



EARTH AND PLANETARY INSIGHTS FOR HUMAN SUSTAINABILITY

Ildiko Tulbure^{1,2,3}

¹ “1 December 1918” University of Alba Iulia, **Romania**

² Technical University of Cluj-Napoca, **Romania**

³ Clausthal University of Technology, **Germany**

ABSTRACT

Among different human activities having the goal to increase humanity's quality of life as industrial, agricultural, commercial, transport, touristic ones, also activities connected to Earth and Planetary Insights must be mentioned. In this regard Earth and Planetary Insights especially by exploration, analysis and assessment encompass several scientific fields being an inter-, multi- and transdisciplinary task. The multitude of available approaches and existing applications of mentioned insights are covering almost all human activity fields ranging from main branches of Earth & Planetary Sciences such as for instance Surveying, Geology, in all its aspects, naming here hydrogeology, geotechnics, geophysics etc., Ecology and Environmental Sciences by considering relevant environmental elements such as air, water, soil, oceans, forests, as well as potential environmental impacts because of human activities such as environmental pollution and climate change, coming to Green, Nano- and Space Technologies, as well as to the use of renewable energy resources, all of them being interconnected by modern Management Tools. Space activities must be mentioned in the context of designing new technologies for researching our planet and Outer Space with its many celestial bodies, what means activities for planetary exploration. On the other side using space activities for getting human sustainability also means setting up regional and global emergency programs to support disaster response operations through the provision of satellite data being oriented to reduce disaster risks. With the vision of getting Earth and Planetary Insights for improving humanity quality of life, holistic thinking is per-se required, and in this context connected chances and challenges will be debated with the goal of assuring human sustainability. Developments on global level have emphasized that it depends on our mutual work and cooperation to prevent the increasing processes of current resources consumption from compromising the ability of future generations to meet their own needs.

Keywords: Earth and Planetary Insights, Human Sustainability, Space Activities, Technology Assessment, Systemic Thinking, Inter-, Multi- and Transdisciplinary Task

INTRODUCTION

The multitude of currently available human activities has without doubt the foremost objective of increasing the quality of life of the population in the vision of assuring sustainability of human society. During the last decades lot of activities has been designed as for instance industrial, agricultural, commercial, transport, touristic ones, being supported in a direct or indirect way by several initiatives connected to human mobility. In this context space activities play a main role for supporting gaining Earth and Planetary Insights by providing



- Earth and Planetary Insights-

Open access peer-reviewed journal of SGEM WORLD SCIENCE (SWS) Scholarly Society, Vienna

safe communications and data exchange, navigation and positioning information, images from space used for different purposes, meteorological information and others. On the other side space activities must be pointed out in the context of designing new technologies, researching our planet and the Outer Space with its many celestial bodies [Prunariu/Tulbure 2017].

Technological advance assured in the past humanity vision to increase its quality of life, anyway developments have emphasized that beside wanted effects of technological progress, undesired effects can appear. To find solutions for this dilemma, global debates on scientific and political levels started some time ago, and as a result 1987 in the Brundtland Report the concept of sustainable development has been defined [Hauff 1987]. Humanity evolution since then has emphasized that the concept was pretty fast accepted as a possible solution for the global complex problems. When considering mobility field, the current vision is to develop mobility by respecting the concept of sustainable development, i.e. by shaping *sustainable mobility*. In this regard Technology Assessment must be used, trying to give an answer to the question regarding technologies that humanity needs, and how these technologies integrate into environment and society [Tulbure 2013]. Specific assessment criteria should be also considered regarding used technologies in sustainability decision-making processes allowing by this gaining deeper Earth and Planetary Insights.

The multitude of available approaches and existing applications of mentioned insights are covering almost all human activity fields ranging from main branches of Earth & Planetary Sciences [Planetary science]. In this frame there are aspects related to Surveying, and Geology, in all its aspects naming here hydrogeology, geotechnics, geophysics etc. or related to Ecology and Environmental Sciences. In this regard relevant environmental elements such as air, water, soil, oceans, and forests must be considered, as well as potential environmental impacts because of human activities such as environmental pollution and climate change. Gaining Earth and Planetary Insights is supported in this context also by Green, Nano- and Space Technologies, as well as using renewable energy resources, all of them being interconnected by modern Management Tools. Among the applying odds of Earth and Planetary Insights the one connected to setting up regional and global Emergency Programs can be mentioned in order to support disaster response operations through the provision of satellite data. In this regard the United Nations Platform for Space-based Information for Disaster Management and Emergency Response, UN-SPIDER, is implemented as an open network of providers of space-based solutions to support disaster management activities. With the vision of getting Sustainable Space Activities, the UN-SPIDER program requires systemic thinking by Earth and Planetary Insights for getting human sustainability [UN Spider knowledge portal].

From the very beginning it is to be stated that space activities represent the result of human commitments and efforts undertaken in science, engineering, business, and even politics to succeed flying outside the Earth atmosphere and using the Outer Space for a multitude of purposes. Related to space activities is to be mentioned that the beginning of space and the ending of the atmosphere unofficially is considered at 80-100 km above the ground according to some physical explanations. One argument is the fact that the air pressure is too low for a lifting body to generate meaningful lift force without exceeding orbital velocity, which is the orbital speed of a body in the gravitational field [Soler 2014].

This short presentation emphasizes in an obvious way that *Earth and Planetary Insights* are very diverse and can be successfully used for a multitude of scientific, commercial, industrial and governmental applications. On the other side worldwide aerospace organizations research, design, manufacture, operate, or maintain ground and space infrastructure necessary



- Earth and Planetary Insights-

Open access peer-reviewed journal of SGEM WORLD SCIENCE (SWS) Scholarly Society, Vienna

to accomplish the above-mentioned activities, what is not at all an easy and cheap task. Many countries have space organizations and programs funded by their governments. In this regard can be mentioned the National Aeronautics and Space Administration, NASA, in the United States, Roskosmos as a state corporation for space activities in Russia, the European Space Agency in Europe, the Canadian Space Agency in Canada, the Japanese Aeronautics Exploration Agency in Japan, the China National Space Administration in China, in Romania, the Romanian Space Agency, ROSA, and many others [Space agencies].

One of potential applications of Earth and Planetary Sciences for human sustainability being much discussed especially in the global context is the one concerning the possibility of using space technologies also for disaster management and emergency response [Bumgarner 2008]. As it is to be noticed, global vulnerability to natural disasters has the tendency to increase because the impact of climate change and land degradation processes continues to increase on a worldwide level. Earthquakes, floods, storms, and other natural hazards can bring huge challenges to societies and overload national economic systems because of high expenses induced by such potential unwanted negative events [Tulbure 2013]. Nevertheless, the losses of life and property could be avoided when a better risk information, improved risk assessment, early warning, and disaster monitoring would be available, what means that better applying and using Earth and Planetary Insights can be very beneficial for assuring sustainability of human society [Prunariu/Tulbure 2017].

MATERIALS&METHODS

THE CONCEPT OF SUSTAINABLE DEVELOPMENT

As it was already mentioned, technological advance has always assured humanity desire to increase its quality of life, developments however emphasizing that beside its desired impact, unwanted effects can also appear. After the Conference for Environment in Stockholm in 1972 and the first report of the Club of Rome „Limits to Growth“, published in the same year, was understood that besides wanted effects of technological progress, undesired and negative effects can appear [Meadows 1972]. Nowadays humanity is confronting with a series of global challenges, as presented in Figure 1, which can be mainly grouped into three categories: world population growth, growth of energy and natural resources consumption and environmental pollution [Tulbure 2013].

For finding solutions to remarked challenges debates on scientific and political levels started some time ago on a global level. In the Brundtland Report 1987 the concept of *sustainable development* has been defined and accepted as a possible solution for the global complex ecological, economic and social problems [Hauff 1987]: "*Sustainable development means the ability of humanity to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs.*"

When considering Earth and Planetary Insights, the current vision is to approach them by having the goals of respecting the concept of sustainable development. In this regard Technology Assessment must be used, which tries to give an answer to the question about appropriate technologies having minimal environmental and societal impacts. Technology Assessment brings together almost all scientific disciplines with the common goal of finding best ways for sustainability operationalization and points out that there are needed new assessing criteria for technological applications for assuring sustainability of human society [Jischa 2005, Tulbure 2013]. All these assessing criteria should be considered in sustainability

decision-making processes also regarding Earth and Planetary sciences. Related activities could support the sustainability of our human society by setting up regional and global programs to support especially disaster response operations through the provision of maps derived from satellite imagery.

Related to assuring sustainability of our human society, the technical field is playing a main role, besides the environmental and socio-economic field [Jischa 2005]. Considering the technical field connected with the social one, special attention must be paid to *Earth and Planetary Insights*. This fact is becoming more relevant regarding assuring global sustainability because of the need of cosmical research and applying space activities [Fortescue 2003, Prunariu 2017]. It is well known that without astrological planetary information sustainability research would be almost impossible. Important advances have been made in the last years in the field of gaining *Earth and Planetary Insights* because of using new innovative ICT based technologies by knowing spatial interplanetary relations as being first condition for really assuring the sustainable development on a planetary level [Soler 2014, Prunariu, Tulbure 2017, GEGSLA].

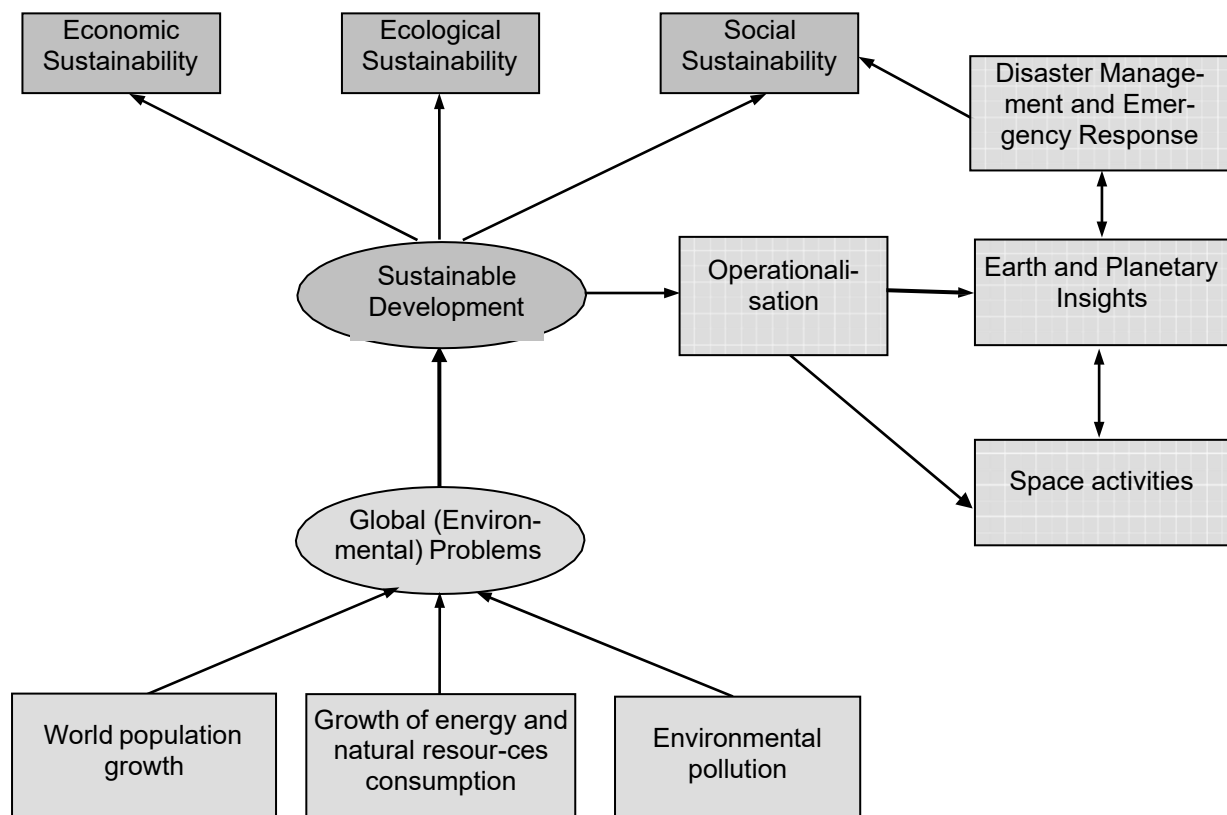


Figure 1: The concept of sustainable development and the role of Earth and Planetary Insights for its operationalization.

OPERATIONALIZATION OF SUSTAINABLE DEVELOPMENT

The operationalization of the concept of sustainable development means the transformation or translation of its goals into political measures and controlling instruments [Jischa 2005]. A



- Earth and Planetary Insights-

Open access peer-reviewed journal of SGEM WORLD SCIENCE (SWS) Scholarly Society, Vienna

general methodology to operationalize the concept of sustainable development can be materialized in following steps [Tulbure 2013]:

- defining sustainability challenge;
- establishing space and time scales;
- systemic approach of the region or analysed approach by modelling the interactions;
- establishing concrete aims for the studied case;
- developing concepts and measures by establishing priorities;
- designing assessing and control instruments, indicators;
- proofing potential results, which could be obtained after introducing proposed measures, comparing different scenarios;
- applying into the practice developed concept.

The operationalization is only possible when for single individual problem-case are established concrete aims and from these aims specific concepts are designed to achieve them. It means that sustainability is to be newly considered for each different case, and space and time scales are to be newly established for each case. Assessing and controlling instruments should be used being so-called sustainable development indicators, SDI [Sustainable Development Goals 2015]. These indicators enable the process of quantitatively formulating proposed objectives and goals for sustainable development [Tulbure 2013]. After introducing proposed measures, the fulfilling degree can be controlled and verified by calculating these indicators and by comparing them to specific reference values. The possibility to make corrections is assured in this way. On the other hand, indicators serve as an instrument which supports better understanding potential effects of introducing certain measures and informing the public.

Part of what engineers can do in this regard is represented by assessing existing and planned technological developments. Their evaluation has been focused up to now almost without exception on technical aspects and on economic aspects following legal and financial boundary conditions. With respect to sustainability more criteria must be considered like environmental quality, social and human values, and quality of life. The complex activities of engineers when evaluating technologies can be sustained by the pretty new discipline called Technology Assessment, TA [Jischa 2005, Tulbure 2013].

Following made presentation about the relevance of operationalizing sustainability means that Earth and Planetary Insights should be also focused on materializing the vision of getting Sustainable Earth and Planetary Activities. Continuing presented idea, this could be got by operationalizing sustainable development through Technology Assessment on a global and even cosmic level for assuring Human Sustainability especially in the attempt of Terraforming other planets, this being nowadays another very debated topic on different levels related to Earth and Planetary Sciences [Tulbure 2013, Prunariu 2017, Prunariu/Tulbure 2021].

TECHNOLOGY ASSESSMENT

Technology Assessment, TA means the methodical, systematic, organized process of:

- analyzing a technology and its developmental possibilities,



- Earth and Planetary Insights-

Open access peer-reviewed journal of SGEM WORLD SCIENCE (SWS) Scholarly Society, Vienna

- assessing direct and indirect technical, economic, health, ecological, human, social and other impacts of this technology and possible alternatives,
- judging these impacts according to defined goals and values, or also demanding further desirable developments,
- deriving possibilities for action and design from this and elaborating these, so that well-founded decisions are possible and can be made and implemented by suitable institutions if need be [Tulbure 2013].

When considering given methodology for sustainable development operationalization one can notice that several steps can be also identified in the phases distinguished in applying technology assessment for approaching different technological applications [Jischa 2005, Tulbure 2013]. Often a concrete sustainability challenge especially related to a technological issue is to be approached and even solved by carrying out a TA-study. Or a TA-study has as a goal to research if potential impacts of a technological application do not conflict with the goals of sustainable development [Sustainable Development Goals 2015]. For operationalizing sustainable development there is generally the need to apply the methods and instruments of Technology Assessment especially from an engineering perspective [Jischa 2005, Tulbure 2013].

Technology Assessment always tries to give an answer to the question about appropriate technologies for humanity so that their negative impacts on environment and society are as low as possible because of their usage. From this reason technology assessment must play a central role in the next global technological, environmental and social development [Jischa 2005, Tulbure 2013, Prunariu/Tulbure 2017]. Assessments for technological decisions are usually important and far-reaching, yet only rarely applicable to methodical solutions. The assessment problem can be understood as the optimal arrangement of a set of possible alternatives by considering relevant goals and corresponding preferences of decision makers considering given restrictions [Tulbure 2013]. Solving this technology selection challenge is especially difficult when following restrictions occur: many objectives are to be considered, different assessment scales emerge, objectives are weighted differently, information is uncertain and may be subject to doubt, problems are time-dependent, many are to participate in decision making process, and there is no unique criterion for decision making [Jischa 2005]. Consequently, often can be considered that there is a multidimensional assessment problem as a logical measurement operation. Consequently, one usually must deal with complex and nonlinear systems, where many non-measurable qualities occur, and interactions are at least partially uncertain. To assess potential environmental and social impacts of applying diverse human activities, several tools, so-called instruments of Technology Assessment must be applied with respect to the question which has to be answered. The most used tools of Technology Assessment are environmental management systems, life-cycle-assessment, LCA, eco-audit, as well as eco-balances [Tulbure 2013].

Considering made specifications about Technology Assessment it follows that for assessing potential impacts of applying specific Earth and Planetary Insights with the goal of assuring sustainable development such TA studies can also be carried out for Earth and Space systems and activities by considering specific methods and tools with the goal of carrying out a multi criteria decision analysis, MCDA, as well as of succeeding gaining a multi criteria decision making, MCDM [Jischa 2005, Tulbure 2013, Prunariu 2017, SD knowledge platform].



EARTH AND PLANETARY INSIGHTS BY SPACE ACTIVITIES

In recognition of the needs to assure sustainable development of human beings, UN acknowledged that the use of available space technologies but not only of these ones can play a main role for gaining specific Earth and Planetary Insights. Such insights can be provided mainly by Earth observation and meteorological satellites, nevertheless communication and navigation satellites can play a major role in supporting diverse human related activities especially related to disaster management by providing accurate and timely information for decision making [Bumgarner 2008, GEGSLA].

Earth and Planetary Insights are useful elements for further advance in the field of planetary science, which is the scientific study of planets and their planetary systems including moons, ring systems, gas clouds, and magnetospheres (https://en.wikipedia.org/wiki/Planetary_science) [Planetary Science]. Therefore, it involves understanding how planetary systems has formed, how these systems work and how all their components interact. It is a cross-disciplined field including among others also aspects of astronomy, atmospheric science, geology, space physics, biology and chemistry.

Related to these aspects, it is to be mentioned that NASA's Planetary Science Program explores the objects in our solar system to better understand its history and the distribution of life within, <https://science.nasa.gov/planetary-science> [NASA]. Earth and Planetary Insights based on space-based information are relevant for carrying out lot of human related economic activities anyway are especially supportive in all phases of the disaster management cycle from disaster risk reduction to disaster response and recovery. In this regard already in 2015, a new global framework for disaster risk reduction for the period 2015 – 2030 has been agreed [Sustainable Development Knowledge Platform]. Resulted document debates the main role of Earth and Planetary Insights supporting gaining needed space-based and geospatial information and emphasizes the main role of designing, periodically updating and disseminating location-based information about different human related activities which are connected to disaster risks. Such information includes diverse maps, such as risk maps, which can be used in certain cases by decision makers, by public and by communities at risk to disaster in an appropriate format by using, if necessary, geospatial information technology for assuring the community sustainability [Sustainable Development Knowledge Platform, UNOOSA]. On a global level the United Nations Office for Outer Space Activities, UNOOSA, through its Committee, Policy, and Legal Affairs Section, CPLA provides main support to the United Nations Committee on the Peaceful Uses of Outer Space, UN-COPUOS with the vision of applying Earth and Planetary Insights for humanity well-being [UN-COPUOS, UN SPIDER].

UN-SPIDER FOR EARTH AND PLANETARY INSIGHTS

The United Nations Platform for Space-based Information for Disaster Management and Emergency Response, UN-SPIDER (<https://en.wikipedia.org/wiki/UN-SPIDER>) [UN-SPIDER], established in 2007, represents the platform supporting the use of space technologies especially for disaster management and emergency response, this means for assuring human sustainability. It has three offices, one in Vienna, one in Bonn, and one in Beijing. Among the UN-SPIDER activities for supporting Earth and Planetary Insights the most relevant ones can be stated as being knowledge management, outreach and technical advisory support [UN-SPIDER Newsletter].



- Earth and Planetary Insights-

Open access peer-reviewed journal of SGEM WORLD SCIENCE (SWS) Scholarly Society, Vienna

1. Knowledge Management - A knowledge base on space-based information and solutions to support risk and disaster management by Earth and Planetary Insights are available through the UN-SPIDER Knowledge Portal, <http://www.un-spider.org/> [UN SPIDER KNOWLEDGE PORTAL], that started in 2009. This Portal is central to all knowledge management activities carried out within the UN-SPIDER framework, as it provides dissemination tools for specific outputs. Its main tool is the Space Application Matrix, a search engine to make available case studies regarding the application of different space-based resources in different phases of the disaster management cycle <https://www.un-spider.org/space-application/space-application-matrix> [SPACE APPLICATION MATRIX]. UN-SPIDER's knowledge management activities have the goal of raising the awareness of persons targeted, fostering change in attitudes and behavior for using space-based information.

2. Outreach - Activities targeting the full disaster management cycle span a variety of agencies from the public and the private sector at different levels and are best carried out through a coordinated approach. Involving practitioners and experts from disaster management and space communities in UN-SPIDER activities has the end-goal to promote the use of Earth and Planetary Insights by space-based information to support the full disaster management cycle. UN-SPIDER's outreach activities include the organization of workshops, seminars and expert meetings.

3. Technical Advisory Support, TAS - At the national level is one of the prime activities of the UN-SPIDER Program. It serves to identify the existing capacity to use space-based information, and to analyze the institutional framework to support disaster management through space-based information. TAS attempts to enable overcoming these limitations through international cooperation, networking with regional institutions, and setting up disaster management plans by Earth and Planetary Insights. It covers region-specific aspects such as trans-boundary issues, emergency response, risk assessment, GIS-based disaster management systems. UN-SPIDER's TAS has three pillars: Technical Advisory Missions, Capacity Building and Facilitation of Emergency Support/Technical Support [UN SPIDER KNOWLEDGE PORTAL].

The needs for space-based information can be identified by Technical Advisory Missions, TAMs. These are officially requested by the respective national government and are conducted by experts, which make at the end recommendations for improving the use of space-based information at national level [UN SPIDER NEWSLETTER]. Capacity Building is a process of facilitating the concrete application of individuals, and agencies competencies to use space-based information to prevent, and effectively respond to the challenges because of natural hazards and related humanitarian crises. UN-SPIDER capacity building efforts include especially four types of activities for gaining Earth and Planetary Insights [UN SPIDER Newsletter]:

- providing policy-relevant advice to institutions regarding the use of space-based information;
- facilitating access to space-based data and services;
- facilitating the training of individuals on access to and use of such data;
- facilitating access to infrastructure, hardware, and software for space-based applications.

In the case of emergencies and disasters situations, UN-SPIDER provides the Emergency Support by taking the role of a bridge linking the disaster management agencies in charge of response operations with space agencies or the mechanisms which have been established by the space community [UN SPIDER Newsletter]. The UN-SPIDER program is seeking to be a



- Earth and Planetary Insights-

Open access peer-reviewed journal of SGEM WORLD SCIENCE (SWS) Scholarly Society, Vienna

gateway to space information for supporting disaster management, but for environmental management as well [Prunariu 2017]. UN-SPIDER is implemented as an open network of providers of space-based solutions to support activities regarding environmental as well as disaster management with the goal of assuring sustainable development [Prunariu/Tulbure 2017]. With this goal the aim of this mission is to assess national capacities and existing policies and activities to use space-based technologies and space-based information for disaster risk reduction as well as for management and emergency response [UN SPIDER KNOWLEDGE PORTAL].

On the other hand, with the vision of getting human sustainability by Earth and Planetary Insights, different space programs may contribute to gaining information about green design possibilities, reduction of natural resources use as well as about the use of appropriate bio-fuels and -resources, and should be implemented in the future, where systemic thinking is per-se required, as requested by shaping global sustainability [Sustainable Development Goals 2015, Prunariu/Tulbure 2017, 2021].

CONCLUSION

In the present article the potential contribution of Earth and Planetary Insights for assuring human sustainability has been debated. An adequate use of space systems based on Earth and Planetary Insights is indispensable for supporting the sustainable development of humanity. Potential contribution of Earth and Planetary Insights to meet the sustainable development goals has been debated especially by presenting direct applying odds, as for instance the UN-SPIDER platform. On the other side there is a need to assume specific responsibility for inappropriate usage of gained Earth and Planetary Insights and of space systems, because this issue can really compromise the sustainability of our human society. The general conclusion that can be drawn regarding these aspects is that the existing possibilities of using Earth and Planetary Insights must be continuously explored in the efforts of assuring Human Sustainability. Delivering in the future a kind of general agenda of using possibilities of space systems based on Earth and Planetary Insights for getting Human Sustainability could be one of the most important contributions of aerospace engineering in the attempt of assuring sustainability of human society. For industry and engineers, the operationalization of sustainable development could mean to carry out technology assessment studies for trying to recognize early enough potential unwanted impacts of using such technologies. The heightened awareness of the importance of space systems for getting global sustainability has increased the interest in designing methods and tools of Technology Assessment to better comprehend potential impacts of applying gained Earth and Planetary Insights for designing new space technologies for the benefits of human beings. Assessing questions must be deeply approached and assessment challenges by using Earth and Planetary Insights for getting sustainability must be debated. Got feedback from public authorities and users of Earth and Planetary Insights underlines the need to further develop existing systems for getting human society, a future challenge is surely represented by insufficient human resources in terms of national experts to work with space-based information, or simply lack of awareness about potential benefits of Earth and Planetary Insights for Human Sustainability. The overall objective of all these efforts is to ensure that countries and organizations are efficiently using Earth and Planetary Insights to efficiently design specific strategies for getting human sustainability.



- Earth and Planetary Insights-

Open access peer-reviewed journal of SGEM WORLD SCIENCE (SWS) Scholarly Society, Vienna

REFERENCES

[Prunariu/Tulbure 2017] Prunariu, D., Tulbure, I., 2017: *Space Activities and Sustainable Development*. In: Proceedings of the 17th International Multidisciplinary Scientific Geoconference, SGEM2017, Volume 17, “Nano, Bio, Green and Space – Technologies for a Sustainable Future”, Issue 62, Section “Space Technologies and Planetary Science”, ISBN 978-619-7408-13-3, DOI 10.5593/sgem2017/62, pag. 947-954, Albena, Bulgaria.

https://scholar.google.ro/citations?view_op=view_citation&hl=ro&user=KwEjR-AAAAAJ&pagesize=80&citation_for_view=KwEjR-AAAAAJ:BqipwSGYUEgC

[Hauff 1987] Hauff, V., (Ed), Our Common Future. The Brundtland Report of the World Commission on Environment and Development, Oxford Univ. Press, Oxford, 1987.

[Tulbure 2013] Tulbure, I., Technikbewertung (Technology Assessment). Lecture Notes, Clausthal University of Technology. Clausthal-Zellerfeld, Germany, 2013.

[Planetary science] Planetary science, https://en.wikipedia.org/wiki/Planetary_science

[UN Spider knowledge portal]. UN-SPIDER Knowledge Portal <http://www.un-spider.org/>

[Soler 2014] Soler, M, Fundamentals of aerospace engineering. Create Space. Madrid, 2014. <http://hdl.handle.net/10016/21184>

[Space agencies] List of government space agencies,

https://en.wikipedia.org/wiki/List_of_government_space_agencies.

[Bumgarner 2008] Bumgarner, J. B., Emergency Management, *ABC-Clio*, Santa Barbara, 2008.

[GEGSLA] Global Expert Group on Sustainable Lunar Activities, GEGSLA, Recommended Framework and Key Elements for Peaceful and Sustainable Lunar Activities, 2023, <https://swfound.org/news/all-news/2023/03/global-expert-group-on-sustainable-lunar-activities-releases-the-recommended-framework-and-key-elements-for-peaceful-and-sustainable-lunar-activities>

[UNOOSA] UNOOSA, Treaty on Principles governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies, 2022, <https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introouterspacetreaty.html>

[Tulbure 2013] Tulbure, I., Technikbewertung – Vorlesungsskript (Technology Assessment – Lecture Notes). Institute for Applied Mechanics, Clausthal University of Technology, Germany, 2013.

[Meadows 1972] Meadows, D. and D., The Limits to Growth; Universe Book, New York, 1972.

[Jischa 2005] Jischa, M. F., Herausforderung Zukunft (Challenging the Future)., second edition, Elsevier, Spektrum Akademischer Verlag, Heidelberg, 2005.

[Fortescue 2003] Fortescue, P., Stark, J., Swinerd, G., Spacecraft Systems Engineering, 3th Edition, Wiley&Sons, New York, 2003.

[Prunariu 2017] Prunariu, D., D., Space activities in support to climate change mitigation and climate resilience, Presentation in South Africa, 2017.

[Prunariu/Tulbure 2021] Prunariu, D., D., Tulbure, I., Chances, and Challenges of Terraforming other Planets. In: O. Trofymchuk, B. Rivza (Ed.), Proceedings of 21st



- Earth and Planetary Insights-

Open access peer-reviewed journal of SGEM WORLD SCIENCE (SWS) Scholarly Society, Vienna

International Multidisciplinary Scientific GeoConference SGEM 2021, Albena, Vol. 21, “Space Technologies and Planetary Science”, 2021. https://epslibrary.at/sgem_jresearch_publication_view.php?page=view&editid1=8241

[Sustainable Development Goals 2015] Sustainable Development Goals, 2015, <http://www.undp.org/content/undp/en/home/sustainable-development-goals.html>

[Sustainable Development knowledge platform] Sustainable Development Knowledge Platform, Disaster Risk Reduction, <https://sustainabledevelopment.un.org/topics/disasterriskreduction>

[NASA] Planetary Science Program by NASA, <https://science.nasa.gov/planetary-science>.

[UN-COPUOS] UN-COPUOS, Committee on the Peaceful Uses of Outer Space - Meeting Schedule for 2024, <https://www.unoosa.org/oosa/en/ourwork/copuos/current.html>

[UN SPIDER] United Nations Platform for Space-based Information for Disaster Management and Emergency Response, UN-SPIDER, <https://en.wikipedia.org/wiki/UN-SPIDER>

[UN SPIDER Newsletter] UN-SPIDER Newsletter, 03.2015. Space-based Information for Disaster Risk Reduction, 2015, <http://www.un-spider.org/news-and-events/newsletter/un-spider-newsletter-115-space-based-information-disaster-risk-reduction>

[UN SPIDER KNOWLEDGE PORTAL] UN-SPIDER Knowledge Portal, <http://www.un-spider.org/>

[SPACE APPLICATION MATRIX] Office for Outer Space Affairs, UN-SPIDER Knowledge Portal: Space Application Matrix, <https://www.un-spider.org/space-application/space-application-matrix>



- Earth and Planetary Insights-

Open access peer-reviewed journal of SGEM WORLD SCIENCE (SWS) Scholarly Society, Vienna
