

## **The Importance of Exploring Earth and Space Science (ESS) Throughout the Educational Experience**

*The American Geophysical Union (AGU) supports a global effort to increase accurate, engaging, comprehensive, and rigorous Earth and Space Science (ESS) literacy in all levels of education. ESS understanding is critical in addressing issues that confront society such as resource sustainability, climate change, and the risks from natural hazards. Understanding ESS is vital to a sustainable future for humanity and our planet's ecosystems; it is key to a healthy global economy and the continuing development of a modern society.*

### **Justification for Earth and Space Science Education**

Many of the challenges facing humanity have solutions that are explored in ESS research and education<sup>i</sup>. Incorporating ESS into all levels of formal, and informal, education will provide learners with the knowledge to make informed choices promoting a sustainable future. ESS education is not only the gateway to understanding celestial space and our planet but also a means to explore the joy, recreation, fascination, and a sense of awe and wonder they provide as well. The nurturing of a child's imagination of living on another planet or becoming a scientist in an ESS field is central to our society's future. These dreams and imaginations should be fostered at all levels of education through ESS. ESS education also promotes scientific and technical knowledge, emphasizes a broad range of STEM careers, and enriches people's lives by exploring the wonders of the natural world. ESS education inspires individuals and helps to give our lives meaning by addressing fundamental questions such as: How did Earth form? How did life evolve? Is there life on other planets?

### **Human Connections**

ESS education is vital for humanity to equitably manage our interconnected relationships with; resources, natural hazards, and climate change especially through the lenses of our most vulnerable populations. In order for humanity to have a sustainable future it will need to be guided by ESS education and research and the principles of Environmental Justice. The future success of our society requires us to make equitable and sustainable choices while considering the impact on low-income and minority populations around the globe. ESS education promotes the exploration and study of the following critical issues.

**Natural Resources.** Fundamental to ESS is the identification, safe use, and sustainable management of Earth's resources. The once abundant and easily accessible supplies of clean water and air, mineral resources, soil, and hydrocarbon reserves are now dwindling rapidly.

**Natural Hazards.** Earth and space can pose dangers to society. It is vital that society be educated in ESS to understand the potential hazards that are related to weather and climate (hurricanes, droughts, floods), surface processes (soil erosion, landslides), tectonic processes (earthquakes, volcanoes), and space phenomena (solar flares, meteoroid impacts).

**Human Impacts.** Humans are now amplifying the risks of many natural disasters and creating entirely new ones through our emergence as the greatest agent of geologic change at Earth's surface<sup>ii</sup>. Human impacts have multifaceted and unexpected consequences for the more fragile components of Earth's complex systems, particularly the biosphere. They can also create environmental hazards that threaten humans, often in marginalized or disenfranchised communities.

**Environmental/Resource Equity.** A key component to ESS education is the concept of Environmental Justice. The fair treatment and meaningful involvement of individuals regardless of ethnic or national origin, race, religion,

citizenship, language, political or other opinion, sex, gender identity, sexual orientation, disability, physical appearance, age, or economic class, with respect to natural resources and the development, implementation, and enforcement of environmental laws, regulations and policies are key to moving ESS education and understanding forward.

## Challenges

- Educational systems around the globe often lack adequate ESS content due to the perceived lack of relevance of ESS. This is due in part to a lack of ESS exposure in both education and in popular culture as well as to the slow pace of change, or adoption, in many educational systems.
- In many parts of the world, schools are underfunded with insufficient resources for both educators and learners, and these deficiencies are inequitable across different communities.
- Science and science education are increasingly the targets of polarization on political and/or religious grounds and are facing growing calls for defunding, particularly in areas such as climate change and evolution. This polarization has led to an increased spread of pseudo-scientific misinformation that negatively impacts access to scientifically accurate information.

## Recommendations

*AGU advocates for universal access to equitable, high-quality, evidence-based, and comprehensive ESS education, eliminating existing disparate access by different communities.*

AGU advocates for the following in order to improve global ESS literacy:

- The creation of scientifically accurate, pedagogically sound, and up-to-date educational resources that are accessible to all students, regardless of ethnic or national origin, race, religion, citizenship, language, political or other opinion, sex, gender identity, sexual orientation, disability, physical appearance, age, or economic class.
- Sufficient funding for formal and informal science education, including educator salaries and learner resources, as well as foundational geoscience disciplinary research in pedagogical best practices.
- High-quality professional development for educators at all levels and at all stages in their professional careers to stay current with both ESS discoveries and advances in equitable and effective teaching methods.
- Educational system assessments that are accurate, unbiased, and fully inclusive of ESS concepts<sup>iii</sup>.
- Opportunities for all students to meet and engage with ESS scientists and engage in ESS research.
- Increased participation by Earth and space scientists in the development, review and implementation of high-quality geoscience and space science curricula.
- Adoption and equitable implementation of educational standards such as the *Next Generation Science Standards* (NGSS) (NGSS Lead States, 2013), based on the U.S. National Research Council's *Framework for K-12 Science Education* (NRC, 2012). The NGSS include ESS at all grade levels as a vibrant, complex, quantitative, data-driven, trans-disciplinary, and societally relevant science, learned through an approach that is practice-based, systems-oriented and solution-focused.

*Adopted by AGU December 2001; Reaffirmed December 2005, May 2009 and February 2012; Revised September 2016 and September 2021.*

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<sup>i</sup> [National Academies of Sciences, Engineering, and Medicine. 2021. Next Generation Earth Systems Science at the National Science Foundation.](#)

<sup>ii</sup> [AGU. 2019. Society Must Address the Growing Climate Crisis Now.](#)

<sup>iii</sup> [AGU. 2021. Teaching Climate Change and Evolution is Essential to Understand our Past and Shape our Future.](#)