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Space Administration

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NASA & the Space Solutions Compendium

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Challenges and progress in applying space technology in support of the sustainable development goals

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A R T I C L E I N F O

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Sustainable Development Goals (SDGs)
Space technology
2030 agenda for sustainable Development

A B S T R A C T

The global community, with coordination from the United Nations, is energized to pursue the Sustainable Development Goals (SDGs), a list of 17 important aspirations that summarize the key challenges of our era. The SDGs apply to every nation and represent an international effort to eliminate extreme poverty, ensure access to safe drinking water, strengthen food security, and produce clean and reliable energy, among other pursuits. Space technology is already being used around the world to advance progress toward the SDGs and monitor their related Indicators. This paper explores how six technologies related to space—satellite Earth observation, satellite communication, satellite navigation and positioning, human spaceflight and microgravity research, space technology transfer, and basic scientific research—are being used to realize the vision that the SDGs represent.

6 space technologies we can use to improve life on Earth

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Technologies from Multiple Sectors of Space Can Support the Sustainable Development Goals

Satellite Earth Observation

Satellite Positioning & Navigation

Human Space Flight & Microgravity Research

Satellite Communication

Space Technology Transfer

Fundamental Scientific & Technology Research; Education

Image Source: https://freepik.com

Technologies from Multiple NASA organizations contribute to the Sustainable Development Goals, such as….

NASA Earth Science Division

NASA Space Communications and Navigation

NASA Biological and Physical Sciences

NASA Space Communications and Navigation

NASA Spinoff Office

NASA Astrophysics, Heliophysics & Planetary Science; Office of STEM Engagement; NASA Space Technology Mission Directorate

Image Source: https://freepik.com

We identified 272 examples of NASA projects that are proposed for submission to the Space Solutions Compendium

104 Examples
Earth Observation

5 Examples
Positioning

30 Examples
Human Space Flight & Microgravity Research

4 Examples
Communications

47 Examples
Spinoffs

82 Examples
Fundamental Scientific & Technology Research; Education

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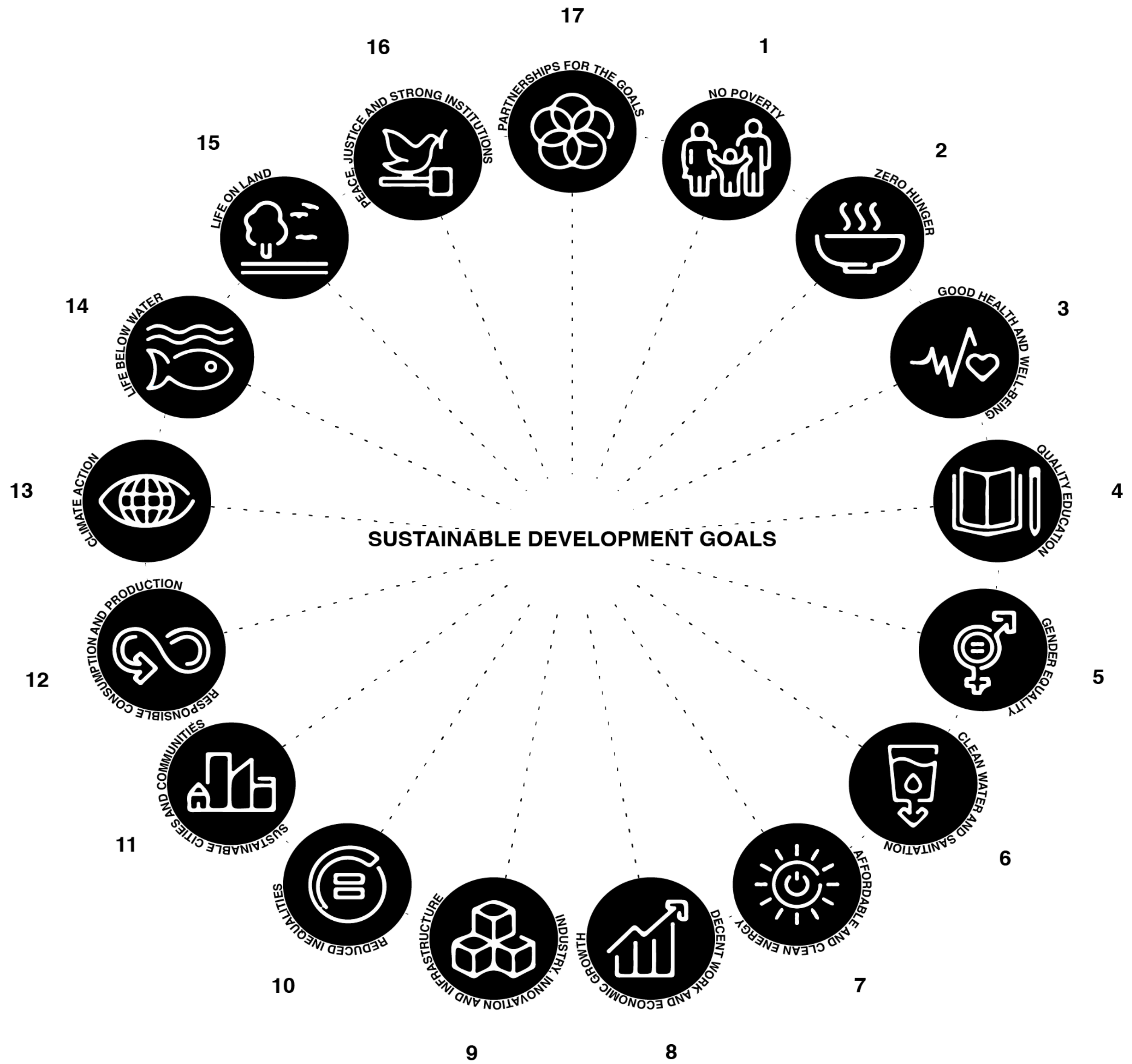
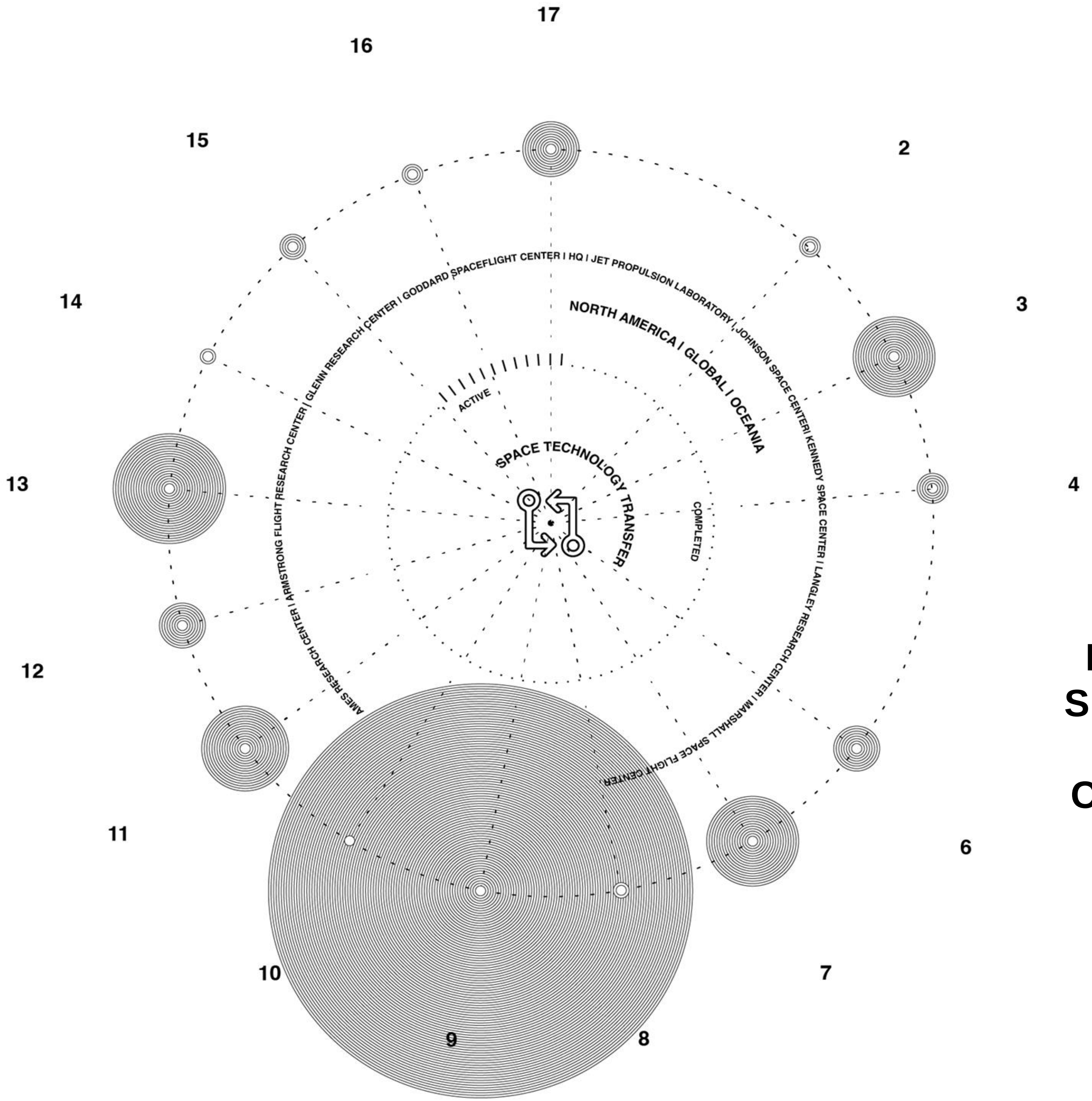
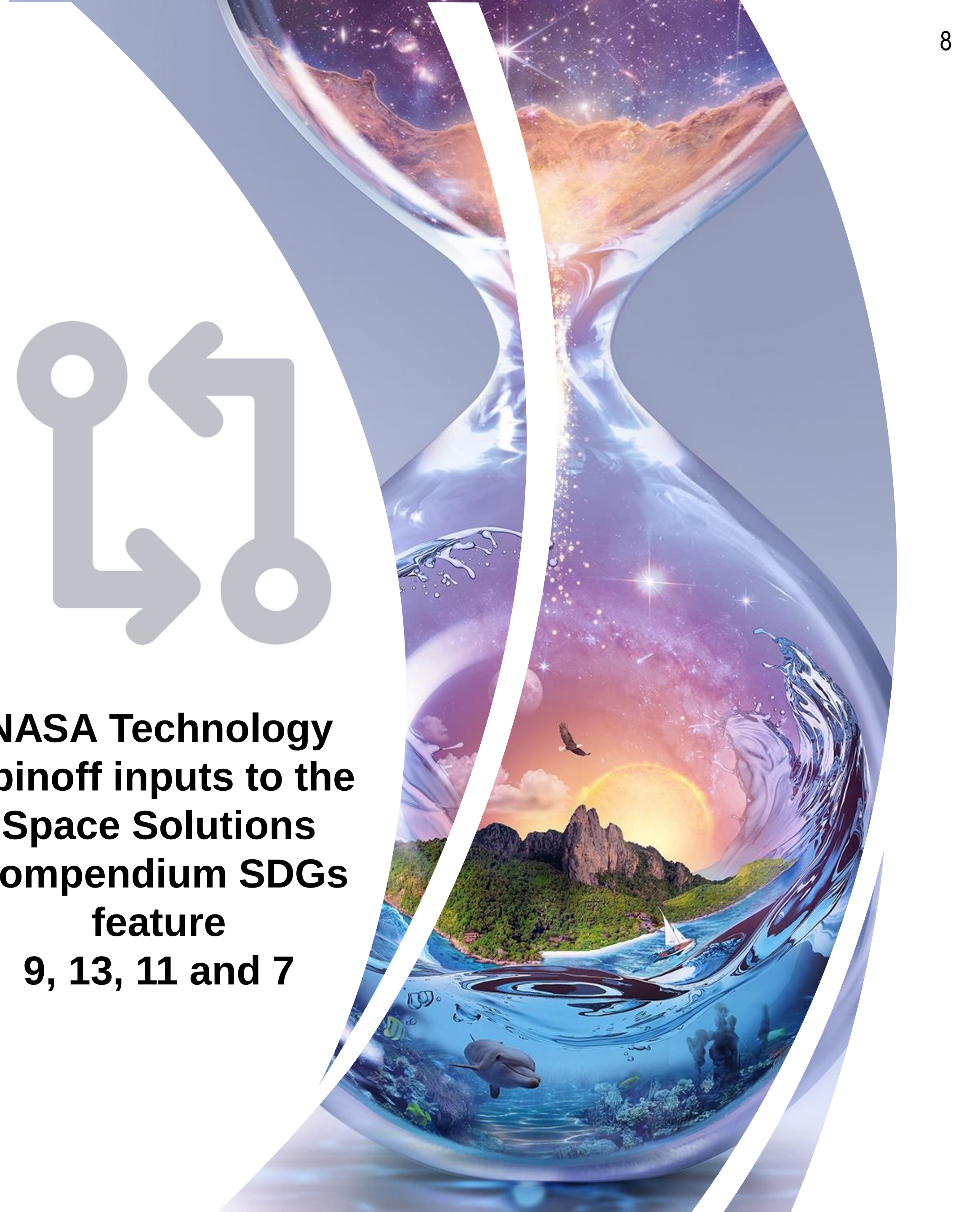

SUSTAINABLE DEVELOPMENT GOALS
1
NO POVERTY
2
ZERO HUNGER
3
GOOD HEALTH AND WELL-BEING
4
QUALITY EDUCATION
5
GENDER EQUALITY
6
CLEAN WATER AND SANITATION
7
AFFORDABLE AND CLEAN ENERGY
8
DECENT WORK AND ECONOMIC GROWTH
9
INDUSTRY, INNOVATION AND INFRASTRUCTURE
10
REDUCED INEQUALITIES
11
SUSTAINABLE CITIES AND COMMUNITIES
12
RESPONSIBLE CONSUMPTION AND PRODUCTION
13
CLIMATE ACTION
14
LIFE BELOW WATER
15
LIFE ON LAND
16
PEACE, JUSTICE AND STRONG INSTITUTIONS
17
PARTNERSHIPS FOR THE GOALS

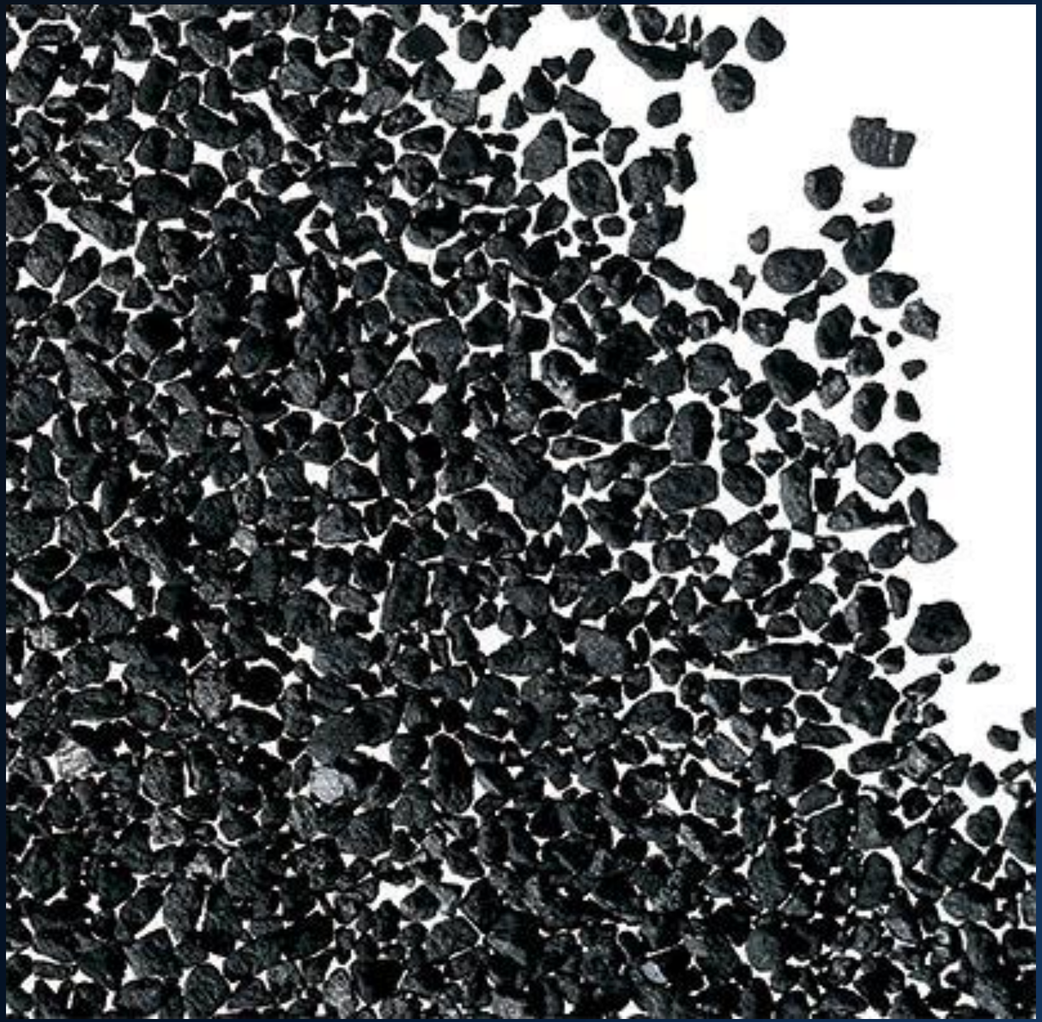


NASA Technology Spinoff inputs to the Space Solutions Compendium SDGs feature 9, 13, 11 and 7



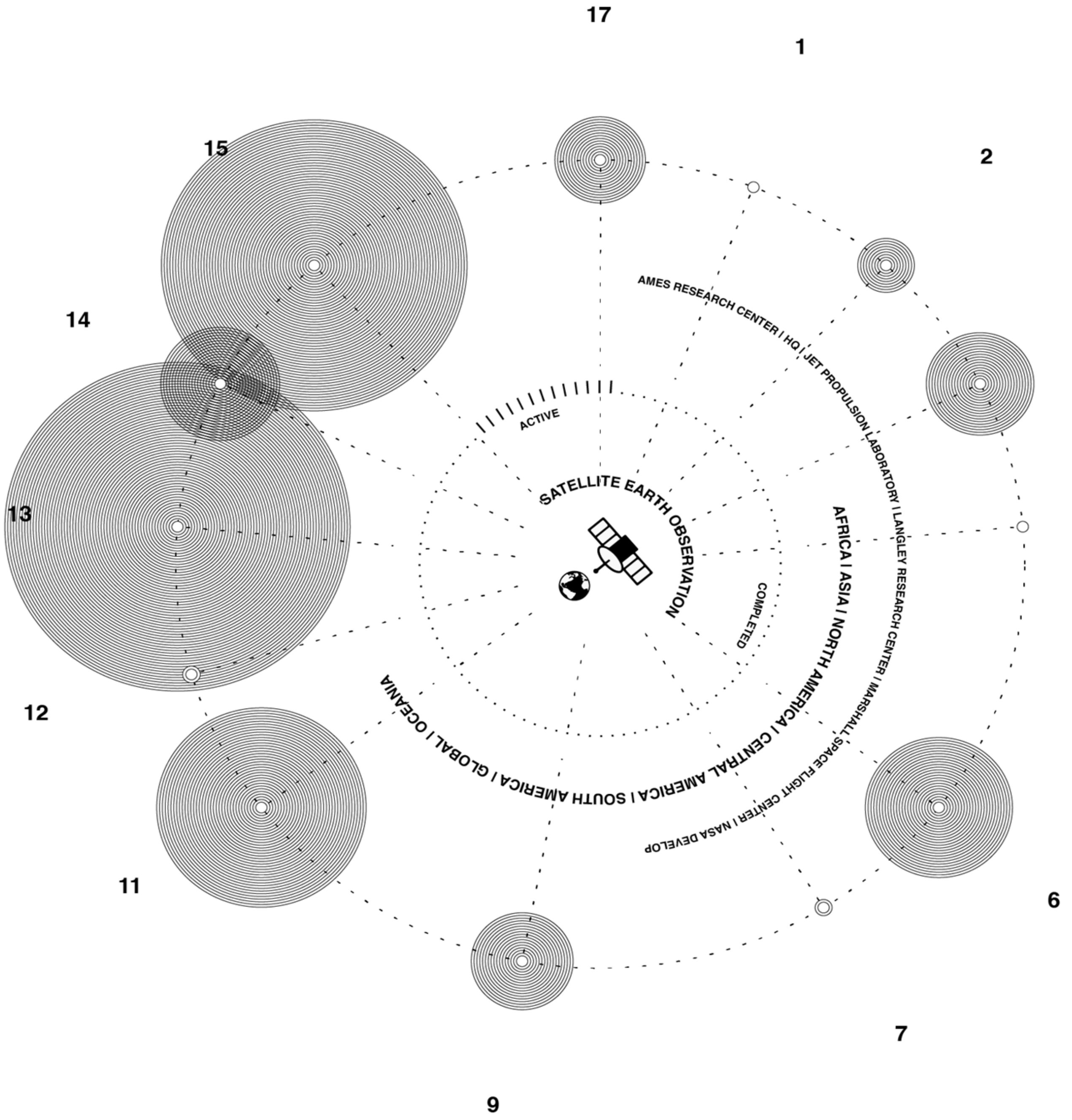
NASA research on water filtration for astronauts has been applied in commercially available products

In the 1960s, Johnson Space Center commissioned an electrolytic silver ion generator to purify water on the Apollo missions. The silver ion-based purifiers never flew on NASA missions, but here on Earth, they've given rise to filter systems for home faucets, pools, spas, boilers, hospitals, and more.

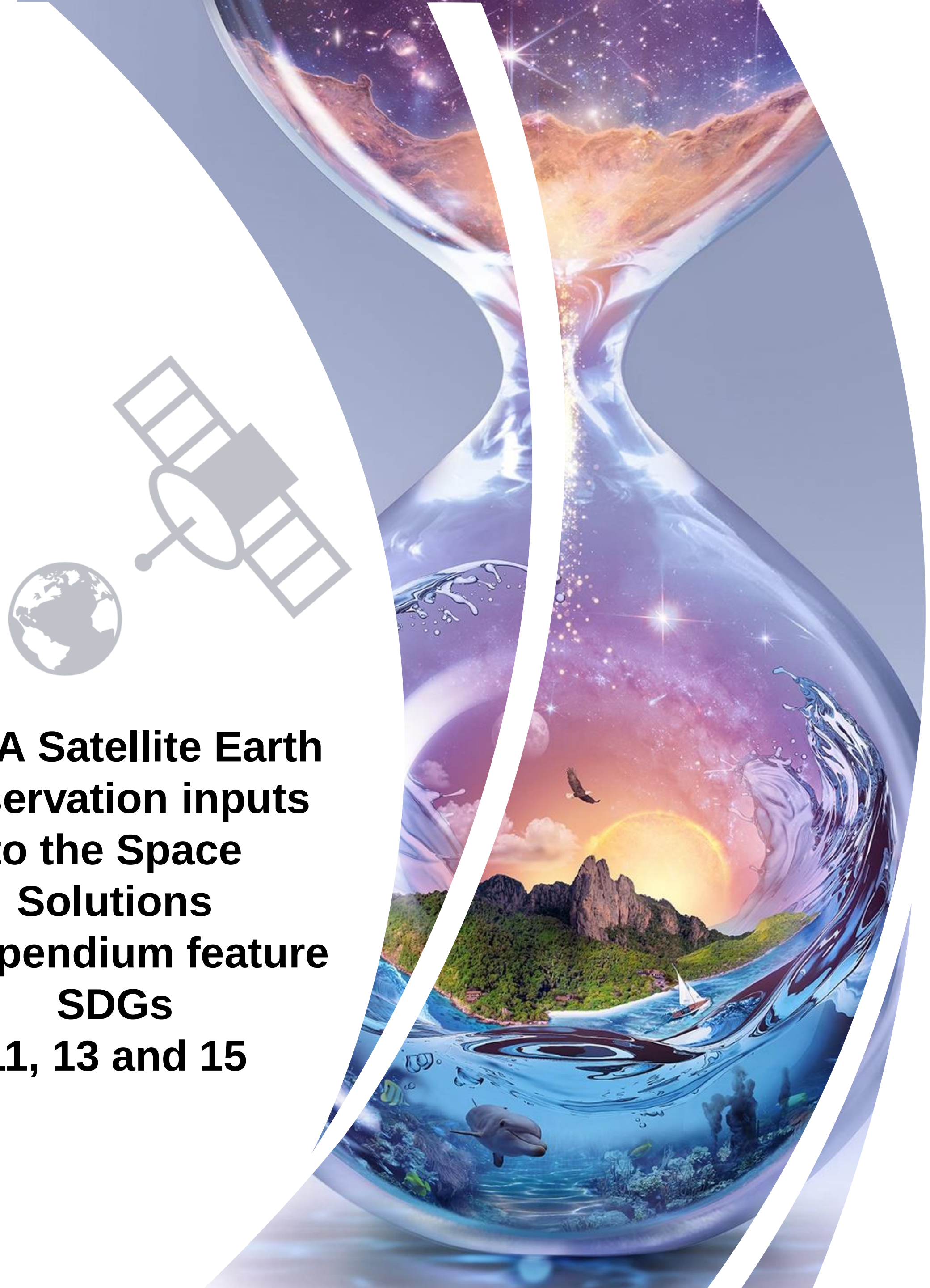


Carbon impregnated with silver ions forms the filter bed for most of Puronics' product lines. Credit: Puronics Water System Inc.

https://spinoff.nasa.gov/page/space-age-water-conservation-nasa



NASA Satellite Earth Observation inputs to the Space Solutions Compendium feature SDGs 11, 13 and 15



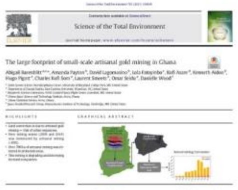
Impact Assessment for Applying Satellite Earth Observation Data to SDG15 Monitoring in Ghana

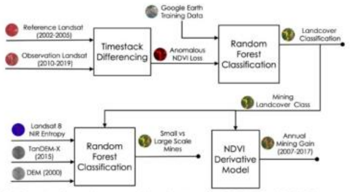
Professor Danielle Wood[1], Priscilla Baltezar[1], Dr. Temilola Fatoyinbo[2], Dr. David Lagomasino[3], Charles Kofi Som[4], Kofi Asare[5]

Space Enabled Research Group at MIT Media Lab[1]; NASA Goddard Space Flight Center[2], East Carolina University[3]; Ghana Statistical Service[4]; Ghana Space Science and Technology Institute[5]

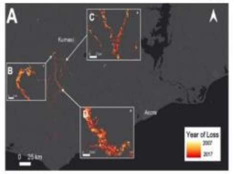
Project Background

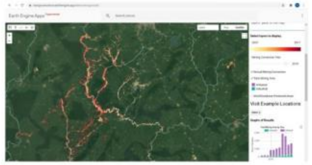
This effort assesses the impact of a project funded by the NASA Ecological Conservation Program between 2018 and 2023. The project was created in response to an invitation by the Ghana Statistical Service and the Ghana Space Science and Technology Institute. The government of Ghana prioritized creating space-based approaches for mapping mining and estimating metrics for Sustainable Development Goal #15 using satellite Earth Observation data. PI Wood formed U.S. team with participants from the Massachusetts Institute of Technology, Goddard Space Flight Center and East Carolina University. The team completed the tasks of mapping deforestation due to mining in southwest Ghana between 2007 and 2021; creating national land use maps for 2015 and 2020; and creating an application to estimate three SDG15 Indicators based on the Land Use/Land Cover maps.



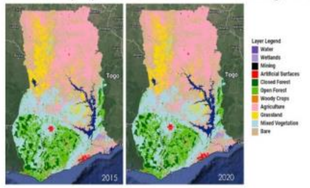


In previous work, the team published estimates of deforestation due to mining between 2007 and 2017 in southwestern Ghana. The results showed that the majority of the mining was due artisanal or small scale mining which is often unregulated. The methods used LandSat data and Random Forest classification. See Barenblitt et al 2021 for details.

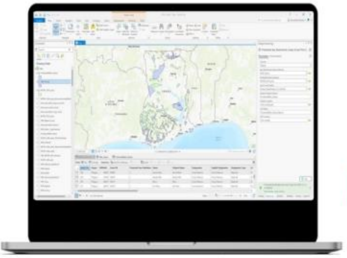




The findings from Barenblitt et al 2021 show the year that vegetation is lost and transitioned to mining (left). The team released the findings via a Google Earth Engine Application (right).



The work also includes a national land cover change assessment comparing 2015 and 2020 for multiple and use classes (left). These results were also released using a Google Earth Engine Application (right).



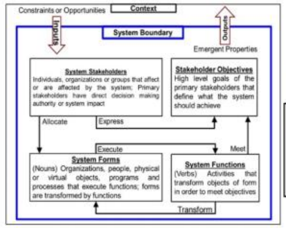
A key outcome of the project is an ESRI Desktop application that uses the Land Use maps as an input and outputs estimates for the SDG15 Indicators 15.1.1, 15.1.2 and 15.4.1 (left). The team is working to create a User Guide for the full set of analysis from the project currently (right).

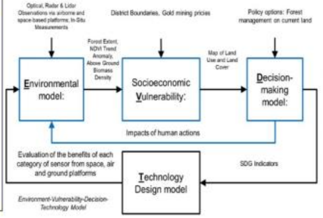
Project Objectives

The Objective of the current impact assessment is to learn the benefit for the Government of Ghana. The mining mapping outputs allow the Ghana Space Science and Technology Institute (GSSTI) to provide data that informs actions taken by the national legislative body and the Environmental Protection Agency to manage mining. The SDG Indicator calculations allow the GSSTI to provide a technical input to the SDG data compilation for Goal #15.

The project creates an ESRI Desktop application for the Ghana Statistical Service that calculates estimates of the following SDG indicators using an input of any Land Use/Land Cover Map:

- SDG 15.1.1: Forest area as a proportion of total land area
- SDG 15.1.2: Proportion of important sites for terrestrial and freshwater biodiversity that are covered by protected areas, by ecosystem type
- SDG 15.4.1: Coverage by protected areas of important sites for mountain biodiversity





Project Methodology

The project applies the Systems Architecture and EVDT Frameworks to guide the approach for assessment. Systems Architecture is a structured method from Systems Engineering for data collection and analysis to describe and evaluate a system. In this case study, the system is the government of Ghana's capability to produce maps related to mining and SDG 15. The team uses interviews and administrative documents to collect data about the Stakeholders, Needs, Objectives, Functions and Forms for the system, showing changes before and after the project. The EVDT Integrated Modeling Framework tracks the technical inputs, outputs and work flows that allow the team to produce maps of mining and the SDG15 Indicators. Using EVDT, the team accounts for evidence related to environmental changes, socioeconomic outcomes, policy decisions and technology investments.

Partner Profile: Ghana Statistical Service coordinates national SDG monitoring, including a working group on Geospatial and Big Data for the SDGs

Partner Profile: Ghana Space Science and Technology Institute performs uses space technology for remote sensing applications, astronomy and small satellite development

The US team as presented our remote sensing methods and exchanged approaches with administrative and technical experts in Ghana to improve the validity of the findings.

The GSS team led a field visit to see locations impacted by water pollution due to unregulated mining in the Cape Coast region of Ghana. The image on the left shows a coastal fishing village impacted by polluted water due to upstream mining.

The GSS team led a field visit to see locations impacted by deforestation due to unregulated mining in the Cape Coast region of Ghana. The US/Ghana team asked local artisanal miners what motivated them to participate in mining.

space enabled

NASA

Ghana Statistical Service

GHANA SPACE SCIENCE AND TECHNOLOGY CENTRE

View the poster for this project by following the QR Code.

Earth Science to Action

A new strategy for science & solutions

Vision

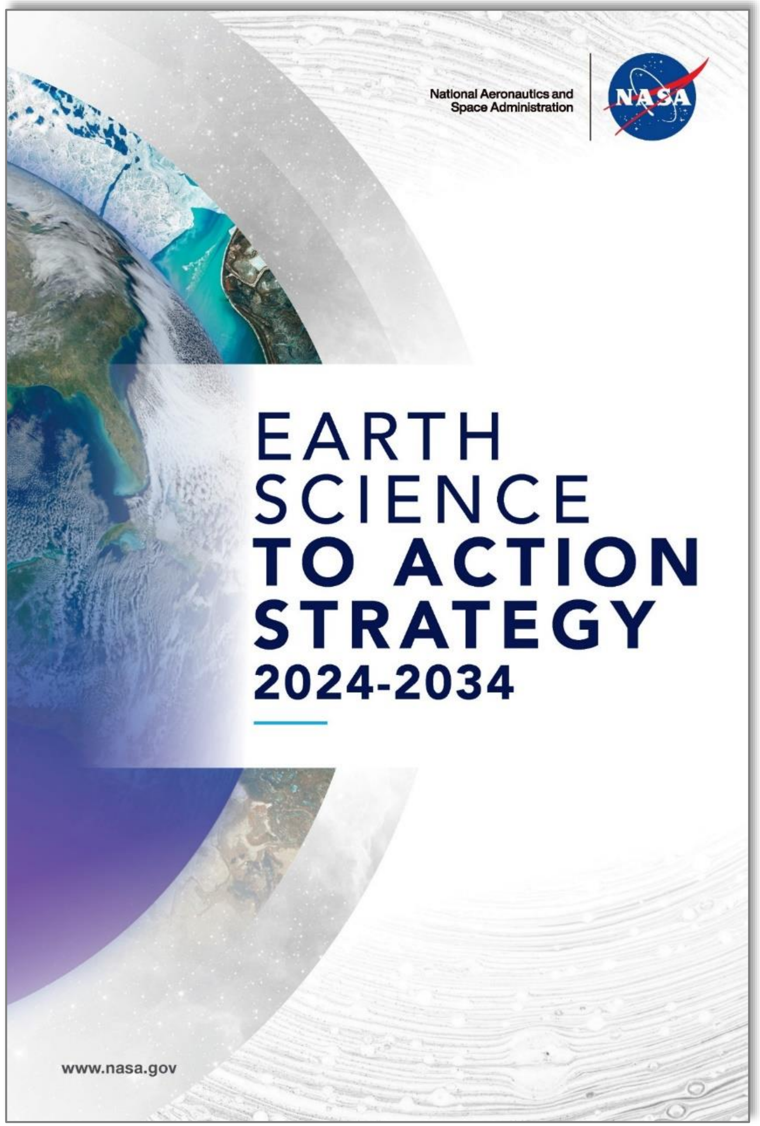
A thriving world driven by trusted, actionable Earth science

Objective 1: Knowledge

Holistically observe, monitor and understand the Earth system

Objective 2: Solutions

Deliver trusted information to drive Earth resilience activities



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NASA earth

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