

QnAs with Dawn J. Wright

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Geographic information science (GIScience) is the study of entities that can be tagged with geographic coordinates, such as features, events, measurements, organisms, and observations. Originally developed for cartography, GIScience now has applications in transportation, law enforcement, military, public health, emergency management, and social and environmental systems monitoring. Dawn J. Wright helped pioneer the application of GIScience to oceanography and seafloor mapping. Wright is the chief scientist of the Environmental Systems Research Institute in Redlands, California, and an affiliate professor of geography and oceanography at Oregon State University. Elected to the National Academy of Sciences in 2021, Wright spoke with PNAS about the current state of GIScience and the need to incorporate ethics, empathy, and equity into the field.



Dawn J. Wright. Image credit: Esri Inc. (photographer: Eric Laycock).

PNAS: How did you first become interested in GIScience?

Wright: I became interested in geography and geographic information science at the doctoral level. Just prior to that time, I had spent 3 years at sea as an ocean-going technician working aboard a scientific drill ship. As I was transitioning out of that job after my Master's degree, I became very interested in the history of seafloor maps and, particularly, in the cartographic work of Marie Tharp, who is probably the mother of oceanographic cartography. And it was my own mother who pointed me to a new center that had been funded at the time by the NSF, the National Center for Geographic Information and Analysis. This was in the late 80s and early 90s, which was also when geographic information system (GIS) software was becoming more well known across a range of physical sciences. I decided to apply to [the University of California] Santa Barbara, which had one of the three sites of the National Center for Geographic Information and Analysis. I was fortunate to be taken on as a doctoral student and with such great mentors as my main thesis advisers: bio-optical oceanographer Raymond C. Smith, marine geologist Rachel M. Haymon, geographer Michael F. Goodchild, and marine geophysicist Ken C. Macdonald, who were all on my doctoral committee.

PNAS: What are the challenges of applying GIScience in an oceanographic versus a terrestrial context?

Wright: It really comes down to the three-dimensionality (3D) of the ocean. The ocean and the atmosphere are essentially fluids. We're very good at capturing snapshots or freeze frames of what's going on in those fluids, but in order to really understand the processes at play in the ocean and, in my case, on the ocean floor, we must understand them in the context of that third and fourth dimension: [that is], space and time. So that's a huge challenge

for oceanographic mapping, in general, and for oceanographic mapping with geographic information systems. Hence, a lot of my research in the early 90s was about how to actually structure 3D and 4D processes within these systems. And then there was also the challenge of knowing exactly where we were. On land, we know exactly where we are, thanks to GPS and to very detailed images and measurements from other types of satellites and aircraft. However, the sensors on these same aircraft and satellites cannot "see" through the water as accurately as they can through the atmosphere and certainly not down to the ocean floor. So wayfinding and knowing the exact positions of features and measurements in the deep ocean is a pretty complex navigational endeavor and perfect fodder for a geographic information system.

PNAS: You've been on several deep-sea expeditions aboard submersibles, including the Woods Hole Oceanographic Institution's *Alvin*. Is there a trip that you found particularly impactful?

Wright: My first dive in *Alvin* is still the one that blows my mind because it was the first time. Interestingly enough, we're having this [interview] today as William Shatner went up in the Blue Origin spaceship, and if you've had a chance to see his reaction, I think it's quite remarkable how he describes it [On October 13, 2021, *Star Trek* actor William Shatner went the edge of space aboard Blue Origin's *Shepard* suborbital space tourism rocket and described the trip as "the most profound experience" he could imagine (1)]. I felt very much like that after my first *Alvin* dive. After

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watching hours and hours of Argo 2 [a camera system towed behind a ship] videography, I thought I knew my study area fairly well. But going down in the submersible and actually seeing it through the porthole greatly opened up my spatial cognition and, hence, my understanding of how things were arranged on the seafloor.

PNAS: In your Inaugural Article (2), you discuss the importance of incorporating ethics, empathy, and equity into GIScience. Can you expand on this aspect of your Inaugural Article?

Wright: [One example is] the issue of gerrymandering, where voting districts are drawn so that there will be one candidate or political party advantaged even though that party is not representative at all of the people who live in that area. In fact, I call gerrymandering the dark side of GIS, because GIS is often used to make these very questionable maps. So, when you talk about what's going on with the systems, the science behind that is also the study of the social interactions of people as they draw these maps. This is really an ethical issue in technology. Mark Monmonier, a famous cartographer from Syracuse University who wrote a book called *How to Lie with Maps* (3), warns map users of any number of things that might be done to doctor maps or have them tell a story that is not really true.

There's also empathy and equity. We're drawing, in the paper (2), a connection to empathy in terms of how things are represented and who is represented. For instance, whose data are included? A really quick example: As we're doing research in neighborhoods or communities, are we actually including the perspectives of Indigenous people

[and] cultures in the research that we're conducting, the spatial questions that we're asking? And in terms of equity, a big issue is democratizing the access to data. Can you obtain a satellite image only if you are a very rich organization or a rich university department? Or if you are city council in a small, poor area, maybe you don't have the funds to access certain data or the software required to redo the urban plans for your community. As such, how might those challenges be solved with research outcomes and related resources?

PNAS: What recommendations do you lay out in your Inaugural Article (2) for making GIScience more ethical, empathetic, and equitable?

Wright: We talk about broadening measures of excellence and success as one way to grapple with this. If there are scholars who are involved in community organizing or community development, if there are scholars who are actually making their research actionable by communities, by organizations that need this type of help, this should be considered scholarship and recognized accordingly. In my generation of the professorate, this type of activity was not nearly as recognized. The Inaugural Article (2) also discusses the issue of diversifying who we are actually willing to work with. One of the things that I've enjoyed about being in the discipline is that it is so broadly interdisciplinary, and there are so many people who come to the discipline having been trained in all kinds of ways. My coauthors and I believe that all of this should be reflected in our curricula and in our modes of training students.

1. J. Wattles *et al.*, William Shatner goes to space on Blue Origin mission. *CNN*, 13 October 2021. <https://www.cnn.com/business/live-news/william-shatner-blue-origin-space-flight/index.html>. Accessed 11 November 2021.
2. T.A. Nelson, M. F. Goodchild, D.J. Wright, Accelerating ethics, empathy, and equity in geographic information science. *Proc. Natl. Acad. Sci. USA* **119**, e2119967119 (2022).
3. M. Monmonier, *How to Lie with Maps* (University of Chicago Press, 1991).