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Moving beyond money to measure the true value of Earth science information

They’re all around us: sensors and satellites, radars and drones. These tools form vast remote sensing networks that collect data on the climate, the ground, the air, and the water. This information is immensely useful for research, conservation, and disaster preparedness. But, according to an interdisciplinary group of Earth science researchers in a paper led by Casey O’Hara of UC Santa Barbara, we’re only just scratching the surface of understanding just how beneficial Earth Science Information can be.

“We’re trying to use the information we gather from all this instrumentation to answer questions, but we don’t just want to know the scientific answers to these questions; we want to be able to take that science and use that to benefit society,” said O’Hara, who is a project scientist at the campus’s National Center for Ecological Analysis and Synthesis (NCEAS). However, O’Hara notes that the broad societal value of this Earth science information (ESI) is currently poorly understood. To shed light on the topic, the researchers have mapped out methods for assessing the societal benefits of ESI. It is an effort that could lead to more effective uses of remote sensing technology while increasing the tangible and intangible benefits to people at large.

The findings are published in the *Proceedings of the National Academy of Sciences*.

Pixelating the social

For half a century, researchers have relied on remote sensing instrumentation to gather information about planetary conditions. They have pieced together complex puzzles, such as how conditions in Southeast Asia affect rainfall in East Africa, or how the daily migrations of zooplankton drive ocean carbon sequestration.

“We use ESI to make real-world decisions that benefit people and society, such as managing climate impacts, improving agricultural yields, targeting policies to reduce air pollution and responding to natural disasters,” O’Hara said. “But we rarely measure the degree to which ESI improves decision outcomes. When we do, the valuation methods may only account for monetary benefits and fail to account for others — such as the benefits of social connection among people or with nature.”

“Considering these intangible benefits is vital because they represent an overlooked dimension of how humans value the natural world,” he added.

“My interest was sparked by realizing that we often measure what is easy to measure, rather than what matters most to the people on the ground,” said co-author and UC Berkeley professor of conservation science Alejandra Echeverri. “Some humans don’t just view nature as a commodity or a resource to be used. When we only use econometric metrics to value ESI, we miss the relational values … things like cultural identity, aesthetic beauty or place attachment to the landscapes and seascapes that matter most to us.”

Echeverri, whose work often involves mapping species distributions and forest cover, notes that while data is instrumentally useful, it often lacks a human dimension.

“I have often wished for a relational valuation overlay; one that *pixelates the social*,” Echeverri said. “For instance, are there places in the forest where people feel safer? What about areas that contribute to public well-being, or that inspire communities to create music, art, or poetry? We need to measure those intangible values just as rigorously as we measure canopy cover.”

Building a better toolbox

Understanding these relational values (how people relate to our planet) can have practical outcomes. Generating trust through a shared understanding of nature's value can increase public participation in conservation or safety programs.

"For example, improved trust in wildfire risk warnings or hurricane forecasts would likely increase compliance with evacuation orders, saving lives and reducing rescue costs," O'Hara pointed out.

In their study the researchers started with a set of thousands of peer-reviewed earth science information papers, eventually narrowing down to 171 studies that applied specific valuation methods to their data. They mapped these methods assessing their strengths and weaknesses, and sorted them into three value types: Instrumental (i.e, means to an end) where the benefit was measured in monetary and non-monetary (e.g. healthy crops or clean water) terms and relational, in which the benefit is less tangible, such as community-building or cultural significance.

The vast majority of studies valued their data using a "Value of Information" framework, which assigns value based on the data's ability to reduce uncertainty in decision-making; or through cost-benefit analysis.

"One of our sub-goals was also to look at methods that go beyond monetary value," O'Hara said. "Not just the instrumental value of more money or more crops or more clean water, but also the way that we relate to the world and to each other through the medium of nature." For instance, he said, recreational fishing has economic value, but there is also the benefit of being out in nature, doing something enjoyable with friends that would be important. For these types of benefits, other valuation methods, such as surveys or interviews, may be more useful, he added.

The aim, according to O'Hara, is to create a toolbox from which researchers can draw to interpret their data. O'Hara noted that because methods like cost-benefit analysis are well-studied ("success breeds success"), they often become the only lens through which ESI is viewed.

"But not every question can be answered by those methods," he said. " If you focus only on those, you miss asking really rich, interesting questions that other methods are much better suited to answer."

Ultimately, this broader approach is about equipping the future workforce.

“It teaches the next generation of scientists that data is not neutral; it is a tool that interacts with deep human values,” Echeverri said. “If they can speak the languages of both remote sensing and socio-cultural value, they will be the most effective leaders in their field.”

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