Bringing the geospatial world's silent foundation into the spotlight

The visibility challenge of geodesy

By Martin Sehnal, IAG

When people think of geospatial technologies, they often imagine drones, sensors and smart maps, but rarely think about the underlying reference frames that provide reliability. Awareness of geodesy's scientific foundations as well as its practical applications is essential to safeguard investment in infrastructure. At IAG, they are working to bring the 'invisible framework' to the forefront, but they cannot do it alone. It requires a whole community.

▲ *Figure 1: VLBI radio telescope alongside a permanent GNSS receiver at the Onsala Space Observatory in Sweden, illustrating key geodetic infrastructure that forms the backbone of the global geodetic supply chain and underpins the International Terrestrial Reference Frame (ITRF). (Photo by Martin Sehnal, May 2023)*

Imagine you wake up tomorrow to find your smartphone navigation no longer works. Even your clock shows the wrong time. Air traffic controllers cannot plan safe routes for planes, ships drift off course, tsunami warning systems go silent. What's happened? In short: geodesy has gone missing.

Geodesy is the invisible foundation of our modern world. It measures the Earth's shape, gravity field and rotation. Geodesy provides stable reference frames that support everything from global navigation satellite systems (GNSS) to climate monitoring. Despite its vital importance, geodesy is still largely unfamiliar to those outside the scientific community.

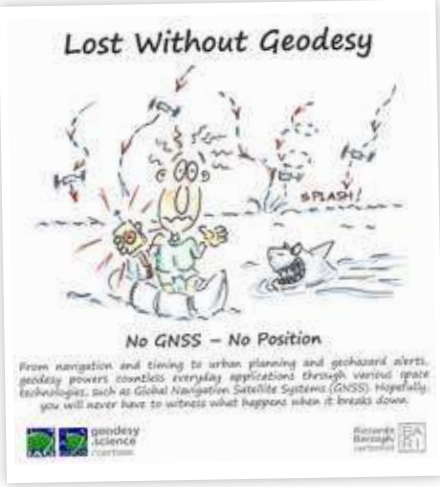
Why geodesy matters

Anyone working with coordinates, maps or positioning relies daily on global geodetic reference frames. The International Terrestrial Reference Frame (ITRF), for instance, enables positions and movements to be measured with millimetre-level precision. Without these highly accurate coordinate frames, surveys drift over time, digital twins misalign and GNSS positions become unreliable. Geodesy is also essential for monitoring sea-level rise, glacier melt and land subsidence, supporting disaster management such as earthquake or tsunami warnings, and keeping global time systems in sync. Whenever accuracy, stability and trust in geospatial data are critical, geodesy is quietly at work.

The global geodetic supply chain

Behind every coordinate lies a global infrastructure of geodetic observatories equipped with GNSS receivers, satellite laser ranging (SLR) systems, very long baseline interferometry (VLBI) radio telescopes, and Doppler Orbitography by Radiopositioning Integrated on Satellite (DORIS) beacons (see Figure 1). These stations gather raw observations, which are then analysed by universities, research institutes and mapping agencies around the world.

Through the International Association of Geodesy (IAG) and its Global Geodetic Observing System (GGOS), all this data is transformed into reliable products like the ITRF. Hundreds of organizations worldwide contribute, usually funded nationally but serving global needs. These freely available products showcase IAG's collaborative and generous nature. At the same time, IAG remains vulnerable. As current funding cuts in some US government agencies show, reductions at the national level can directly



▲ *Figure 2: This geodesy cartoon humourously illustrates that GNSS and its applications fundamentally depend on geodesy. (Image courtesy: IAG-GGOS https://geodesy.science/cartoon, cartoonist Riccardo Barzaghi)*

affect IAG-related entities and, in turn, threaten the resilience of the global geodetic supply chain.

From science to policy

Political support is essential. In 2015, the UN General Assembly adopted a resolution on a Global Geodetic Reference Frame (GGRF) for Sustainable Development, recognizing the importance of reference frames and the fact that no country can build or maintain such a reference frame alone. While IAG has been providing the scientific geodetic backbone since 1862, it does not operate on a political level. To fill this gap, in 2023 the United Nations established the Global Geodetic Centre of Excellence (UN-GGCE) in Bonn, Germany. Its mission is to connect science with policy: raising awareness, securing resources and strengthening global geodetic infrastructure.

One major task is mobilizing sustainable funding for critical supply chain elements: building geodetic stations in underrepresented regions (e.g. the southern hemisphere), modernizing aging observatories, and supporting experts who transform raw measurements into global reference frames. Progress takes time, but geodesy is steadily gaining a firmer place on the international political agenda.

The visibility challenge: bringing geodesy into the spotlight

Geodesy is largely invisible. When people think of geospatial technologies, they frequently imagine drones, sensors and smart maps, but rarely the reference frames that make these tools reliable. This invisibility risks underinvestment in infrastructure, education and awareness. At IAG and GGOS, we strive to bridge the gap between geodesy's scientific foundations and its practical applications in geomatics.

Accessible entry points are crucial. To this end, we recently redesigned the IAG website and switched to a more descriptive domain name: 'https://geodesy.science'. It provides an introductory step into geodesy, complemented by the GGOS information platform, which presents geodetic observation techniques and products in clear, easy-to-understand language. We have also invested in visual storytelling. The geodesy films *Discover GGOS and Geodesy* and *Terrestrial Reference Frames* were produced with volunteers from across our community and are now available in up to 14 languages. Between them, they have already reached more than 77,000 viewers worldwide. Due to this success we are continuing to develop videos to explain geodetic products in simple, engaging ways.

To make geodesy even more accessible, we turned to humour and creativity. The Geodesy Cartoons initiative (see Figure 2) started with a few sketches by a geodesy professor who happened to draw in his spare time. Today, it has evolved into a recently launched international Geodesy Cartoon Competition that invites scientists, students and artists to 'turn science into smiles' with their own geodesy-themed cartoons. By visualizing geodesy in a playful, relatable way, we open the door for new audiences to see its relevance.

Another milestone is the upcoming GGOS Portal, which will serve as a one-stop access point for geodetic data and products. Instead of searching across dozens of specialized databases, users will be able to discover geodetic resources in a structured, user-friendly way. For geomatics professionals, this means easier access to the foundational data that supports surveying, mapping, navigation and Earth observation.

A call to action

Bringing geodesy to the forefront is not a task for scientists alone; it requires a whole community. Educators can include it in curricula. Media can tell its stories. Surveyors can highlight the value of reference frames to clients. Policymakers can invest in sustaining global infrastructure. And there is another challenge: whereas people immediately recognize terms like 'geology' or 'meteorology', 'geodesy' is barely known outside professional circles. Whenever I told friends or family that I studied geodesy, the inevitable question was, "What's that?" and I found myself explaining it from scratch each time. This simple experience highlights the reality we face: geodesy is all around us in daily life, but as a concept it is almost invisible. That has to change. If society can connect the word 'geodesy' to something they already use, like navigating with a smartphone, checking their location or building a digital twin, then awareness will grow naturally. The more people recognize the name, the more they will understand its importance.

As director of IAG's GGOS Coordinating Office, I have seen the enthusiasm that emerges when people discover how much geodesy shapes their lives. Whether through a cartoon, a video or an initiative at the UN-GGCE, the message is the same: geodesy matters – for science, for society and for you. So next time you open your GNSS receiver, create a digital twin or simply check your location on your phone, remember the invisible framework that makes it possible. Help us to spread the word about 'geodesy'. Because only if it is seen, named and understood, can it continue to serve as the indispensable foundation of our geospatial future. ■

About the author

Martin Sehnal studied geodesy and is director of IAG's GGOS Coordinating Office, secretary of the IAG Communication and Outreach Branch (COB), and assistant secretary general of IAG. He performs these roles while working at the Federal Office of Metrology and Surveying (BEV) in Vienna, Austria. He is a corresponding member of the Austrian Geodetic Commission (ÖGK).

Further reading

https://geodesy.science

Geodesy films via the IAG-GGOS YouTube channel, https://youtube.com/@iag-ggos