

1.1. Background

Sustainability concept or, one of its applications, 'sustainable development' has been increasingly discussed in many international forums. It infiltrates and creates many agendas, including in outer space matters. Dozens space technology advocates argue that in order to solve developmental issues on terrestrial Earth, international community should utilize space technology extensively as a driver for sustainable development. Space technologies can contribute to the achievement of Sustainable Development Goals (SDGs) by all nations regardless of each capabilities through international cooperation. The environmental crisis that has affected all nations globally make this collaborative efforts more demanding.

Meanwhile, current development of space activities pose new challenges for the security and sustainability of activities in the space environment, especially the near-Earth space. New technologies have sprung up with the growth in the number and types of new players. The issues of outer space right

now is no longer just about struggle among nations like space races that occurred during the Cold War, but also involves massive commercialization with the use of space technology become more vital by the global community in their daily lives. This dynamic increases the risk of security, safety and sustainability of space activities at a level that was never imagined before. One party's careless actions in the space environment can be a disaster for all parties, without exception.

The term sustainability on the issue of terrestrial environment gets more attention compared to the space environment. This is something ironic if sustainable development efforts on the surface of the Earth need to be supported by space technologies, but at the same time the space environment in which these technologies are deployed begins to face catasthopic threats as well. It is shown by facts that the SDGs are very easily adopted by all countries in 2015 after three years (United Nations Development Programme, 2015), while the *Guidelines for the Long-term Sustainability of Outer Space Activities* (LTS) have been just completed in 2019, since the inception of its working group in 2010. The fierce debate between countries in the Working Group concerned make a dead end in completing negotiations on the the guidelines that have not been agreed upon. It revealed an indication that the international community, to some extent, does not consider the space environment, especially near-Earth space (NES), an endangered environment as equally threatened as the atmosphere or the ocean.

Last year, UNCOPUOS has adopted a resolution to establish an agenda to formally supporting the achievement of SDGs by 2030. The so-called *Space2030 Agenda* consists of an all-encompassing concept to further develop international cooperation in peaceful uses of outer space as a main driver of sustainable development. The agenda, while mainly addressing ways and means of utilizing space technologies in cooperative nuance to meet SDGs, incorporates the idea of enhancing the global governance of outer space activities as well. The issue of the long-term sustainability of outer space activities is included. It gives a new opportunity to bring the space environment, especially its near-Earth part, not only as the platform for assisting sustainable development efforts on Earth but also as an integral part of Earth-system to be protected for sustainable, ever-lasting use.

1.2. Research problem

How is an application of sustainability concept to near-Earth space as an integral part of Earth-system in the context of sustainable development goals?

1.3. Objectives

This article provides an analysis of the application of sustainability concept to near-Earth space as an integral part of Earth-system in the context of sustainable development goals.

1.4. Methodology

This paper uses library research methods with qualitative methodology. All data collected is secondary data. These data include official UN documents related to Space2030 Agenda and LTS that are mostly available but not limited on the websites of unoosa.org and undocs.org. These documents contain the content and the context of Space2030 and LTS. In addition to data from the United Nations, this paper collects and processes data from reports, scientific journal articles, and other sources.

2. THEORETICAL BASIS

Despite a long history of its use, theoretical concept of sustainability is still underdeveloped. There is no widely accepted acedemic definition of neither sustainability nor the more popular 'sustainable development' term. Even a number of scholars have made several review articles to summarize divergent definitions of the notion. Among these review efforts, this paper relies on the work of Harrington (2016). She extracted several key ideas from many interpretations of sustainability and also using them for examining rural environment. One of the ideas is to see sustainability through systems thinking as the organizing principle.

According to systems thinking, systems and subsystems are conceptualized by organziation of stocks and flow of matter as well as energy. Certain sets or types of conditions are parts of and dependent on other spheres of influence. An important consideration for sustainability-oriented policymaking and management is the capacity of a system to remain productive. To some extent, we also need to identify both direct and indirect drivers of change in the system. Additionally, the limits of a system—for example, to continue its functioning under conditions of change—are important.

From this one definition, we get the factors of sustainability: interrelated relationship of subsystems, system's limits and drivers of change identification. These three tenets would guide this paper in analyzing the sustainability of the Earth-system by its subsystems: traditional Earth-bound subsystems and near-Earth space (NES). After describing the existing situation, this paper prescribes some measures to establish a more comprehensive sustainable development agenda regarding the inclusivity of NES as an integral part of Earth-systems.

3. FINDINGS

3.1. Sustainability from outer space: Path to Space2030 Agenda

Before looking at the *Space2030 Agenda* as the means of outer space for achieving sustainable development, the notion of sustainable development itself has been being developed since many decades ago. The concept of sustainable development was at first internationally recognized in 1972 at the UN Conference on the Human Environment held in Stockholm (United Nations, 2019). The term was popularised fifteen years later in *Our Common Future* or *the Bruntland Report* which introduced the well-known definition of sustainable development: *"development which meets the needs of the present without compromising the ability of future generations to meet their own needs".* This concept became the fundament of the United Nations Conference on Environment and Development held in Rio de Janeiro in 1992. The summit marked the first international attempt, also known as the *Agenda 21*, to draw up action plans and strategies for moving towards a more sustainable pattern of development.

Those attempts, nonetheless, had largely failed to acknowledge the Earth's finite environmental capacity. Facing this context, in 2000, the international community adopted the eight Millennium Development Goals (MDGs), which were by and large targeting poverty-related issues in developing countries. It mentions reducing half of world poverty and hunger, providing universal primary education, improving healthcare, establishing access to safe drinking water, sustainable utilization of resources, combating HIV/AIDS and, developing a global partnership for development to shrink the gap between developed and develping nations. Subsequently, the *World Summit on Sustainable Development* was held in Johannesburg in 2002. It was attended by delegations to assess progress since

Rio 1992. They reached key commitments including those on sustainable consumption and production, water and sanitation, and energy.

However, the Johannesburg Summit did not help much to complement the MDGs agenda. Experts saw that MDGs failed to address sustainability issues, especially the environmental aspect (Brandi, 2015). MDG 7 is the only environmental goal among MDGs, but it is weak, imprecise and limited in scope and does not define any absolute restrictions for the impact that humans make on environment, specifically earth system. According to the recent official data of its final achievement, most of the MDGs were missed. The MDG targets on which the world failed most miserably were the environmental targets in MDG 7 (Ritchie & Roser, 2018).

At the end phase of MDGs, UN member states prepared for the post-2015 development agenda with desire for change. European Union proposed the concept of 'planetary boundaries' at Rio+20 Summit held in 2012, commemorating two decades of its first meeting. According to the *Stockholm Resilience Centre* who introduced the concept as shown in Figure 3.1, there have been identified five out of nine boundaries been crossed.

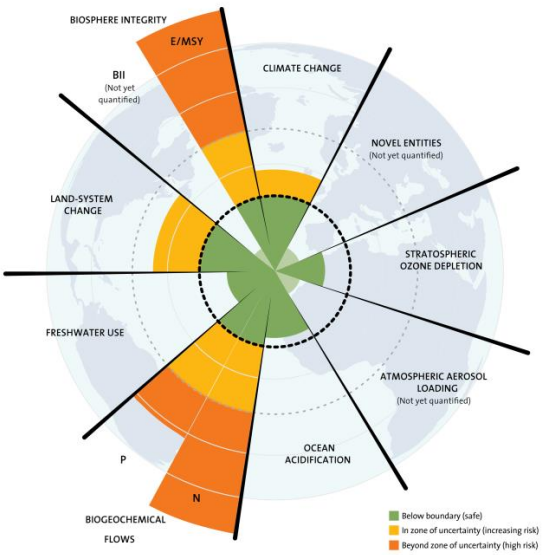

Figure 3.1 Planetary boundaries. Source: Stockholm Resilience Centre

This global situation increases the risk of generating large-scale irreversible unexpected environmental shifts. In the middle of drafting the zero draft resolution, UN Secretary-General Ban Ki-moon supported the concept (Sharma, 2018). Unfortunately, it got unacceptance from developing countries because of its lack of social dimension. However, the introduction of this concept made a breakthrough contribution to earth-system thinking in international development discourse.

In 2015, all UN Member States agreed to pursue seventeen Sustainable Development Goals (SDGs) in fifteen years. These goals are grouped in three dimensions: economic growth, social development and environment protection. Major SDGs critics to MDGs: (i) MDGs are not global goals and ultimately put obligations on the developing countries; (ii) MDGs are generally short to medium term and thus move in the oppsite direction of sustainability, which naturally be longer-term; (iii)

environmental objectives as the central tenets of sustainability are not reflected sufficiently in MDGs (Loewe, 2012, hlm. 20).

In SDGs, States committed to strengthen the role of the United Nations Environment Programme that set the global environmental agenda as the leading global environmental authority, to promote the comprehensive work of the environmental dimension of sustainable development within the United Nations system and to authoritatively advocate for the global environment. They stress the need for regular review of the status of Earth's changing environment and its impact on human well-being. Thus, they support such initiatives like the Global Environment Outlook process in order to bring together environmental information and assessments and capacity-building in national and regional level to support well-informed decision-making. There have been five GEO reports. The last report reveal the importance to think of global environment as an Earth-system.

The SDGs, in its resolution, need a systematic approach to deal with its key issues and challenges at all relevant levels. There is also a need for strengthening coherence and coordination, avoiding duplication of efforts and reviewing progress in implementing sustainable development. In the process, it mentions the needs to promote the science-policy interface, as well as access to reliable, relevant and timely data in areas related to the three dimensions of sustainable development, building on existing mechanisms, as appropriate; in this regard, strengthen participation of all countries in international sustainable development processes and capacity-building especially for developing countries, including in conducting their own monitoring and assessments.

At its 46th Session in 2015, the United Nations Statistical Commission has formed the *Inter-agency and Expert Group on SDG Indicators* (IAEG-SDGs), consists of Member States and including regional and international agencies as observers. The IAEG-SDGs has mandate to develop a global indicator framework for the 17 goals and 169 targets of the SDGs, and to support its implementation. At its 47th Session in the following year, the Statistical Commission agreed the global indicator framework incorporating 230 indicators, which is still developing overtime.

The use of space-based data, particularly geospatial information and earth observation, is recognized to assist the achieving and monitoring SDGs. While the development of the Global indicator framework has primarily been based on a statistical data input-output approach, the need for 'geographic location' in a new era of data needs is well recognized. Many national statistical offices start to realize that geospatial information as well as Earth observations are capabale of providing novel yet reliable data sources and methodologies. It could integrate multiple location-specific variables to support and inform official statistics and the indicators for the SDGs.

To meet the 2030 Agenda, it is crucial for the global indicator framework to deal with the issue of alternative data sources and methodologies, including geospatial information and Earth observations. The March 2016 report of the IAEG-SDGs to the Statistical Commission noted that the integration of statistical data and geospatial information will be key for the production of a number of indicators. As a means to address these issues, and to address specific areas relevant to SDGs indicator implementation, the IAEG-SDGs created the *Working Group on Geospatial Information* (WGGI) at its third meeting in 2016.

Beyond the Statistic Commission, the *Group of Earth Observation* (GEO) initiated EO4SDGs. The EO4SDG has set several priority areas for the development of application methods of Earth observations to the SDGs. This initiative adapted UN IAEG-SDGs WGGI's shortlist of 24 indicators where geospatial information and Earth observations, together with statistical data, can contribute

directly (or indirectly) to the production of these indicators. Several of the indicators are shown in Figure 3.2. These are considered priority indicators for GEO, particularly those that are categorized as Tier III (indicators with no established methodology or standards, but are being or will be developed and tested) and as Tier II (indicators with an established methodology but the data are not regularly available in all countries).

Figure 3.2 Several indicators which could be measured with remote sensing data.
(Source: Anderson, 2017)

In the regional level, the *Economic and Social Commission for Asia and the Pacific* (ESCAP) has created a *Plan of Action* to incorporate space technology applications in achieving SDGs by Asia Pacific nations. In 2018, Ministers and the heads of the space community from more than thirty countries in Asia-Pacific met in Bangkok for the *Third Ministerial Conference on Space Applications for Sustainable Development in Asia and the Pacific*. The conference adopted two documents that will become guidance for their work in Asia-Pacific until 2030: 1) the *Ministerial Declaration on Space Applications for Sustainable Development in Asia and the Pacific*, and 2) the *Asia-Pacific Plan of Action on Space Applications for Sustainable Development (2018–2030).*

Its counterparts at General Assembly, UNCOPUOS, has been developing measures in aligning its own outer space agendas with the SDGs. Several long-standing agenda items such as space application and remote sending for sustainable economic development. But, the momentum culminated when, on the fiftieth commemoration of UNISPACE, UNCOPUOS held UNISPACE+50 and established a new agenda named *Space2030 Agenda.* It is the main global space efforts in achieving the sustainability of global development by 2030 and arranging more robust global space governance, to go hand in hand. It was accepted by Member states in 2018 with a couple of initiation works.

3.2. Sustainability of outer space: Path to LTS

Outer space was a *tabula rasa* until the Soviet Union launched the first human-made satellite, *Sputnik I,* in 1957 (Sheehan, 2007). The United States tried to catch up by the dawn of the space race. This heated competition led to the birth of *Outer Space Treaty 1967* as an instrument to preserve outer space for peaceful uses. Actually, the first treaty that prevent weaponization of outer space was *The Partial Test Ban Treaty (1963)* which prohibited all test detonations of nuclear weapons in outer space and other places except underground. But, instead of the long-term sustainability of outer space activities, the true spirit of both treaties was nonarmament.

Many issues pertaining outer space environment aroused years later. It includes nuclear power sources, space debris, transparency and confidence-building measures, and harmful interference, among others. Most recently, measures on the long-term sustainability of outer space activities revealed the urgency of a comprehensive way to deal with problems in space environment. However, Member States took years to arrive at consensus in these dispersed agenda items. Instead of proliferating new legal-binding instruments, nations has been adopting non-legally binding to set norms for regulating activities in outer space environment since dealing with the issue of space-object registration convention.

Nuclear power sources (NPS) are used in space missions that require more power than usual solar panels or by other means due to their compactness and durability (United Nations Office for Outer Space Affairs, 2019). This kind of power have a hazardous nature to the environment as well as necessity in particular missions. The issue started to be overcame by the adoption of *the Principles Relevant to the Use of Nuclear Power Sources in Outer Space* (NPS Principles) by the General Assembly in 1992. According to the *Principles*, Member States should inform the Secretary-General regarding safety assessments carried out before the launching of nuclear-powered space objects, so it could be disseminated to other States and the general public. Further discussions developed as of, in 2007, the STSC and the *International Atomic Energy Agency* (IAEA) agreed to jointly draft a safety framework for NPS applications in outer space. The *Safety Framework for Nuclear Power Source Applications in Outer Space* was adopted by the Committee in 2009 and is intended to promote the safety of NPS applications in outer space and also be utilized as a guide for national purposes.

In space debris issues, before UNCOPUOS formally created its own guidelines, the *Inter-Agency Space Debris Coordination Committee* (IADC) was founded in 1993 as an inter-governmental forum whose aim to coordinate efforts to deal with debris in orbit around the Earth (Johnson, 2014). IADC has concluded a set of space debris mitigation guidelines. One of the accepted points is the introduction of *'protected regions'* (Inter-Agency Space Debris Coordination Committee, 2007). Figure 3.3 illustrate these particular regions.

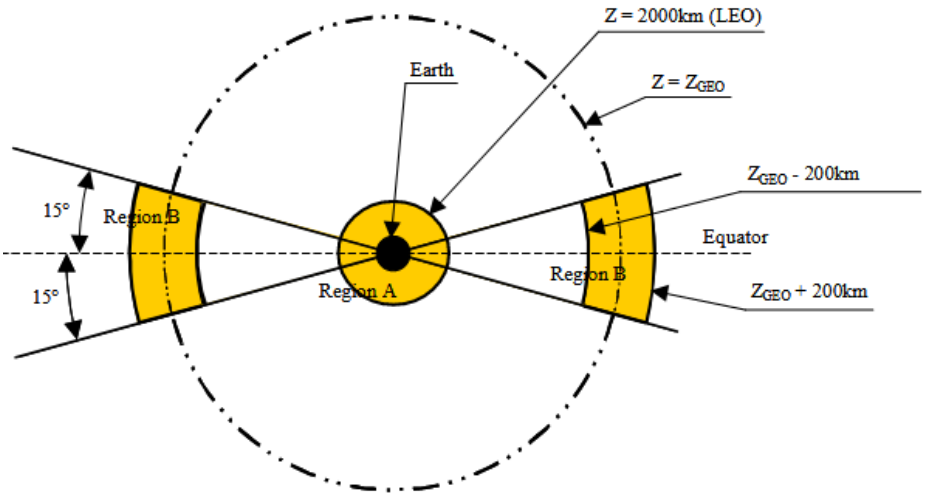

Figure 3.3 Protected regions. Source: IADC Space Debris Mitigation Guidelines.

In the following time, UNCOPUOS Member States discuss this particular issue and resulting in one important output, the *Space Debris Mitigation Guidelines*, which were endorsed by the General Assembly in 2007. The UNCOPUOS guidelines explicitly acknowledge and refer to the IADC guidelines (United Nations, 2007). In 2010, the *International Organization for Standardization* (ISO) participated in normalizing the guidelines in industrial arena by publishing a comprehensive set of space system engineering standards aimed at mitigating space debris with code ISO 24113 (Stokes dkk., 2017).

In the realm of the General Assembly First Committee, in July 2013, the *Group of Governmental Experts on Transparency and Confidence-building Measures in Outer Space Activities* (GGE on TCBMs) delivered its final report, approved by consensus, to the UN Secretary General (Alfathimy, 2018). Even though the very nature of the First Committee is security-centric, the GGE report covers the concerns on safety and sustainability of outer space activities as well. The UN General Assembly received and endorsed the report in 2013, and encouraged UN Member States to review and implement the proposed measures contained in the report through relevant national mechanisms on a voluntary basis. The report outlines the significant development of space activities, conclusions and recommendations on TCBMs that can help ensure strategic stability in the space domain.

Actually the UNCOPUOS has started a measure similar with TCBMs earlier. The *Working Group on the Long-term Sustainability of Outer Space Activities* (LTS) was established in 2010 under the STSC (A/AC.105/958, para. 181) (United Nations General Assembly, 2010) to identify areas of concern for the long-term sustainability of outer space activities, propose measures that could enhance sustainability, and produce voluntary guidelines to lower risks of compromising the long-term sustainability of outer space activities. The Working Group and its expert groups addressed thematic areas including sustainable space utilization supporting sustainable development on Earth; space debris, space operations and tools to support collaborative space situational awareness; space weather; and regulatory regimes and guidance for actors in the space arena. The LTS is also mandated to be in line with the report of GGE on TCBMs.

At the fifty-ninth session of the UNCOPUOS, in June 2016, a first set of guidelines for the long-term sustainability of outer space activities was agreed upon (A/71/20, Annex) (United Nations General Assembly, 2016). In 2018, consensus was reached on a preamble and nine additional guidelines (A/AC.105/1167, Annex III) (United Nations General Assembly, 2018). However, the Working Group failed to reach consensus on its final report or on how to refer the preamble and guidelines to the General Assembly (A/73/20, paras 207-208) (United Nations General Assembly, 2018). The remaining unagreed LTS are the solely peaceful uses of outer space, active removal/intervention, unregistered object, dangerous software and also the implementation of the guidelines. In June 2019, the Committee adopted the agreed set of LTS (United Nations General Assembly, 2019). Following the adoption, the Committee also decided to establish a new working group under the same agenda item in the next STSC sessions.

4. ANALYSIS

4.1. Systems thinking of Earth-system sustainability

Traditional Earth-system and near-Earth space (NES) are both owning systemic characteristics. Both have its own subsystems, limits and changing dynamics. In terms of sustainability, these distinct environmental system is inseparable. This analysis will explain the systemic nature of Earth-system, near-Earh space, and the combination of both.

Sustainable development on Earth is a systemic, limited and changing environmental process. The Earth functions as a system which consists of atmosphere, land, water, biodiversity and human society are all linked in a complex web of interactions and feedbacks. These are subsystems which affects each other like we see in climate change problems. UNEP has been developing regular reports, namely GEO reports, that review those environmental parts. These subsystems are global in scope and not limited by national territories. In this sense, the Earth-system is inherently international and transnational domain which must be addressed in global-level agenda.

The Earth has limitations. The concept of planetary boundaries suggests that Earth is finite. A research shows that Earth System is likely approaching a planetary threshold that could put us in an accelerated global warming conditions which could not be reversed, steered, or substantially slowed (W. Steffen dkk., 2018). It is argued that global plant productivity and carbon storage are limited by terrestrial nutrient availability (Wieder dkk., 2015). Hence, any kind of development or human activities in there must be under certain limits in every boundaries to sustain its systemic works. The boundaries affects each other as well, like Earth subsystems does.

The Earth-system is changing, both naturally and human-driven. Research shows that many factors drive change on Earth. But, according to the recent research, human-driven changes play more in tranforming the Earth environment (Vitousek dkk., 1997). We enter a new epoch called ‘anthropocene’ (Steffen dkk, 2011). The change is so rapid and systemic, affecting the sustainability of the whole Earth-system. This change is normal and acceptable as long as it does not cross the boundaries. To ensure it, people must continuously and effectively monitor the changes. The additional measures from ECOSOC Statistics Commission by establishing IAEG-SDGs WGGI indicates that at some point, space technologies provide unique capacity in order to track global environmental changes.

Since space technologies are becoming an integral part of sustainable development, the needs of it leverages. Consequently, it prolifer new space assets, actors, and activities. It leads to higher risks

and threats to space environment, especially the NES part. Moreover, NES is a systemic, limited and changing environment.

NES is a global environment surrounding the biosphere of our planet which consists of the upper layers of the atmosphere, the ionosphere, and the magnetosphere with radiation belts (Nikoghosyan, 2018). The interaction of the components of the NES with each other causes complex exchange processes which influences the biosphere of the Earth both directly and indirectly (Nikoghosyan, 2018). This affects to a certain extent the course of physical, biological, evolutionary processes in animate and inanimate nature (Nikoghosyan, 2018).

Nowadays, anthropogenic factors of the development of NES are divided into several categories: mechanical, chemical, electromagnetic and radioactive pollution (Nikoghosyan, 2018). These categories indicates NES' natural limitations. In mechanical category, space debris and limited orbital slots are predominant issues. Releases of rocket fuels in NES accumulates and affects the ionosphere layer as chemical pollution. In the same layer of NES, satellites' radio signals ionizes as electromagnetic pollution. Nuclear-powered spacecrafts release radioactive substances which penetrate the atmosphere and even reach the Earth's surface. At some level of limitations, these increasing pollutions will make NES no longer useful to assist sustainable development on Earth, or even poses new threats to Earth-system.

NES is extensively monitored by major spacefaring nations. One of the most prominent example of space monitoring technology is the United States Space Surveillance Network (US SSN) (T. S. Kelso, 2019). The technology consists of sensors which are deployed around the world to track all space objects orbiting the Earth with minimum size of 10cm in LEO and 30cm in GEO. These sensors serve the United States a space situational awareness for its own needs. However, limited amount of tracking data are shared to other nations for cooperation in facing conjunction assessment and/or collision avoidance.

4.2. Towards comprehensive sustainability of Earth-systems

The behavior of spacecrafts and actors in outer space should be regulated using up-to-date instruments in order to deal with those limitations. Fortunately, initiatives such as *Space Debris Mitigation Guidelines, Nuclear Safety Framework, TCBMs,* and lately *LTS* in last decade has indicated seriousness of international community in preserving the sustainability of outer space, particularly NES. However, the unresolved debates on several critical guidelines in LTS indicates the complexities of the issues and the diverse positions among nations.

Member states still disagree in the way of using outer space 'solely' for peaceful purposes, more decisive than 'exclusively'. The problem of active removal, while it seems necessary to clean up outer space environment for proliferation of new space assets, still in uncertainties. Even the issues of unregistered objects still has not be resolved in order to strengthen the legitimacy of Registration Convention. As we enter an era of digital revolution, dangerous softwares comes up as something to be incorporated in the LTS and still in obscure state. Member States are invited to review the LTS, especially its implementation aspects. These indicate the complexity of collective actions in outer space environment which is not governed by any international authoritative body.

The ongoing develpoment of *Space2030 Agenda* should complement existing space-related efforts by another UN or non-UN bodies to avoid efforts duplication. *Space2030 Agenda* could focus on the unique mandate of UNCOPUOS in promoting international cooperation on peaceful uses of outer space activities. While many technical utilization efforts have been developed by other bodies,

Space2030 Agenda is confronted with the governance issues both in realizing sustainability (on terrestrial Earth) from outer space and of outer space. Space2030 Agenda should focus on establishing a strong coordination efforts among technical and regulatory bodies of outer space activities.

In Space2030, space accessibility and space diplomacy plays critical parts to push the agenda for preserving outer space environment in and beyond UNCOPUOS avenue. LTS must be incorporated through these pillars. UNEP cannot delay to take space environment into account. The idea of IADC's protected regions could be adopted. It will mainstream the environmental concerns of outer space activities to higher chambers, and eventually to general public. As starting point, UN-Space should become the hub for all outer space stakeholders at global level. This way, UNEP could receive better understanding about outer space environment situation, particularly NES. UNEP would get a more comprehensive scope of the natural environment they are working on as shown in Figure 4.1.

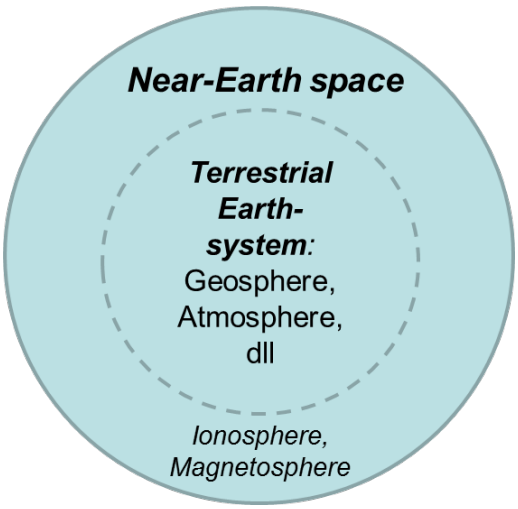

Figure 4.1 Comprehensive sustainable Earth-systems

5. CLOSING

NES is a distinct but inseparable part of Earth-system. The sustainable development of the terrestrial Earth-system, which nowadays dominantly affected by human factors, realies upon space technology in order to gain continuous and comprehensive information about Earth-system limits and changes. This need implies the critical position of outer space, especially NES, as an endangered environment as well. While seeing sustainability in systemic way, it is argued that outer space environment must be included as one of concerns in greater global sustainable development agendas. Thereof, the UN-bodies concerning environmental issues like UNEP should incorporate NES into its agenda, as important as other traditional enviromental regions such as land, ocean, or atmosphere.

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