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Contribution by USA

to the CSTD 2019-2020 priority theme on "Exploring space technologies for sustainable development and the benefits of international research collaboration in this context

CSTD 2019-2020

Submission by the United States Government

Theme 2: "Exploring space technologies for sustainable development and the benefits of international research collaboration in this context."

As you are aware, the CSTD 22nd annual session selected "Exploring space technologies for sustainable development and the benefits of international research collaboration in this context" as one of the priority themes for its 23rd session (2019-20 period).

At least 14 of the 17 SDGs can be achieved with the help of space technologies. Earth observations, satellite communications, navigation, and other technologies are helping countries and communities deliver on key sustainable development issues, including land-use management, agriculture and food security, access to digital infrastructure (via satellite communications), the management of ever-expanding urban centres, adaptation and mitigation strategies for climate change, and disaster risk reduction. These efforts are also taking place in the least developed countries, where countries like Bhutan have recently launched satellites. This priority theme will help STI ministers understand the potential opportunities of space-enabled technologies for delivering on the SDGs, and policy options for harnessing space tech for the SDGs. The priority theme will also focus on regional and international research collaboration to support such efforts. The achievement of ambitious global goals in widely differing local contexts requires the combination of space capabilities with detailed local knowledge. Global research collaboration offers great potential to contribute to this process, providing opportunities both to create new knowledge and to increase the impact of research by diffusing existing knowledge.

The CSTD secretariat is in the process of drafting an issues paper on the theme to be presented at the CSTD inter-sessional panel meeting. In this context, we would like to solicit inputs from the CSTD members on this theme. We would be grateful if you could kindly answer the following questions based on your experience from your country or region.

1. Can you give examples of projects/policies in your country aimed at using space technologies for sustainable development? What are the main challenges confronted while trying to implement these projects/policies in your country or region?

The United States benefits from space technologies in many ways, some of which are available to other countries without requiring launch or flight capabilities. Broadly, these fall into three areas:

1. Space-based Earth observations of land, air, and water;
2. Global Navigational Satellite Systems (GNSS), including the US Global Positioning System, applications on positioning, navigation and timing;
3. Telecommunications based on individual and constellations of satellites.

As countries become more technologically sophisticated, they will likely increase their reliance on space-based applications and technologies. Below are some examples from the United States and beyond relevant to, and organized by, the SDGs (*numbers in parentheses refer to SDG targets*).

1. End poverty - (1.5) Build resilience against climate-related disasters, (1A) Ensure significant resources to help developing nations implement programs and policies to end poverty.
    - The Landsat series of satellites, developed by the National Aeronautics and Space Administration (NASA) and operated by the U.S. Geological Survey (USGS), provide data used by SERVIR, a development initiative of NASA and the U.S. Agency for International Development (USAID). SERVIR uses Landsat and other U.S. satellite data to make maps used in disaster relief (1.5) and support sustainable land use planning by developing nations (1A). The NASA–USAID partnership on the SERVIR network provides data, information, methods combining Earth observation and geospatial data for decision-making and visualizations to address environmental problems including deforestation, pollution, floods, droughts and biodiversity loss. Currently there are SERVIR nodes in the Americas (Panama, Peru), Africa (Kenya, Niger), and Asia (Nepal, Thailand).

2. Zero hunger - (2.2) End malnutrition in children under 5, (2.3) Double agricultural production of small-scale food producers, (2.4) Encourage sustainable production that maintains ecosystems in the face of climate change, (2C) Ensure functioning of food commodity markets.
    - FEWS NET provides early warning and analysis on acute food insecurity in 28 countries. Along with these assessments, they provide reports on weather and climate, markets and trade, agricultural production, livelihoods, nutrition, and food assistance. (2.2, 2C)
    - The U.S.-supported GEOGLAM initiative has been leading global cooperation in crop monitoring and market assessments to ensure transparency in crop markets. (2C)
    - AfriScout is an app that supplies pastoralists in Ethiopia, Kenya, and Tanzania with data on water and vegetation in potential grazing areas so that they can make informed decisions about where to take their herds. (2.3)
    - USAID supports the CGIAR Platform for Big Data in Agriculture, which coordinates efforts to apply machine learning, precision agriculture, and other novel techniques to solve agricultural challenges across the world. (2.2, 2.3, 2.4)
    - The USDA World Agriculture Supply and Demand Estimates (WASDE) report is prepared monthly and includes forecasts for U.S. and world wheat, rice, and coarse grains (corn, barley, sorghum, and oats), oilseeds (soybeans, rapeseed, palm), and cotton. U.S. coverage is extended to sugar, meat, poultry, eggs, and milk. (2C)
    - GADAS (Global Agricultural and Disaster Assessment System) is a web-based GIS system for the analysis of Global crop conditions and the analysis of the impacts of disasters on agriculture. (2C)

3. Good health and well-being - (3.3) End AIDS, TB, and other epidemics of communicable diseases, (3.4) Reduce by a third mortality from non-communicable diseases, (3.9) Reduce illness and death from hazardous chemicals and pollution.

- Data Collaboratives for Local Impact (DCLI), a partnership between the U.S. President's Emergency Plan for AIDS Relief (PEPFAR) and the Millennium Challenge Corporation (MSS), is working in Africa to build the enabling environment for data-driven decision-making to end the AIDS epidemic, improve health outcomes, reduce gender inequality, and support economic opportunity for vulnerable youth. A key focus of PEPFAR is citizen mapping of high HIV-prevalent areas, in partnership with Humanitarian OpenStreetMap Team (HOT) and others, to identify HIV hot spots, health facilities and pharmacies, and improve allocation of program resources. DCLI's Innovation Challenge produced over 40 data innovations that support improved health systems, reduce HIV risks for adolescent girls and young women, and promote economic opportunity. (3.3)
- PEPFAR also worked with the Young African Leaders Initiative (YALI) Regional Leadership Centers in Nairobi, Pretoria and Accra, as well as the U.S. State Department's MapGive initiative, the USAID-supported YouthMappers network, MCC, and HOT organizations to sponsor a wave of mapathons across Africa to end HIV/AIDS. The geospatial activities incorporate space-based Earth observations. (3.3; 3.4; 3.9)
- In 2018, data from NASA satellites were used for the first time to implement a cholera forecasting system in Yemen, which the previous year had achieved a 92% accuracy. Thanks to space data and tools, future health and development workers will be both more efficient and effective in their campaigns against disease outbreaks. (3.4)
- The microgravity environment on the International Space Station (ISS) allows us to grow larger versions of an important protein, LRRK2, implicated in Parkinson's disease. This will help scientists to better understand the pathology of Parkinson's and aid in the development of therapies directed to alleviate this disease and its effects. Thus, this pioneering research aboard the space station may end up helping 7 to 10 million people worldwide currently affected by this disease.
- Drone delivery systems, such as Zipline, can deliver medicines and blood to remote areas much faster than travel by land. This method improves delivery reliability and product safety, which can save lives. (3.3, 3.4)
- Remote health services such as telemedicine can allow patients in remote areas to connect with specialists and facilities not locally available. The Alaska Federal Health Care Access Network (AFHCAN) serves federal beneficiaries in Alaska using a 'store-and-forward' technology. Studies conducted by AFHCAN show high patient and provider satisfaction levels with telemedicine, and third-party payers (Medicaid, Medicare, private insurance) have deemed telemedicine services to be of sufficiently high quality to be reimbursable. (3.3, 3.4)
- Miniaturization of technology for use in nanosatellites has direct benefits for environmental quality measurements. With cheaper and smaller devices, more monitoring can be completed, improving detection of conditions hazardous to human health. (3.9)

Future: *Low-cost instruments built for Cubesats, particularly in communications and data processing, could be helpful in rural clinics for transmitting data out for analysis.*

Connectivity enabled by space technologies such as GNSS, satellite Earth observations, space-based internet services could enhance the tracking of disease epidemics and sharing of medical records.

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4. Quality education - (4.1) Ensure that all youth complete primary and secondary education, (4C) Increase supply of qualified teachers, particularly by training locals.

    - The Map Kibera Trust has used the OpenStreetMap platform to train local residents how to map slums in Kenya. One initiative located all of the informal schools within the area and entered data about the number of students, teachers, and facilities available in each school. (4.1)
    - Through initiatives bringing internet connection to currently disconnected schools, teachers may use online tools to teach more effectively on topics that they may not have personal knowledge of. (4C)
    - Space exploration serves as a means of inspiring young people to continue their education and pursue careers in STEM. The Sally Ride EarthKAM is one pathway for this, which allows students to request and receive photos taken from the International Space Station (ISS) of their chosen locations. (4.1)

Future: *For technical skill-building, Cubesats are becoming ever more affordable as a means of teaching and learning in different science, technology, engineering and math (STEM) fields. Cubesat design and manufacturing can be employed for STEM education and STEM interest-building among non-traditional groups.*

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5. Gender equality - (5.2) Eliminate trafficking and exploitation, (5B) Use tech to empower women.

    - Let Girls Map is a YouthMappers campaign to motivate women to map their communities and participate in efforts around the globe to map issues relevant to the livelihoods of women. Mapping women's challenges offers a way to draw attention to problems that could otherwise go unseen. (5B)
    - Companies such as ORBCOMM are using constellations of satellites in low-Earth orbit to gather Automatic Identification System signals about vessels across the ocean. With this technology tracking all compliant vessels, law enforcement can more easily identify vessels that are not in compliance and are more likely to be used in human trafficking. (5.2)

- Internet access through satellites allows rural women to use technology traditionally unavailable to them for social, economic, and political purposes. (5B)

Future: *With universal internet access, women across the globe will have access to new economic possibilities, the ability to work together on advocacy projects, and opportunities to better educate themselves and their communities on women's issues.*

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6. Clean Water and Sanitation - (6.1) Universal, equitable water access, (6.3), Reduce pollution and dumping, (6.4) Increase water use efficiency, (6.5) Integrated resource management.
   - NASA's Aqua satellite tracks global water cycles and its GRACE-FO mission uses gravity measurements to visualize water placement underground and within ice, both of which can aid with 6.1, 6.4, and 6.5.
   - Microencapsulation technology developed for use aboard the space shuttle has been repurposed for pollutant clean-up in the immediate aftermath of oil spills. (6.3)
   - In 2018, NASA launched the ECOsystem Spaceborne Thermal Radiometer Experiment (ECOSTRESS) instrument on board the International Space Station. A key ECOSTRESS measurement, derived from temperatures of plants, is evapotranspiration, which is a climate and ecosystem variable that is especially important to hydrology research and applications. (6.4, 6.5)

Future: *Our ability to track water contamination will increase as imaging capabilities improve and become more widespread. For example, radar and LIDAR instruments can measure the size of oil spills, day or night, even through cloud cover.*

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7. Affordable and Clean Energy - (7.1) Ensure universal, affordable, and reliable energy services, (7.2) Increase share of renewables in global energy mix, (7.3) Increase energy efficiency.
   - The National Oceanic and Atmospheric Administration's (NOAA) DSCOVR mission monitors solar winds to provide an early warning system in the event of a Coronal Mass Ejection or other damaging solar event that could threaten critical infrastructure including power systems. (7.1)
   - Battery storage capabilities have become more robust due to U.S. government-funded research for space applications. With more efficient batteries, overall energy efficiency increases and use of renewable energy sources becomes more feasible. (7.3)

Future: *While Space Solar Power Systems (SSPS) are currently impractical, technological advancement coupled with reduced launch costs may in the future enable the use of SSPS to direct power towards areas where running physical wires is not feasible and solar panels cannot operate efficiently.*

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8. Decent work and economic growth - (8.2) Increase economic productivity through innovation, (8.4) Improve resource efficiency and decouple economic growth from environmental degradation, (8.7) End slavery and forced labor.

    - Vessel tracking mentioned in 5.2 applies to 8.7. Government and commercial Earth observation data companies provide and/or sell useful satellite-derived information to authorities monitoring migrant boats, refugee camps, and other activities in border and conflict areas.
    - All previous land and water resource optimization mentioned with 1, 2, and 6 apply to 8.2 and 8.4.

9. Industry, innovation, and infrastructure - (9.1) Develop quality, reliable, sustainable and resilient infrastructure, (9.3) Increase access of small-scale enterprises to financial services, (9C) provide internet access to those in least-developed countries.

    - Amazon's Project Kuiper, SpaceX's Starlink constellation, Google's Project Loon, and a collection of others are planning to provide global internet access through nanosatellite constellations and high altitude balloons. (9C).
    - Harvesting Inc., FarmDrive, GRID, and Apollo Agriculture use remote sensing and machine learning as a tool to help assign credit ratings for farmers in the developing world, allowing many to get loans that would otherwise not have been securable. (9.3)
    - A welding technique developed for assembling rocket fuel tanks can provide stronger, safer, more environmentally-friendly, and less power-intensive welds for any type of metal infrastructure. (9.1)
    - Made In Space, Inc. has developed an additive manufacturing facility on the ISS that conducts materials research in microgravity.

10. Reduced Inequalities - (10.2) Promote the social, economic, and political inclusion of all.

    - The Humanitarian OpenStreetMap Team (HOT) organizes volunteers to map uncharted areas for projects covering disaster risk reduction, gender equality, refugee and disease response, and more. These efforts shed light on groups that are underserved and underrepresented by putting their issues on the map. (10.2)
    - The SERVIR project is a partnership between NASA and USAID with a growing network of regional partners in the Americas (Panama, Peru), Africa (Kenya, Niger), and Asia (Nepal, Thailand) dedicated to environmental management through the integration of Earth observations and geospatial technologies. The decision-support, visualization tools, models, information and maps that are produced help stakeholders combat deforestation, floods, wildfires, droughts, red tides, biodiversity loss, and much more. (10.2)

11. Sustainable cities and communities - (11.1) Ensure access to safe and affordable housing, (11.5) Reduce the number of deaths related to disasters.

    - The Secondary Cities (2C) Project, is a field-based initiative of the U.S. Department of State to map for resiliency, human security, and emergency preparedness in emerging urban communities in the developing world. The project builds partnerships to create geospatial capacity, enhance understanding through analysis of satellite and georeferenced data, in order to enable science-based decision-making. (11.1)
    - Information products like Planet's basemaps provide paying customers with current data on the spread of cities and towns, allowing them to better understand and plan urban growth. Such maps may also be used to examine the types of housing in different areas to determine where investment is most needed. (11.1)
    - The International Charter Space and Major Disasters is a worldwide collaboration, through which satellite data are made available for the benefit of disaster management. By combining Earth observation assets from different space agencies, the Charter allows resources and expertise to be coordinated for rapid response to major disaster situations; thereby helping civil protection authorities and the international humanitarian community. (11.5)
    - In December 2016, NASA launched the Cyclone Global Navigation Satellite System (CYGNSS), a fleet of small satellites to improve extreme weather prediction. CYGNSS maps wind speeds and ocean surges in real-time as hurricanes form and progress, allowing governments to better understand, forecast, and track the threat. (11.5)

Future: *Designs planned for life on Mars can provide insights into methods to construct light but durable housing on Earth. Mars habitats will particularly require efficient use of space, which can be helpful to minimize the effects of overcrowding in urban areas.*

12. Responsible consumption and production - (12.3) Halve global food waste at the retail and consumer levels, (12.4) Achieve environmentally sound management of chemical and all wastes throughout their life cycle.

    - Food preservation studies developed to reduce spoilage and maintain nutritional value have generated significant research that can be used to improve food preservation on Earth. (12.3)
    - NASA is testing technology with the TEMPO spacecraft to monitor air pollutants at high spatial resolution for the purposes of air quality forecasting. Once this technology is operationalized, it can be used to monitor and track pollution plumes, including their chemical composition and dispersion trajectories. (12.4)

Future: *Most of the Martian modules incorporate methodologies for growing food into their designs, which when applied on Earth could decrease traffic congestion, pollution, and supply problems if urban areas are not reliant on transportation of goods from distant rural locations.*

Technology developed for long-term space habitation may have applications to reduce air and water pollution flow in and from cities.

13. Climate action - (13.1) Strengthen resilience and adaptive capacity to climate-related hazards, (13.3) Integrate climate change measures into national strategies and planning.

    - The Partnership for Resilience and Preparedness Initiative is a public-private alliance hosted by the World Resources Institute (WRI), which seeks to improve access to data, including space-based Earth observations, to empower communities and business to better plan for and build climate resilience. The United States remains committed to continued leadership in environmental and Earth system research and to full and open data sharing and partnerships. (13.1; 13.3)
    - NASA, NOAA, the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT), and the French National Center for Space Studies (CNES) partnered to launch OSTM/Jason-2 and Jason-3, satellites that monitor sea-level rise and track the transport of heat throughout the Earth's oceans, which can help identify where climate change is most likely to affect coastal communities. (13.1, 13.3)
    - OCO-2, a NASA Earth observation satellite mission, is sampling atmospheric carbon dioxide levels at high resolutions to better understand global carbon sources and sinks. By determining the locations of naturally occurring carbon sinks, governments can optimize their protection plans to give ecosystems the greatest potential to recover from pollution. (13.1) With this data, scientists can model current and future carbon emissions to aid governments in creating strategies to reduce carbon dioxide emission on a scientific basis. (13.3)

14. Life below water - (14.2) Protect marine and coastal ecosystems, (14.4) Regulate harvesting and end overfishing to restore sustainable fish stocks.

    - NASA's PACE mission is scheduled to launch in 2022 to collect data on ocean color and atmospheric composition that will provide information on phytoplankton distribution and abundance, ocean dissolved oxygen content, and atmospheric exchange. This can inform sustainable fishing levels (14.4) and provide better characterization of ocean health (14.2).
    - NOAA's Coral Reef Watch is monitoring global water temperatures in order to provide coral bleaching alerts. While little can be done in response, the alerts raise awareness about potential bleaching events and provide a relative measure of coral health. (14.2)

15. Life on land - (15.1) Ensure proper care for terrestrial ecosystems.

    - Resource Watch, also hosted by World Resources Institute, features hundreds of data sets (many are space-based Earth observations) all in one place on the state of the planet's resources and citizens. Users can visualize global challenges, from climate change, poverty, water risk, state instability, air pollution, human migration, and more. (15.1)

- Global Forest Watch monitors a number of health indicators of forests around the globe and tracks deforestation and other agricultural harms with the use of a growing number of American (NASA, NOAA, USGS) and international (ESA, CNES, Copernicus, etc.) satellite constellations.
- Suomi NPP will map global vegetation, plant productivity, and land temperatures to better understand terrestrial ecosystems. (15.1) Its vegetation mapping in particular will be helpful in tracking global desertification so that appropriate steps may be taken. (15.3)
- A National Research Council study states that satellite imagery is a compelling tool for educating global citizens about their Earth. Those citizens are then empowered to take action in regard to terrestrial ecosystems with a better knowledge base.

Future: *Increased quality and access to Earth observation data will facilitate efforts to ensure compliance with international laws protecting ecosystems, including the movement of protected species.*

16. Peace, justice, and strong institutions - (16.3) Promote the rule of law at the national and international levels, (16.4) Reduce illicit financial and arms flows, (16.7) Ensure responsive, participatory and representative decision-making.
    - Governments have long used satellite imagery to ensure compliance with international treaties and agreements. Increasingly, academic institutions and NGOs are leveraging access to large sets of data to promote peace and justice. For example, Beyond Parallel uses satellite imagery to better inform strategies in regard to Korean unification. (16.3)
    - Satellite data can be used to survey areas where illicit or illegal activities are likely to take place, increasing the ability of law enforcement parties to focus their responses. For example, MAAP tracks illegal logging, and gold mining in the Amazon. (16.4)
    - Global satellite-based internet service will have applications for 16.3, 16.4 and 16.7.

17. Partnerships for the goals - (17.6) Enhance knowledge sharing in science and technology.
    - The United States, through PEPFAR, is a founding member of the Global Partnership for Sustainable Development Data (GPSDD), which is working to convene, connect and catalyze partnerships to build demand, political will and capacity for data-driven decision-making to advance sustainable development challenges. GPSDD partnered with NASA, the Group on Earth Observations (GEO), the Committee on Earth Observation Satellites (CEOS), and others to launch the Africa Regional Data Cube (ARDC), which is building capacity in Kenya, Tanzania, Ghana, Senegal and Sierra Leone for using time-series satellite images and other geospatial data to improve

environmental management, adaptation to climate change, and agricultural productivity. ARDC, which will feature regional Landsat data, will serve as a platform for scale-up of a continent-wide Digital Earth Africa geospatial capability. (17.6)

- NASA shared data from the Terra satellite with South Africa's Council for Scientific and Industrial Research, allowing them to develop useful models using satellite data and build capacity in data analysis. (17.6)
- All Earth science data from NASA, NOAA, and USGS satellites is made available under a policy of free, full and open, under a non-discriminatory principle "where all users will be treated equally." This allows countries who may not have the capability to operate satellites to benefit from globally relevant datasets. (17.6)
- In carrying out our mandate of research and space exploration, NASA has, entered into more than 3,000 agreements with more than 120 nations and international organizations since its establishment. NASA's global partnerships are represented today by more than 700 active agreements with partner entities around the world. These partnerships offer multiple benefits to NASA and its partners, from enhancing the pace of scientific progress through rapid, open access to science mission data to sharing risks and costs while promoting discovery and advancement.
- The Radiant Earth Foundation has built a library of training data, models, and standards for machine learning in support of space-based Earth observation. This can help train many different applications of machine learning for development. (17.6)
- Cubesats are excellent platforms for developing/emerging countries develop in-house science and technology expertise that is applicable to a variety of engineering and scientific applications.

2. Can you provide examples of policies/projects/initiatives aimed at promoting international research collaboration in the area of space technologies for sustainable development? What are the main challenges confronted in implementing these projects?

The United States is actively involved in international organizations established to coordinate activities in space, such as CEOS, GEO, the Coordination Group for Meteorological Satellites (CGMS), and the International Committee on GNSS (ICG). For more information, please refer directly to information provided by, or representatives of, those groups. We also recommend to readers the Scientific and Technical Subcommittee (STSC) of the UN Committee on the Peaceful Uses of Outer Space (UNCOPUOS) and UNCOPUOS' work to develop a "*Space2030 Agenda*," which will set COPUOS' agenda through 2030 and will include a number of important topics, one being how space-based assets contribute to the implementation of the SDGs.

3. What are the actions that the international community, including the CSTD, can take to leverage the potential of space technologies for sustainable development, including through international research collaboration in this context? Can you give any success stories in this regard from your country or region?

See responses above.

4. Could you suggest some contact persons of the nodal agency responsible for projects/policies, related space technologies for sustainable development and international research collaboration in this context as well as any experts (from academia, private sector, civil society or government) dealing with projects in this area? We might contact them directly for further inputs or invite some of them as speakers for the CSTD inter-sessional panel and annual session.

Several U.S. Government agencies are involved in coordinating U.S. policies and activities in space. For purposes of CSTD, we suggest directing questions to the Office of the Science and Technology Adviser to the Secretary, U.S. Department of State (STAS-Staff@state.gov), and the Office of Space & Advanced Technology, Bureau of Oceans, Environment, and International Scientific Affairs (OES-SAT-DG@state.gov). You may also consider contacting these individuals:

- UNOOSA Director, Ms. Simonetta Di Pippo (simonetta.di.pippo@unoosa.org; http://www.unoosa.org/oosa/en/aboutus/director.html)
- Executive Director of the Secure World Foundation, Dr. Peter Martinez (pmartinez@swfound.org; https://swfound.org/about-us/our-team/dr-peter-martinez/)
- Director OECD Space Forum, Ms. Claire Jolly (Claire.JOLLY@oecd.org; https://www.oecd.org/sti/inno/space-forum/)
- CEOS Ad Hoc Team on Sustainable Development, Alex Held, Flora Kerblat, Marc Paganini (sdg-leads@lists.ceos.org; Alex.Held@csiro.au; flora.kerblat@csiro.au; marc.paganini@esa.int; http://ceos.org/ourwork/ad-hoc-teams/sustainable-development-goals/)

5. Do you have any documentation, references, or reports on the specific examples on the priority theme in your country or region?

See responses above.