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Coordination of space-related activities within the United Nations system: directions and anticipated results for the period 2020–2021 – megatrends and realization of the Sustainable Development Goals

Report of the Secretary-General

I. Introduction

1. The Inter-Agency Meeting on Outer Space Activities (UN-Space) was established in the mid-1970s with the aim of promoting synergies and avoiding duplication of efforts related to the use of space technology and applications in the work of United Nations entities. In its resolution 74/82, the General Assembly urged UN-Space, under the leadership of the Office for Outer Space Affairs of the Secretariat,[1] to continue to examine how space science and technology and their applications could contribute to the 2030 Agenda for Sustainable Development, and encouraged entities of the United Nations system to participate, as appropriate, in UN-Space coordination efforts.

2. At its thirty-ninth session, held in October 2019, UN-Space agreed that the present report of the Secretary-General should focus on megatrends and the realization of the Sustainable Development Goals.

3. This focus stems from the recognition by the Secretary-General, set out in his report on the long-term impact of current trends in the economic, social and environmental areas on the realization of the Sustainable Development Goals (E/2019/66), that a number of megatrends, namely, demographic changes, urbanization, climate change, conflicts and protracted crises and frontier technologies, will have a major impact on the realization of the Goals.

4. The present report, which is the thirty-ninth report of the Secretary-General on the coordination of space-related activities within the United Nations system, was prepared by the Office for Outer Space Affairs on the basis of submissions from the following United Nations entities: the Economic and Social Commission for Asia and the Pacific (ESCAP), the International Atomic Energy Agency (IAEA), the International Maritime Organization, the International Telecommunication Union

[1] The functions and organization of the Office for Outer Space Affairs are described in Secretary-General's bulletin ST/SGB/2020/1.

(ITU), the Office for Disarmament Affairs, the Office for Outer Space Affairs, the secretariat of the United Nations Framework Convention on Climate Change (UNFCC), the United Nations Environment Programme (UNEP), the United Nations Office for Disaster Risk Reduction, the Operational Satellite Applications Programme (UNOSAT) of the United Nations Institute for Training and Research and the World Meteorological Organization (WMO).

5. The present report reflects continuing activities as well as activities planned for the period 2020–2021.[2] Additional information is available on the website dedicated to the coordination of outer space activities within the United Nations system (www.un-space.org).

II. Megatrends, space activities and the realization of the Sustainable Developments Goals

6. The 2030 Agenda is anchored around 17 Sustainable Development Goals, which in turn set the targets to be met by all Governments by 2030. These ambitious and important Goals can only be reached through concerted effort by all stakeholders and by making best use of the right tools. In some contexts, space tools can be sustainable development game changers.

A. Demographic changes

7. Three major trends currently characterize the world's population. First, its growth continues, albeit at a slower rate, and the world's population is expected to reach 8.5 billion people by 2030.[3] The world's population is also experiencing unprecedented ageing. In 2018, for the first time in history, persons of 65 years of age or more outnumbered children under five years of age at the global level.[4] Third, international migration has, in some parts of the world, become a major component of population change.

8. Within the overall trends, there are major differences among regions. Much population growth, for example, is expected to be concentrated in developing countries, with population growth in the 47 least develop countries expected to remain very high beyond 2050, including in 32 countries in sub-Saharan Africa.[5] On the other hand, two thirds of the world's older persons live in developed regions, with population ageing having a profound effect on the potential support ratio (i.e., the number of people of working age per person of 65 years of age or more).[6] There is also a divide between net receiver countries and sender countries as regards international migration: it is estimated that 10 countries experienced a net outflow of more than 1 million migrants between 2010 and 2020, while 14 countries received a net inflow of migrants exceeding 1 million people over the same period.[7]

9. Demographic changes have the potential to alter the trajectory of global sustainable development. They underscore the need to reduce inequalities, protect human rights and ensure that no one is left behind in the attainment of the Sustainable Development Goals. Changing demographic trends will likely also place new and added stresses on, inter alia, health-care systems.

[2] Contributors to the present report have made efforts to include up-to-date information but acknowledge that developments related to the global coronavirus disease (COVID-19) pandemic may result in the rescheduling of some activities.

[3] *World Population Prospects 2019: Highlights* (ST/ESA/SER.A/423).

[4] Ibid.

[5] Ibid.

[6] Ibid.

[7] Ibid.

1. Health

10. Space-related activities within the United Nations system can provide unique contributions to the realization of many aspects of sustainable development and address challenges linked with changing demographics. Key applications of satellite technology include telemedicine, tele-health, disease surveillance systems and health mapping. Space technology offers appropriate and affordable tools to achieve universal health coverage, including for growing, ageing and mobile populations.

11. The World Health Organization (WHO) is exploring ways and means for improving and promoting the use of space technology, space systems and space-derived information and data in the global health domain, subject to the availability of sufficient financial and human resources. In so doing, WHO focuses on the following aims: (a) strengthening country health systems and the delivery of health services at the national and subnational levels; (b) assisting in forecasting public health epidemics and raising the alert at the national and subnational levels; (c) responding to health emergencies; and (d) providing technical assistance to Member States in establishing a research agenda on the benefits of space science and technologies to public health.

12. In the area of space technology applications and public health, WHO has held discussions with numerous national space agencies about using existing technological capabilities in the service of public health and jointly developing new capabilities, in particular in e-health and telemedicine, deployable and miniature laboratory technology and environmental monitoring. In the area of research, applications and technology relating to human space flight, a number of health areas are being explored, including personalized medicine, nutrition, healthy living and exercise, health issues associated with ageing, and water treatment and sanitation.

13. Space applications are currently being used to tackle the global coronavirus disease (COVID-19) pandemic. The Office for Outer Space Affairs supports the use of these applications to combat the virus and address issues related to global health in the long term,[8] and it has created a repository of examples of how they may help to mitigate the pandemic.[9]

14. In addition to providing medical and health-care solutions, integrating geospatial information and digital technologies can help Governments to monitor infection trajectory and empower people with information in times of such pandemics as COVID-19. In support of those efforts, ESCAP is facilitating the regional sharing of georeferenced big data, the analysis of geospatial and temporal interlinkages and the understanding of risk correlations between COVID-19 and socioeconomic sectors (health, finance, connectivity, education, energy and safety). There is scope in the Asia-Pacific Plan of Action on Space Applications for Sustainable Development (2018–2030) (ESCAP/MCSASD/2018/2, annex III) for leveraging existing regional cooperation mechanisms to promote the sharing of geospatial data and technical expertise for global health and the mitigation of pandemics, including through the mapping of risk hotspots and the integration of space technology applications for evidence-based decision-making (ESCAP/75/10/Add.2).

15. In 2018, the Committee on the Peaceful Uses of Outer Space, supported by the Office for Outer Space Affairs, added a new item entitled “Space and global health” on the agenda of its Scientific and Technical Subcommittee and established a working group under that item. The Working Group on Space and Global Health continues to work under its multi-year workplan, covering the period 2019–2022, to enhance, inter alia, the capacities of Member States in meeting the health-related Sustainable Development Goals through the increased use of space science, technology and applications for global health (see A/AC.105/1224, annex II).

[8] Office for Outer Space Affairs, Space for health, “UNOOSA is helping countries leverage space for global health”. Available at www.unoosa.org/oosa/en/ourwork/space4health/index.html.

[9] Office for Outer Space Affairs, UN-Spider knowledge portal, “Coronavirus disease (COVID-19)”. Available at http://un-spider.org/advisory-support/emergency-support/covid-19.

16. Additional information on this topic is contained in the special report of UN-Space on the use of space science and technology within the United Nations system for global health (A/AC.105/1091).

2. Migration

17. International migration is often a major factor in demographic changes. The Office of the United Nations High Commissioner for Refugees (UNHCR) believes that displaced populations and the communities that host them have the right, and the choice, to be part of a connected society and to have access to technology that enables them to build better futures for themselves and the world. Its Connectivity for Refugees initiative creates safe spaces to experiment with connectivity solutions in the field and works with UNHCR operations to develop local, context-specific and community-driven approaches to digital challenges.

18. Based within the Field Information and Coordination Support Section of UNHCR, the Visual Information and Mapping Team transforms raw data into visual information, such as graphs, maps, timelines and composite products (e.g., infographics and dashboards).

19. UNOSAT is supporting the humanitarian community with refugee camp planning and mapping based on satellite imagery. It also conducts analyses of internally displaced persons settlements. The support is provided primarily to UNHCR and the global camp coordination and camp management cluster. UNOSAT also frequently conducts this type of work through the REACH joint initiative.[10]

B. Urbanization

20. Fifty-five percent of the world's population currently lives in cities.[11] Cities are reaching unprecedented sizes, and it is projected that, by 2030, there will be 43 megacities with more than 10 million inhabitants and that most megacities will be located in developing countries.[12] As the world's population continues to urbanize, sustainable development will increasingly rely on careful and effective urban management. This includes, inter alia, land-use sustainable consumption patterns, water and waste management and emergency preparedness and response.

21. In order to support sustainable urban planning and development, ESCAP is integrating space- and ground-based data into cross-sectoral support for local government decision-making, ensuring access to the right information at critical times. For example, it is promoting regional cooperation to co-develop a common data format and platform to capture, store, display, query and analyse geospatial information and cross-sectoral statistical data simultaneously. As urban development faces increased environmental challenges, ESCAP addresses coastal plastic and air pollution by facilitating the development of a digital tool to visualize plastic waste leakage, integrating georeferenced data from the ground, air, space and crowdsourcing. In addition, ESCAP is establishing an open platform for using effectively scientific data generated by the Geostationary Environment Monitoring Spectrometer and ground sensors to address air pollution in Asia.

22. WMO has addressed the increasing demand for services in urban areas to improve their resilience to environmental hazards, extreme weather events and the impacts of climate change and variability by establishing a cross-cutting urban focus in 2015 (see World Meteorological Congress resolution 68 (Cg-17)) and adopting a resolution on advancing integrated urban services in 2019 (World Meteorological

[10] www.reach-initiative.org.
[11] *World Urbanization Prospects 2018: Highlights* (ST/ESA/SER.A/421).
[12] Ibid.

Congress resolution 32 (Cg-18)). WMO has developed a methodology for establishing integrated hydrometeorological, climate and environmental services.[13]

23. Recognizing the role of nature-based solutions in building urban resilience, the United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER)[14] of the Office for Outer Space Affairs organized with the Indian Institute of Technology – Roorkee an international training programme on the use of techniques for analysing satellite remote sensing images in ecosystem-based disaster risk reduction with a focus on blue-green infrastructure in urban planning and the development of resilient communities. A related joint publication on geospatial tools and natural solutions for urban risk analysis and Earth observation for blue-green infrastructure planning will be published in 2020.

1. Agriculture and sustainable food production

24. Agriculture, sustainable food production and sustainable consumption are all vital to urban management. Satellite imagery obtained from Earth observation systems, for example, informs decision-making in agriculture, aquaculture and forestry and provides inputs for yield forecasting and risk assessments of pests, diseases and other threats in those sectors. In addition to space-derived geospatial data and information, space technology and its applications provide other solutions to address global supply uncertainty and improve the productivity and resilience of food production, in combination with other sources of data and information from terrestrial applications. The effective use of existing Earth observation information, in combination with data gathered in the field, provides tools that enhance the collection, storage, analysis and dissemination of food security information.

25. United Nations entities use space technology in their activities aimed at enhancing food security and sustainable food production. WMO, for example, provides climate services to farmers, herders and fishing communities through its Agricultural Meteorology Programme in order to promote sustainable agricultural development, increase agricultural productivity and contribute to food security.

26. Recognizing the need for adequate resourcing of the agricultural monitoring activities of its member countries to support sustainable agriculture development and address food security, the Food and Agriculture Organization of the United Nations (FAO) fosters the use of medium- and high-resolution Earth observation agricultural monitoring and technology, combined with in situ observation, to provide reliable information as support products.

27. To further promote climate-resilient agricultural development and contribute to food security, ESCAP strengthens the capacity of the lower Mekong basin countries to integrate geospatial information and in situ water, weather and crop data for identifying suitable climate-resilient agricultural practices through enhanced access to digital early warning monitoring information for climatic shocks, transboundary water issues and georeferenced production forecasts. The ESCAP regional cooperation platform, maintained in collaboration with global and regional partners, supports the training, customization and validation of crop monitoring systems, encouraging country ownership and operationalization.

28. The Office for Outer Space Affairs supports the promotion and adoption of sustainable space-based agricultural practices and technologies through awareness-raising and the creation of interlinkages between providers and users of space solutions. For example, as the executive secretariat of the International Committee on Global Navigation Satellite Systems, the Office organized a series of workshops on the Global Navigation Satellite System (GNSS) at which participants learned how GNSS technology could be used to implement regional infrastructure

[13] World Meteorological Organization (WMO), *Guidance on Integrated Urban Hydrometeorological, Climate and Environmental Services*, vol. I, *Concept and Methodology*, WMO-No. 1234 (Geneva, 2019).

[14] www.un-spider.org/.

and land use planning for agricultural areas and map and model land degradation, in particular in developing countries.

29. Additional information on this topic is contained in the special report of UN-Space on the use of space technology within the United Nations system for agriculture development and food security (A/AC.105/1042).

2. Water management

30. Through a collaboration with the Prince Sultan bin Abdulaziz International Prize for Water, the Office for Outer Space Affairs has developed the Space4Water Portal,[15] a platform for interdisciplinary knowledge exchange on space technology and water-related topics. The multi-stakeholder portal brings together organizations and professionals active in the field to share relevant articles, information on projects, initiatives, satellite missions, software, community portals, capacity-building and training material, events and data.

31. UNEP has developed a Sustainable Development Goal data portal dedicated to Sustainable Development Goal indicator 6.6.1 (Change in the extent of water-related ecosystems over time).[16] The portal aims to assist decision makers in understanding dynamic changes to freshwater ecosystems, with freshwater data provided on the site at different spatial and temporal scales.

32. At the eighteenth World Meteorological Congress, WMO adopted a comprehensive Earth system approach characterized by a stronger focus on water resources and the ocean, more coordinated climate activities and a concerted effort to translate science into services for society. This approach will ensure that WMO is better equipped to tackle mounting challenges, such as climate change, extreme weather events, environmental degradation and urbanization, while harnessing technological advances from satellites, supercomputing and big data.

33. The WMO Integrated Global Observing System [17] and its surface- and space-based components, guided by the *Vision for the WMO Integrated Global Observing System in 2040*, aims to meet the observing system requirements of all WMO applications areas in support of sustainable development. The observations form the basis for local, regional and global monitoring and forecasting systems for weather, climate and water, which in turn support applications for weather forecasting, food security, health and disaster risk reduction, among others. The System is complemented by the WMO Information System and the seamless Global Data-processing and Forecasting System. For the space-based component of the System, the WMO Space Programme acts as bridge between satellite operators and users with the overall objective of promoting the wide availability and use of satellite data and products for weather, climate, water and other related applications.

34. The Hydrology and Water Resources Programme and the joint initiatives of WMO and the Global Water Partnership known as the Associated Programme on Flood Management and the Integrated Drought Management Programme are informed by satellite-derived products. WMO is also strengthening its collaboration with FAO to enhance cooperation in the response to climate variability and climate change and to strengthen agrometeorological services.

35. The WMO Global Hydrological Status and Outlook System aims to ensure proper monitoring of water availability and to inform the sustainable management of water and sanitation for all, and it takes into account water-related issues across many development areas. The System includes global remotely sensed satellite data collected in cooperation with global and modelling centres and initiatives, such as the European Commission Copernicus Emergency Management Service and its Global Flood Awareness System.

[15] www.space4water.org.
[16] www.sdg661.app/.
[17] https://community.wmo.int/activity-areas/wigos.

36. Recognizing that flash floods have a particularly disastrous impact on the lives and properties of the affected populations, WMO approved at its Fifteenth Congress the implementation of the Flash Flood Guidance System project. The System, developed by WMO in collaboration with the National Weather Service of the National Oceanic and Atmospheric Administration of the United States of America, the Office of Foreign Disaster Assistance of the United States Agency for International Development and the Hydrologic Research Center, serves almost three billion people in more than 60 countries. The System provides a series of products using hydrological models, in near real time, including satellite and radar precipitation estimates, gauge data and soil moisture information.

3. Emergency preparedness and disaster management

37. The effectiveness of response and relief operations during and after natural disasters and in complex humanitarian emergencies is highly dependent on space technology. Space technology facilitates data collection and transmission, smooth and expedient communications and tracking and tracing efforts during such devastating events.

38. UN-SPIDER promotes the use of space-based information in disaster management, disaster risk reduction and emergency response operations with a view to closing the gap between the information potential and the actual use made of it. UN-SPIDER raises awareness of the benefits of space technology for disaster management and is aimed at building the capacities of Member States to use that technology effectively. It contains databases containing freely available satellite data, derived products and software and the compilations of all relevant maps and resources for selected major disasters.

39. ESCAP provides satellite imagery and tailored tools and products to its member States for early warning, response and damage assessment relating to earthquakes, floods, drought, tropical storms and landslides. All of these space-based data, products and services are provided free of charge by ESCAP member States through the Regional Space Applications Programme for Sustainable Development and the partnership with other United Nations agencies and international and regional initiatives.

40. At its sixth session, in August 2019, the ESCAP intergovernmental Committee on Disaster Risk Reduction recognized that the implementation of the Asia-Pacific Plan of Action on Space Applications for Sustainable Development (2018–2030) was important to support disaster risk reduction and resilience, and it requested ESCAP to enhance its collaboration, including with the Regional Committee of United Nations Global Geospatial Information Management for Asia and the Pacific, in the management of geospatial information in the region. The Committee also acknowledged the importance of geospatial information applications for disaster risk reduction and requested ESCAP to enhance its efforts in capacity-building, the sharing of good practices and the provision of technical support on geospatial information applications to countries affected by disasters.

41. In 2020, ESCAP and the Association of Southeast Asian Nations produced a joint study on drought entitled “Ready for the Dry Years: Building Resilience to Drought in South-East Asia” that featured a space-based data analysis of drought trends and impacts, highlighting that drought contributed on average approximately 60 per cent to annual losses caused by disasters in South-East Asia.

42. To support disaster risk reduction efforts, WMO will operate a global multi-hazard early warning system. The system will provide stakeholders with aggregated and standardized authoritative multi-hazard alerts and warnings based on the Common Alerting Protocol. The alerts and warnings will be issued by the national meteorological and hydrological services of the WMO members and other officially registered alerting authorities. Multiple sources of satellite data are used in the Sand and Dust Storm Warning Advisory and Assessment System and to assess regional and

global air quality, including its alterations caused by biomass burning and other extreme phenomena.

43. With a view to helping with the realization of Sustainable Development Goal 11 (Sustainable cities and communities), WMO is developing the integrated urban hydrometeorological, climate and environmental services[18] to support safe, healthy, resilient and climate friendly cities. Such services involve combining (dense) heterogeneous observation networks, satellite data, high-resolution forecasts, multi-hazard early warning systems and climate services.

44. UNOSAT continues to provide its long-standing Rapid Mapping Service following disasters, with 41 activations in 2019. This is done on the basis of requests from Member States, United Nations sister agencies and the International Federation of Red Cross and Red Crescent Societies. In this context, the Programme works closely with the International Charter Space and Major Disasters, which provides free satellite imagery in the event of disasters.

45. The Office for Outer Space Affairs is availing itself of a memorandum of understanding signed with Airbus to increase awareness of new, very high-resolution space-based data and services within the United Nations, and to promote the availability of and access to such data and the provision of open data to the United Nations system during disasters.

46. To further support disaster risk reduction efforts, the United Nations Office for Disaster Risk Reduction is closely collaborating with the Group on Earth Observations (GEO)[19] secretariat and the wider GEO community on making risk-related earth observation data accessible to practitioners and decision makers through the Global Risk Assessment Framework. The GEO secretariat is also participating in the development of the special report on drought under the *Global Assessment Report on Disaster Risk Reduction 2020* and the *Global Assessment Report 2021*.

47. To foster the use of earth observation data to inform decision-making related to disaster risk reduction, the United Nations Office for Disaster Risk Reduction, the Disaster Program of the National Aeronautics and Space Administration of the United States and AmeriGEO are working closely together in the Americas and Caribbean region. Within the framework of this collaboration, a conference under the theme “Earth observations and geospatial technologies as tools for disaster risk reduction in the region of the Americas” will be held in Guatemala in late 2020.

48. IAEA has an active programme in the area of preparedness for and response to nuclear and radiological emergencies. IAEA maintains the international Emergency Preparedness and Response framework, which is based on international legal instruments and facilitates the development and maintenance of capabilities and arrangements for preparedness for and response to nuclear and radiological emergencies. In this context, the Inter-Agency Committee on Radiological and Nuclear Emergencies, of which the Office for Outer Space Affairs is a member and whose secretariat is provided by IAEA, maintains the Joint Radiation Emergency Management Plan of the International Organizations, which provides a mechanism for coordination and clarifies the roles and capabilities of the participating international organizations. The Plan describes a common understanding of how each organization acts during a response and in making preparedness arrangements for a nuclear or radiological emergency.

49. In disaster and emergency situations, telecommunications can save lives, and ITU, which has long advocated a more effective use of technology in disaster relief efforts, is an important player in disaster response. To further support the work and improve coordination between the satellite industry and the humanitarian community,

[18] WMO, *Guidance on Integrated Urban Hydrometeorological, Climate and Environmental Services*.

[19] The Group on Earth Observations is not a United Nations entity, but its secretariat is hosted by WMO.

ITU joined the Crisis Connectivity Charter in 2020. The Charter is a mechanism created between the satellite industry and the humanitarian community to make satellite-based communications more readily available to humanitarian actors and affected communities in times of disaster.

50. The International Satellite System for Search and Rescue (COSPAS-SARSAT), a satellite-based search and rescue distress alert detection and information distribution system, is operated with the assistance of the International Civil Aviation Organization, the International Maritime Organization, ITU and other international organizations. Participants in the system work to ensure the compatibility of its distress alert services with the needs, standards and applicable recommendations of the international community.

C. Climate change

51. Human activities are estimated to have caused an increase in global temperature comprised between 0.8°C and 1.2°C since pre-industrial levels. The increase in temperature is likely to reach 1.5°C between 2030 and 2050 if global warming continues at the current rate. The past decade has been characterized by increasing temperatures, retreating ice caps, a record rise in sea level, increasing ocean heat and acidification and extreme weather events. The combination of these phenomena has had major impacts on the environment and human health and well-being.

52. Detailed information on the impacts of global warming and on strengthening sustainable development and the global response to the threat of climate change may be found, for example, in the reports of the Intergovernmental Panel on Climate Change, the "Report of the Secretary-General on the 2019 Action Summit and the way forward in 2020", and the *WMO Statement on the State of Global Climate 2019*.[20]

53. Climate change puts additional pressures on land and water resources, agriculture and food production. It increases the likelihood and severity of extreme weather events, and consequently the need for disaster management and risk reduction. Within a complex and interconnected system of feedback loops, agriculture, fisheries, food production and deforestation are themselves also frequently major drivers of climate change.[21]

54. The impact of extreme weather events and climate change on economic development, food security, health and migration continues to increase. With countries working to fulfil their commitment to the realization of the 2030 Agenda, the demand for accessible and accurate weather, climate, hydrological, marine and related environmental services will also continue to grow. In this respect, satellite applications and technologies offer credible, high-resolution, broad-scale monitoring of the planet to facilitate informed decision-making.

55. The secretariat of the United Nations Framework Convention on Climate Change, which is the custodian agency of various indicators under Sustainable Development Goal 13 (Take urgent action to combat climate change and its impacts), focuses on advancing all aspects of climate action. Earth observations inform the international climate regime, actions taken under Goal 13 and national and regional climate policies. Sharing and exchanging data bring benefits to all countries. The

[20] Valérie Masson-Delmotte and others, eds., *Global Warming of 1.5°C: An IPCC Special Report on the Impacts of Global Warming of 1.5°C above Pre-industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty* (Geneva, Intergovernmental Panel on Climate Change, 2019); United Nations, "Report of the Secretary-General on the 2019 Action Summit and the way forward in 2020" (December 2019); and WMO, *WMO Statement on the State of the Global Climate in 2019*, WMO-No. 1248 (Geneva, 2020).

[21] WMO and others, "United In Science: high-level synthesis report of latest climate science information convened by the Science Advisory Group of the United Nations Climate Action Summit 2019" (Geneva, 2020).

intergovernmental climate change process, under the secretariat, relies on scientific information on climate change through several work streams. The secretariat collaborates with many United Nations entities, international and regional scientific programmes, agencies and organizations to strengthen the interface between science and policy under the Framework Convention.

56. The systematic observation community works in collaboration with the modelling community and data and reanalysis providers to monitor emissions, support parties to the Convention and measure long-term progress under the global stocktake of the Paris Agreement. The development by space agencies of the constellation architecture for monitoring carbon dioxide and methane from space has the potential to provide a system approach for emission estimates for carbon dioxide and methane.

57. The Global Climate Observing System, co-sponsored by WMO, the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization, UNEP and the International Science Council, is an integrated, long-term endeavour to ensure the systematic observation of Earth's changing climate. The System has identified 54 essential climate variables that provide comprehensive information on the entire climate system across the physical, chemical and biological properties of the atmospheric, oceanic, hydrologic, cryospheric and terrestrial systems. Analysis of these variables facilitates climate system monitoring, climate change detection and prediction and the monitoring of the impacts of and responses to climate change, including adaptation and mitigation. Not all variables are measurable from space, and data on all or part of 30 essential climate variables are currently available through the Essential Climate Variables Inventory[22] of the joint Working Group on Climate established by the Committee on Earth Observation Satellites and the Coordination Group for Meteorological Satellites.

58. WMO, a partner agency for various Sustainable Development Goal 13 indicators,[23] uses the Global Climate Observing System essential climate variables (land, atmosphere and ocean) and climate indicators in such products as its Statement on the State of the Global Climate and climate services.

59. The monitoring of the climate is increasingly informed by space-based systems. In the near future, measurements of the atmospheric greenhouse gas composition made on board space-borne platforms will allow for estimates of greenhouse gas fluxes to be made. These systems will inform the bottom-up approaches recommended in the guidelines of the Intergovernmental Panel on Climate Change, thereby improving integrated estimates of anthropogenic emissions and removals, in line with the Paris Agreement, assist Parties in meeting their reporting commitments under the United Nations Framework Convention on Climate Change and support the global stocktake to be conducted by its secretariat every five years. The first global stocktake, to start in 2021 and end in 2023, will benefit from prototype systems, which are expected to be developed into an improved system.

60. In order to guide the actions of its members aimed at mitigating climate change, WMO established the Integrated Global Greenhouse Gas Information System.[24] The System takes a tiered approach to observations, combining satellite- and ground-based measurements to improve knowledge of greenhouse gas emissions.

61. WHO focuses its efforts on Earth observation data relevant to climate and climate change as a determinant of health; epidemiology; water mapping, quality assessment, sanitation and hygiene; big data analytics, pattern recognition and visualization; education, training and capacity-building; emergency medical response and routine health care; and non-communicable diseases and healthy living.

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[22] https://climatemonitoring.info/ecvinventory/.

[23] United Nations, Department of Economic and Social Affairs, Statistic Division, "Tier classification for global SDG indicators" (December 2019).

[24] Phil DeCola and others, *An Integrated Global Greenhouse Gas Information System (IG_3IS) Science Implementation Plan*, Global Atmosphere Watch Report No. 245 (Geneva, World Meteorological Organization, 2019).

62. ESCAP research indicates that, beyond the human cost, 40 per cent of global economic losses caused by disasters between 2015 and 2030 will occur in Asia and the Pacific, a region that accounts for around 36 per cent of global gross domestic product.[25] ESCAP suggests that measures for disaster risk reduction should take account of the shifting risks associated with climate change, especially in risk hotspots where a greater likelihood of change coincides with a higher concentration of poor, vulnerable or marginalized people.

63. Through its Regional Cooperative Mechanism for Drought Monitoring and Early Warning, ESCAP helps countries to use space-derived information available from spacefaring countries in the Asia-Pacific region and service nodes in China, India and Thailand to ensure comprehensive real-time drought monitoring, manage an early warning system and seamlessly link long-term climate scenarios with seasonal climate outlooks. The Mechanism works to determine the most appropriate products and services obtained with frontier space technology, build the capacity of countries to customize and operate monitoring and decision support tools, and disseminate information to people in need. ESCAP has established new partnerships with United Nations agencies and regional institutes to contribute to the future implementation of the Asia-Pacific Plan of Action on Space Applications for Sustainable Development (2018–2030) and build capacity to use its information and services.

64. The Office for Outer Space Affairs and its partners combine satellite and field data with scientific research to model and track climate change and its impacts at the global and local scales through the Space Climate Observatory. The Observatory aims to improve access to space-based and in situ socioeconomic data and develop products, services and decision-support tools in a coordinated and cross-disciplinary fashion.

65. Through a memorandum of understanding with the China National Space Administration, the Office for Outer Space Affairs assists with the provision of imagery for monitoring the effects of climate change, disaster management and efforts to attain the Sustainable Development Goals. The satellite images are offered where assessments or monitoring are required for areas of relevance to the Goals in developing countries.

66. As part of its ongoing Space4Youth work, the Office for Outer Space Affairs, together with the Space Generation Advisory Council, launched its Space4Youth competition 2020, asking students and young professionals to submit essays on space as a tool to address climate challenges, providing examples from local communities.

67. UNOSAT leads CommonSensing, an innovative project based on a partnership among Fiji, Solomon Islands and Vanuatu and a consortium of international partners, working together to support and build climate resilience and enhance decision-making through the use of satellite remote sensing technology. CommonSensing, which is financed through the International Partnership Programme of the UK Space Agency, focuses on long-term capacity development by deploying experts hosted by national Governments, coupled with the provision of technological solutions and training.

68. Additional information on this topic is contained in the special report of UN-Space on the use of space technology within the United Nations system to address climate change issues (A/AC.105/991).

D. Conflicts and protracted crises

69. The 2030 Agenda provides a plan of action for shared prosperity in a sustainable world, one where all people can live productive and peaceful lives on a healthy planet. Peace is intrinsically linked with the other elements (people, planet, prosperity and partnership) that underpin the Agenda. Without peace, it will be impossible to achieve

[25] *The Disaster Riskscape Across Asia-Pacific: Pathways for Resilience, Inclusion and Development – Asia-Pacific Disaster Report 2019* (United Nations publication, Sales No. E.19.II.F.12).

not only Sustainable Development Goal 16 (Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels), but also the other Goals.

70. The Geospatial Information Section of the Operations Support Division, Office of Information and Communications Technology, continues to coordinate the provision of selected products and services to the Secretariat to support the management of operations, situational awareness and geospatial intelligence for crisis response operations. The volume of analytical products and services based on satellite imagery that has been provided to the Security Council and its subsidiary organs and to the United Nations Operations and Crisis Centre has increased at a rapid pace.

71. UNOSAT provides satellite imagery-based damage assessments to humanitarian and human rights actors during conflicts and protracted crises. This work enables sister agencies to get up-to-date information on areas not accessible on the ground. This type of information is used to inform the decisions of a wide range of actors.

72. The preservation of outer space as a domain free of active hostilities and weaponization remains an integral part of the objectives of the United Nations in the field of disarmament. The Office for Disarmament Affairs supports efforts by Member States to prevent an arms race in outer space, including through the work of the General Assembly Political and Security Committee (including the regulation of armaments) (First Committee), the Conference on Disarmament and the Disarmament Commission of the United Nations.

73. The Office for Disarmament Affairs supports discussion on the implementation of transparency and confidence-building measures in various disarmament forums, including the Conference on Disarmament, the Disarmament Commission and the First Committee. In 2018, for example, the Disarmament Commission adopted the following item for consideration during the period 2018–2020: “in accordance with the recommendations contained in the report of the Group of Governmental Experts on Transparency and Confidence-building Measures in Outer Space Activities (A/68/189), preparation of recommendations to promote the practical implementation of transparency and confidence-building measures in outer space activities with the goal of preventing an arms race in outer space”. The Commission considered this item at its 2018 substantive session; however, owing to unresolved procedural matters, it was ultimately unable to convene its 2019 substantive session. In response to the situation with COVID-19, the General Assembly decided to postpone the 2020 substantive session of the Commission to 2021.

74. The Office for Disarmament Affairs and the Office for Outer Space Affairs provide support to the Chairs of the First Committee and the Fourth Committee (Special Political and Decolonization Committee) in the organization of joint meetings and panels related to the cross-cutting nature of space security and sustainability.

75. Information on national space polices and activities has been reported and disseminated through the Committee on the Peaceful Uses of Outer Space, supported by the Office for Outer Space Affairs, since the early 1960s. Since that time, such information has been disseminated through annual general exchanges of views and reports submitted on national activities, as well as under specific items on the agenda of the Committee and its subcommittees.

76. Under the five United Nations treaties on outer space and five sets of principles governing space activities,[26] the Secretary-General has a number of responsibilities, such as maintaining the Register of Objects Launched into Outer Space; disseminating information relating to outer space activities, including the discovery of harmful phenomena; issuing notifications on the recovery of astronauts in distress and space objects; disseminating information on lunar exploration and habitation; and serving as a

[26] The treaties and principles are available at www.unoosa.org. Every year, the Office for Outer Space Affairs makes available to the Legal Subcommittee of the Committee on the Peaceful Uses of Outer Space an updated table on the status of international agreements relating to activities in outer space, based on information provided by the depositories of the respective instruments.

facilitator on such issues as nuclear-powered space objects prior to launch and issuing notifications relating to the malfunction and re-entry of nuclear-powered space objects.

77. The Office for Outer Space Affairs assumes the aforementioned responsibilities on behalf of the Secretary-General, the primary responsibility being the maintenance of the Register of Objects Launched into Outer Space. The intent behind the registration of a space object with the Secretary-General is to identify which State retains jurisdiction and control over a space object and bears international responsibility for it. The Register should be considered the first international mechanism established for promoting transparency in outer space activities, and with the ever-increasing number of space object launches, the registration system plays an important role in ensuring the responsible conduct of space activities.

78. Since 2015, the Office for Disarmament Affairs has requested that all Member States provide information on their national space policies and strategies and on major military outer space expenditure, for inclusion in the annual United Nations Report on Military Expenditures.[27]

79. In 2019, the Committee adopted the Guidelines for the Long-term Sustainability of Outer Space Activities (A/74/20, annex II). The Guidelines comprise a substantive preamble and 21 individual guidelines and can be considered as potential transparency and confidence-building measures. The Committee encouraged States and intergovernmental organizations to voluntarily take measures to ensure that the Guidelines were implemented to the greatest extent feasible and practicable, and decided to establish a new working group under the agenda item on the long-term sustainability of outer space activities of its Scientific and Technical Subcommittee (ibid., paras. 163 and 165).

80. The Working Group on Nuclear Power Sources in Outer Space of the Scientific and Technical Subcommittee continues to facilitate the implementation of the Safety Framework for Nuclear Power Source Applications in Outer Space developed jointly by IAEA and the Subcommittee. The Office for Outer Space Affairs acts as the secretariat of the Working Group, while IAEA supports the work as a member of the Working Group.

81. Additional information on this topic is contained in the special report of UN-Space on the implementation of the report of the Group of Governmental Experts on Transparency and Confidence-Building Measures in Outer Space Activities as pertaining to the United Nations system (A/AC.105/1116).

E. Frontier technologies

82. Frontier technologies, including space technology and its applications, offer unique opportunities and can play a transformative role in the achievement of the Sustainable Development Goals. In many situations, frontier technologies possess the potential to offer better, cheaper and faster solutions to overcome challenges. Space-derived information, for example, is a key decision-making tool for the efficient management of assets, environments and communities. Research has also shown that around 40 per cent of the Sustainable Development Goal targets benefit from the use of geolocation and Earth observation.[28]

83. Not all populations are, however, able to equally benefit from technical developments. While developed countries may be grappling with frontier technological developments, developing countries, and in particular the least

[27] The United Nations standardized instrument for reporting military expenditures (previously known as the United Nations System for the Standardized Reporting of Military Expenditures) was introduced pursuant to General Assembly resolution 35/142 B. The Office for Disarmament Affairs includes the request to Member States in the regular note verbale transmitted to all States on the annual submissions to the Report on Military Expenditures.

[28] The Office for Outer Space Affairs Space4SDGs work elaborates on how the peaceful uses of outer space support the attainment of the Sustainable Development Goals.

developed countries, landlocked developing countries and small island developing States, are yet to fully benefit from existing technologies. Space-related activities of United Nations entities play a major role in addressing the interrelated technical, development and space divides.

84. In his strategy on new technologies, the Secretary-General aims to define how the United Nations system will support the use of these technologies to accelerate the achievement of the 2030 Agenda and to facilitate their alignment with the values enshrined in the Charter of the United Nations, the Universal Declaration of Human Rights and the norms and standards of international law. United Nations entities have been working on, inter alia, deepening the internal capacities and exposure of the Organization with regard to new technologies; increasing understanding, advocacy and dialogue in this area; and enhancing the support of the United Nations to government capacity development.

85. The Access to Space for All initiative of the Office for Outer Space Affairs aims to provide research and orbital opportunities to Member States and ensure that the benefits of space activities, in particular for sustainable development, are truly accessible to all. Opportunities under the initiative include microgravity and hypergravity research, satellite development, in-orbit research and access to the International Space Station and the China Space Station for educational and research purposes. Through partnerships with spacefaring nations and industry and the private sector, the portfolio of opportunities continues to grow.

86. Small and very small satellites and their applications have made it possible for a growing number of actors to participate in and benefit from space activities. Recognizing the requirements under international law for all entities launching and operating satellites, the Office for Outer Space Affairs and ITU collaborated on the development of guidance to assist small satellite developers and operators with space object registration and frequency management.[29]

1. Open access to data

87. Efforts to enhance open satellite data collection and dissemination also support the aim of making the benefits of space available to all States on a mutually agreeable and equitable basis. The Global Climate Observing System and the Global Ocean Observing System are examples of joint international undertakings that involve United Nations entities and international organizations and employ, encourage the use of and coordinate space systems and data for collaborative observation, modelling and analysis.

88. Promoting and facilitating the visibility, free accessibility and ease of use of space science data, in particular astronomical data, collected by space- and ground-based facilities, are the objective of the Open Universe initiative of the Office for Outer Space Affairs, conducted in partnership with Italy. The initiative aims to enhance and complete the online availability and visibility of astronomical and space science data following internationally agreed standards and to promote the development of software applications and educational and outreach environments for astronomy and space science.

2. Artificial intelligence

89. There is growing acknowledgment that machines can execute repetitive tasks with absolute precision, and that they are gaining the ability to learn, improve and make calculated decisions in ways that will enable them to perform tasks previously thought to require human experience, creativity and ingenuity.

90. Following on past Artificial Intelligence for Good Global Summits, ITU will hold the 2020 edition as a continuous digital event, featuring weekly programming

[29] Office for Outer Space Affairs, United Nations Register of Objects Launched into Outer Space, “Resources and reference material for States and organizations” (available at www.unoosa.org/) and International Telecommunication Union, “ITU filing procedures for small satellites” (available at www.itu.int/).

across multiple formats, platforms and time zones.[30] The Summit will bring into contact innovators in the field of artificial intelligence and "problem owners" with a view to overcoming global challenges.

91. UNOSAT and the Global Pulse initiative have developed together the PulseSatellite tool. This is an open tool for artificial intelligence and machine learning for the benefit of Member States and sister agencies focused on building models and flood detection.

3. International cooperation and interoperability

92. In its Guidelines for the Long-term Sustainability of Outer Space Activities, the Committee acknowledged the linkages between scientific and technical research and development and the social, economic and environmental dimensions of sustainable development. For example, they provide guidance to States and intergovernmental organizations on how to promote the development of technologies that minimize the environmental impact of manufacturing and launching space assets and that maximize the use of renewable resources and the reusability or repurposing of those assets. They also provide guidance on facilitating international cooperation and promoting and supporting capacity-building.

93. The Committee of Experts on Global Geospatial Information Management of the United Nations is an intergovernmental global geospatial policymaking body that fosters a geospatial approach to attaining the Sustainable Development Goals and has been successful in building a global architecture and regional geospatial committee architectures in Asia and the Pacific, the Americas, the Arab States, Europe and Africa. The Committee of Experts focuses on strengthening national capabilities, capacities and institutional arrangements around geospatial information in Member States. The Department of Economic and Social Affairs and the Geospatial Information Section provide secretariat support to the Committee of Experts.

94. The International Committee on Global Navigation Satellite Systems, established under the umbrella of the United Nations and serviced by the Office for Outer Space Affairs, promotes voluntary cooperation on matters of mutual interest relating to civil satellite-based positioning, navigation, timing and value-added services. The International Committee strives to encourage and facilitate compatibility, interoperability and transparency among all navigation satellite systems. In order to maximize the use and application of GNSS to support sustainable development, the Office continues to promote cooperation on issues related to GNSS compatibility, interoperability, performance and other space-based positioning, navigation and timing matters.

95. The Office for Outer Space Affairs acts as the secretariat for the Space Mission Planning Advisory Group (SMPAG). The Group's responsibilities include laying out the framework, timeline and options for initiating and executing space mission response activities and promoting opportunities for international collaboration on research and techniques for near-Earth object deflection. In the event of a credible impact warning by the International Asteroid Warning Network (IAWN), the Group would propose mitigation options and implementation plans for consideration by Member States.

4. Space weather and resilience

96. "Space weather" refers to variations in the space environment between the Sun and the Earth (and throughout the solar system), which can affect human beings and technologies in space and on Earth. Space weather has an impact on the dynamics of the near-Earth space environment, specifically the magnetosphere, the ionosphere and the neutrosphere, and affects human activities and the operation of terrestrial and space infrastructure, including high-voltage electrical transmission systems and pipelines, and can lead to electrical blackouts, potentially on a continental scale.

[30] https://aiforgood.itu.int/.

97. At the seventeenth World Meteorological Congress, it was decided that WMO should undertake international coordination of operational space weather monitoring and forecasting with a view to supporting the protection of life, property, critical infrastructure and affected economic activities.[31] WMO established the Inter-Programme Team on Space Weather Information, Systems and Services to lead its space weather-related work. The space weather information service for international air navigation became operational in November 2019.

98. The Committee on the Peaceful Uses of Outer Space continues to consider the topic of space weather through a dedicated item on the agenda of its Scientific and Technical Subcommittee and through the Expert Group on Space Weather. The Expert Group, for example, is preparing a report on opportunities for the efficient coordination of space weather activities undertaken at the international level to implement the Guidelines for the Long-term Sustainability of Outer Space Activities. The report is expected to map the international space weather actors and their mandates and linkages, identify gaps and recommend actions to improve coordination.

99. The Office for Outer Space Affairs supports the International Space Weather Initiative, an international cooperation programme designed to advance space weather science, which plans to hold a workshop on space weather in November 2020, under the aegis of the United Nations.

100. In preparation for the next World Radiocommunication Conference, in 2023, ITU will study means to ensure the legal recognition and technical protection of space weather radio sensors used for global prediction and warnings. The two main objectives of the studies are to establish potential regulatory provisions for the appropriate recognition of receive-only space weather sensors in the radio regulations and to gather and assess technical and operational characteristics of active space weather sensors.[32]

101. Additional information on relevant activities undertaken by United Nations entities is contained in the special report of UN-Space on developments within the United Nations system related to space weather (A/AC.105/1146).

III. Changing realities in outer space activities

102. All the megatrends identified by the Secretary General as having a major impact on the realization of the Sustainable Development Goals (demographic changes, urbanization, climate change, conflicts and protracted crises and frontier technologies) also intersect with the changing realities in the use of outer space, which result to a significant extent from rapid technological advancements.

103. For more than a decade, the space sector has been expanding faster than the global economy. There are an increasing number of new space actors and of objects being launched into space, leading to a growing congestion of objects in orbit around the Earth. States that were previously not spacefaring are beginning space programmes, and private and commercial actors are dramatically increasing their activities.

104. The importance of multilateralism and the key role of the United Nations will be seen not only in progress made towards the Sustainable Development Goals, but also in the fostering of the global governance of outer space activities to accompany the expansion of the space economy.

[31] WMO, Space Programme. Available at https://community.wmo.int/.

[32] Information about the World Radiocommunication Conference 2023 (WRC-23), agenda item 9.1 (a), is available at www.itu.int/en/ITU-R/study-groups/rcpm/Pages/wrc-23-studies.aspx.