UNITED NATIONS GLOBAL GEODETIC CENTRE OF EXCELLENCE

MODERNISING GEOSPATIAL REFERENCE SYSTEM CAPACITY DEVELOPMENT WORKSHOP

Actions of the UN-GGCE

Nicholas Brown
Head of Office, UN-GGCE

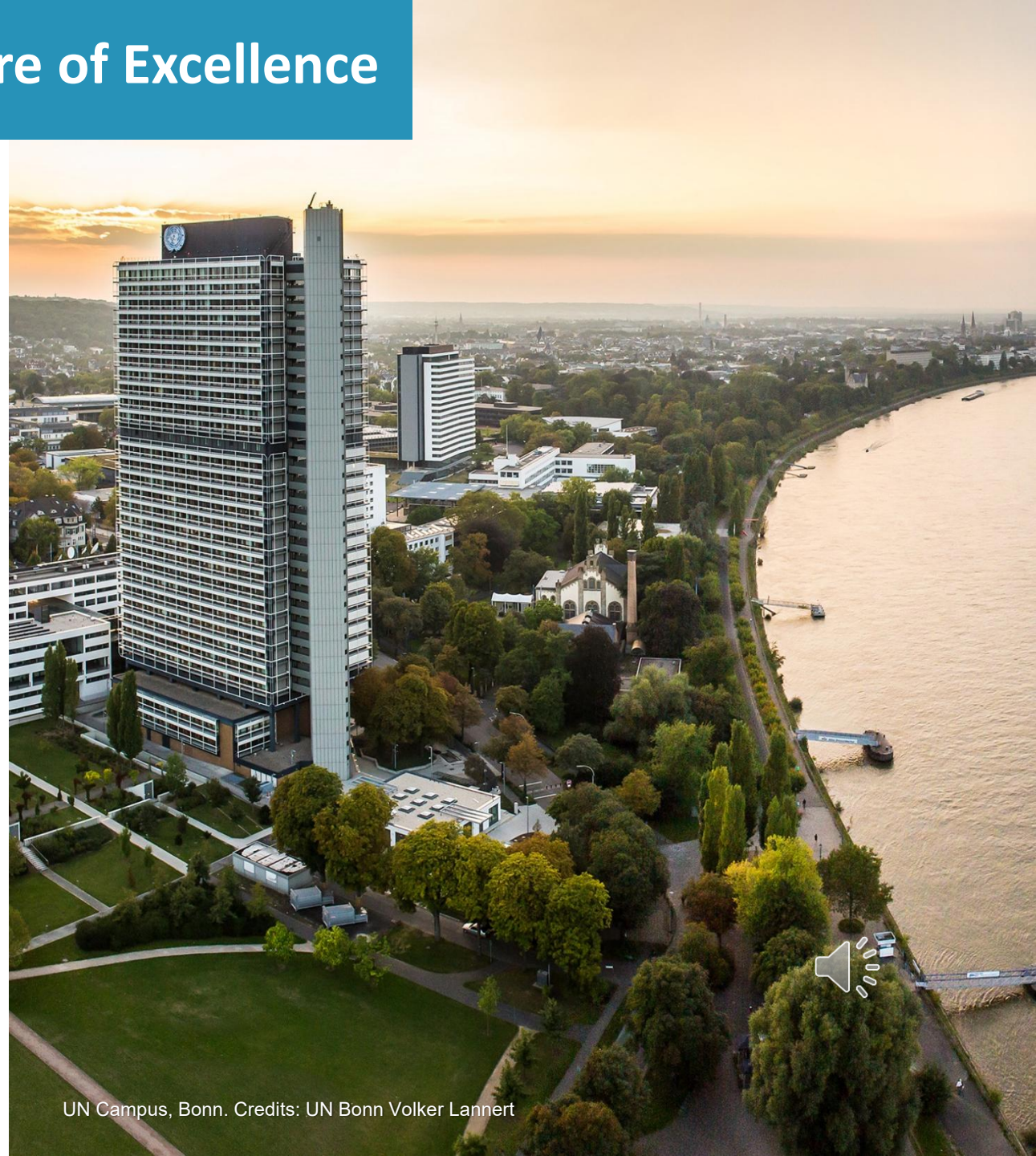
HOW

Day 1, Session 2 1_2_2

United Nations Global Geodetic Centre of Excellence

Our Vision

All countries have **strong political support** for geodesy.



UN Campus, Bonn. Credits: UN Bonn Volker Lannert

Operating Critical Infrastructure

"15 of 18 critical infrastructure and key resources sectors relied on the Global Positioning System (GPS) including telecommunications, emergency services and financial exchanges."

~ U.S. Department of Homeland Security

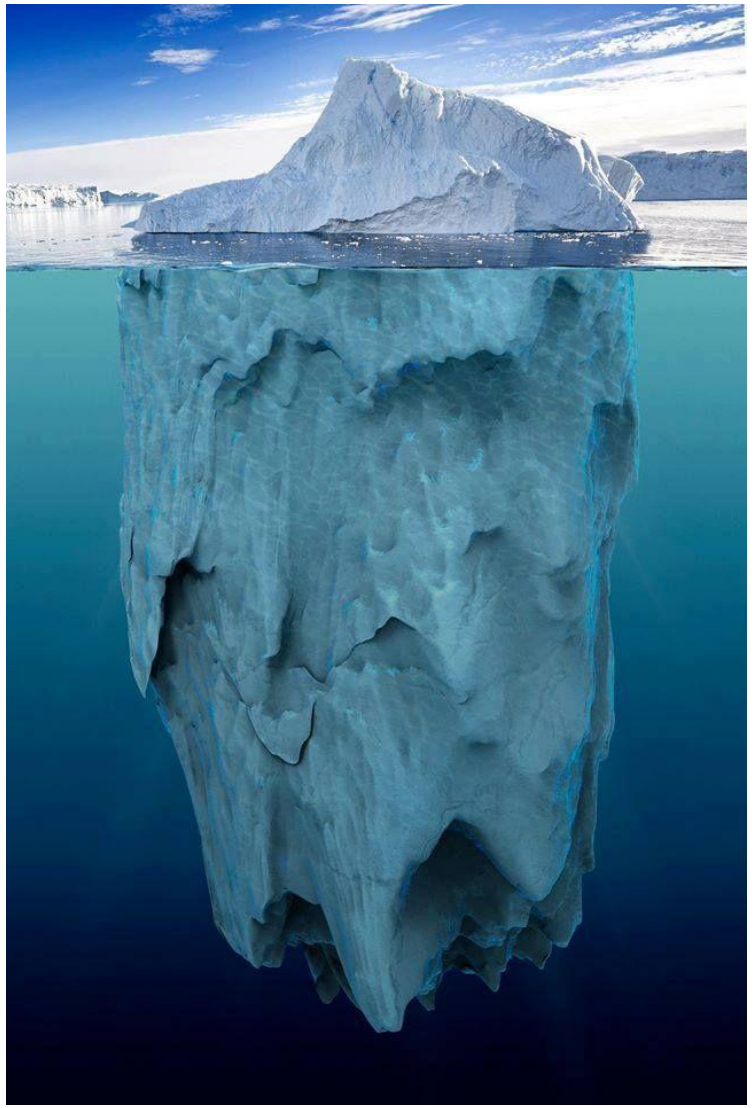
Driving Economic Growth

"Over the next decade, revenue from GNSS, Earth Observation and satellite telecommunications (80% of the space industry market revenue) has growth rate of ~9%"

~ EUSPA Market Report and Euroconsult

Hidden Risk

The risk that some Member States, space agencies and satellite operators aren't aware of that threaten the use of satellites, and all the applications derived from them.



Global Geodesy Supply Chain

OBSERVATORIES
[VLBI, SLR, DORIS, GNSS, Gravity]

01

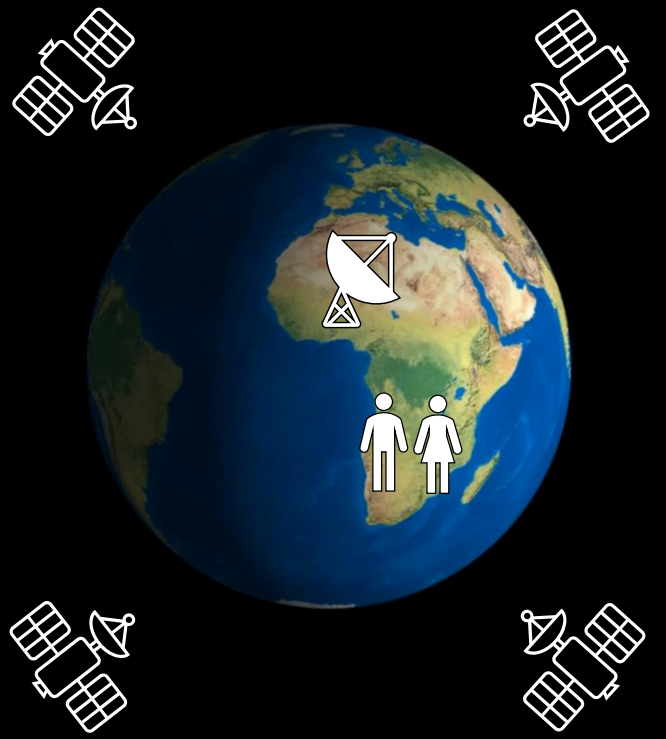
02
DATA

ANALYSIS
03

04
GEODETIC PRODUCTS
[TRF,EOP]

GROUND SEGMENT

SPACE SEGMENT



USER SEGMENT

UN General Assembly Resolution (2015)

UN General Assembly resolution (2015) “A global geodetic reference frame for sustainable development”

Stronger. Together.

Weaknesses in the Global Geodesy Supply Chain

EVIDENCE

RESOURCES

01 OBSERVATORIES

02 DATA

03 ANALYSIS

04 GEODETIC PRODUCTS

USERS

AWARENESS

CAPACITY

GOVERNANCE

Global Navigation Satellite Systems

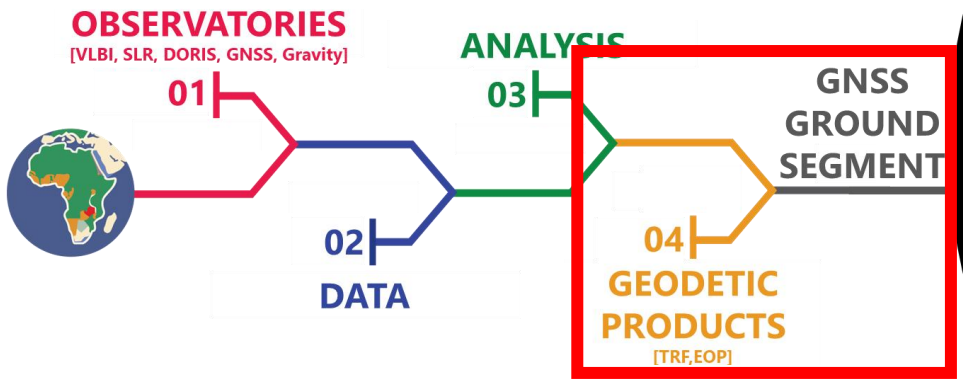
Safety of life

Communications

Earth Observation

**The perspectives of 500 people from 110 countries from 11 online Listening Sessions with people from science organizations, industry bodies, policy agencies, science agencies and defence agencies.*

GNSS Ground Segment



GNSS Ground Segment

- Monitor GNSS satellites (position, health, status)
- Command and Control
  - Updating ephemeris (every few hours)
    - GNSS Ground Control Stations use Earth Orientation Parameters to accurately calculate the positions and orbits of GNSS satellites and the timing corrections applied before the ephemeris is uploaded to the satellites.
    - Since the Earth's orientation and rotation can change slightly over time, EOPs are critical to ensure satellite positions are calculated with high precision relative to a fixed reference frame (Terrestrial Reference Frame (TRF)).

    - **Dependencies:** Terrestrial Reference Frame and Earth Orientation Parameters

Are the geodetic products robust?

- **Terrestrial Reference Frame**
  - It is accurate to 5 mm with stability of 0.5 mm/yr (Altamimi et al., 2023)
    - Low concern - it is accurate enough for GNSS operational requirements (critical infrastructure operations and key resource sectors)
  - Is it reliable enough?

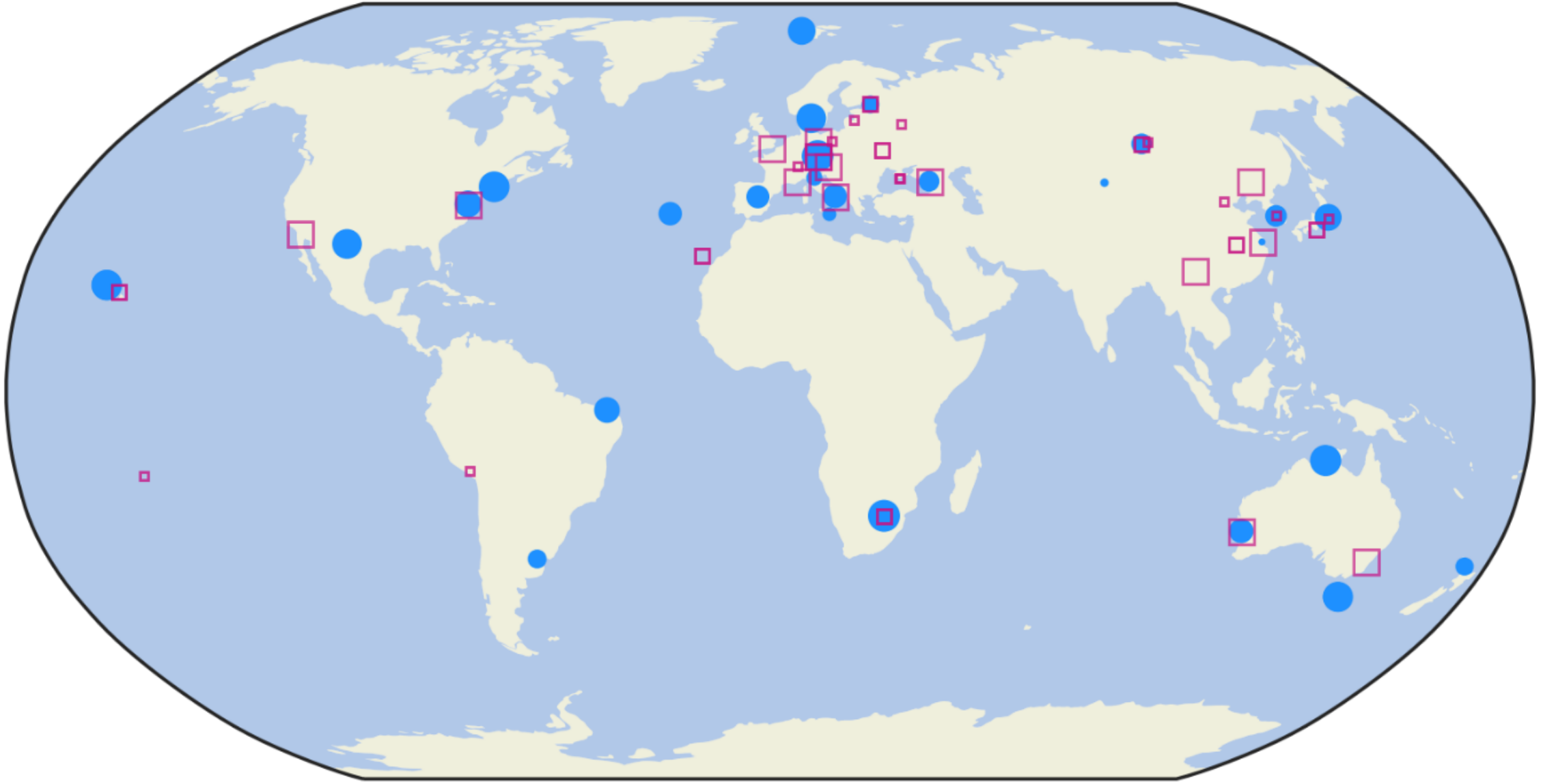


Figure: Locations of ground-based VLBI *stations; and* SLR *stations. The size of the circles and squares are roughly proportional to how much data each station provides to the global geodesy supply chain. The data is from 2023-2024.*

Are the geodetic products robust?

- **Terrestrial Reference Frame**
  - It is accurate to 5 mm with stability of 0.5 mm/yr (Altamimi et al., 2023)
    - Low concern - it is accurate enough for GNSS operational requirements (critical infrastructure operations and key resource sectors)
  - Is it reliable enough?
    - Does it have ground observatory network have the redundancy and consistency?
    - Medium concern - it is not robust enough.

Are the geodetic products robust?

- Terrestrial Reference Frame
- **Earth Orientation Parameters**
  - Precession and Nutation – highly predictable – low concern
  - Length of Day – dynamic – medium concern
  - Polar motion – dynamic – medium concern
  - UT1-UTC – dynamic – high concern

** It is debatable how often these parameters need to be updated before causing a loss of accuracy or reliability in satellite services, however, even if it is three years before problems occur, VLBI, SLR and DORIS are needed.*

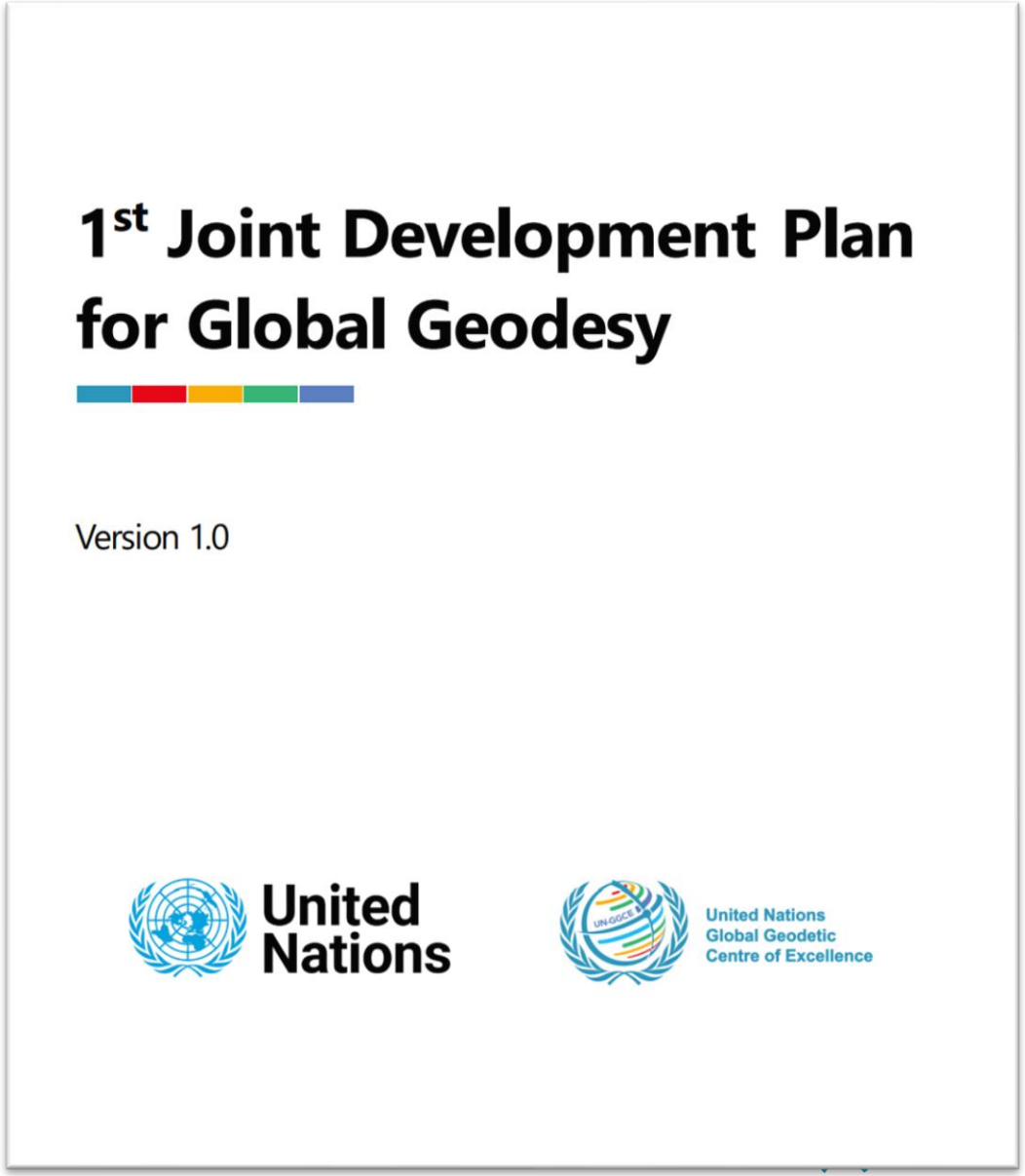
Are the geodetic products robust?

"The Global Geodesy Supply Chain exhibits an exceedingly fragile stability and could easily collapse due to a number of material and non-material concerns."

- JN Markiel [U.S. National Geospatial-Intelligence Agency]
- Expert Consultation meeting on Strengthening the Global Geodesy Supply Chain (April 2024)

1st Joint Development Plan for Global Geodesy

- Available in 6 UN languages now https://ggim.un.org/UNGGCE/#documents
- **Action plan** (linked with a strategy) to address weaknesses in the global geodesy supply chain
    1. Avoid further degradation of the supply chain (support current operational requirements)
    2. Robust (improve reliability)
    3. Next Generation (meet more ambitious requirements)
- Includes activities for UN-GGCE, Member States and partners



Phase 1: Avoid further degradation of the global geodesy supply chain

Objective 1.1 – Member States are engaged in geodesy governance

Outcomes

1.1.1 Member States have improved governance arrangements within their country including a workplan to manage strategic, operational, and technical geodetic risks.

1.1.2 Governments, science organizations, industry, and universities understand their roles in the global geodesy supply chain, as well as how they relate to other elements of the chain.

1.1.3 Member States understand their dependency, on the global geodesy supply chain, as well as the impact of loss due to failure or degradation of the global geodesy supply chain.

1.1.4 Risks associated with weaknesses in the global geodesy supply chain are beginning to be mitigated.

Proposed Activities of Member States

1. Establish, or strengthen an existing, country level geodesy working group which includes representatives from government (science, policy, defence), industry and academia.
2. Lead the development and implementation of a country level strategy and action plan to:
   - Assess strategic, operational and technical risks associated with weaknesses in the global geodesy supply chain.
   - Increase awareness of the global geodesy supply chain.
   - Address risks that, if realised, would have significant economic, social, and environmental consequences.

Proposed Activities of UN-GGCE

3. Develop and share guidance material which can be used by Member States to establish or strengthen country level working groups, strategies and action plans.
4. Establish a website for Member States to voluntarily report on the Activities assigned to them in the Joint Development Plan, monitor their progress and provide summary statistics of Member State activities.
5. Engage with Member State representatives and assist them to establish or strengthen country level working groups, strategies and action plans.

Proposed Activities of Partners

6. Engage with Member State representatives and assist them to establish or strengthen country level working groups, strategies and action plans.

Policy Briefs

United Nations

United Nations Global Geodetic Centre of Excellence

POLICY BRIEF NO 001

Hidden Risk

How weaknesses in the global geodesy supply chain could have catastrophic impacts on critical infrastructure and national economies

INTRODUCTION

Modern society is dependent on satellites. In many countries, satellite information is essential for economic growth, the operation of critical infrastructure, and is a cornerstone of national defence forces.

In some cases, the dependence is so strong that countries have developed sovereign space systems. For example, several countries or regions, e.g., the European Union (EU), have their own Global Navigation Satellite System (GNSS) to provide Positioning, Navigation and Timing (PNT) services for civilian and defence applications including the Global Positioning System (GPS; USA), GLONASS (Russian Federation), Galileo (EU) and BeiDou (PRC). These countries recognize that a loss of PNT services, either due to technological failures or malicious activity, would have catastrophic and cascading effects for their economy and critical infrastructure. This reliance and need for control is not limited to GNSS satellites which provide PNT services, but extends to telecommunications satellites and Earth Observation (EO) satellites.

Observing the Earth

Satellites providing vital defence and civilian applications are reliant on constant updates about their 'place in space' (satellite orbit information) and the Earth's 'place in space' (shape, orientation, gravity field, and coordinate reference frame).

This Earth and satellite 'place in space' information are collectively known as geodetic products. Constant updates to the geodetic products are needed because the Earth and satellites are always moving. Without updates to geodetic products, satellite applications that society takes for granted, and all the benefits they provide would degrade or fail.

GLOBAL GEODESY SUPPLY CHAIN

The geodetic products are created through the global geodesy supply chain (Figure 1) which includes:

- ground observatories and scientists who constantly observe the movement of the Earth and satellites;

Key Messages

- Society's dependence on satellite services for economic development, the operation of critical infrastructure, and defence applications is very high and growing at a rapid pace.
- Satellite services are at risk of degradation or failure due to the lack of resources provided to the global geodesy supply chain.
- For satellites to operate accurately and reliably, their 'place in space' and Earth's 'place in space' need to be observed and analyzed constantly. This information is provided through the global geodesy supply chain.
- The global geodesy supply chain is the collection of ground observing stations, data centres, analysis centres and highly qualified experts who observe the Earth and convert these observations into geodetic products which are essential to communicate accurately and reliably with satellites.
- Although the supply chain is a vital foundation of the space sector, it is relatively unknown and therefore under-resourced. Less than 0.05% of the revenue generated from GNSS and EO services are reinvested in the global geodesy supply chain.
- Member States and partners are forming a Joint Development Plan describing how they will work together to strengthen the supply chain to enhance the reliability and integrity of the geodetic products.
- Key activities for Member States include: strengthening national awareness and governance in geodesy, recognizing the global geodesy supply chain as national critical infrastructure and engaging in bilateral or multilateral agreements with other Member States.

- data centres and data centre operators who quality check the data from observatories and make it available to the global geodesy analysis community; and,
- analysis centres, correlation centres and analysts who translate the raw data into geodetic products.

It is a *global* geodesy supply chain because the observatories and highly qualified people need to be distributed around the world to achieve the required accuracy and reliability of the geodetic products.

Recognizing the risk of a degrading supply chain, the United Nations General Assembly adopted resolution 69/266 in 2015, entitled 'A Global Geodetic Reference Frame for Sustainable Development'. The resolution encourages Member States to

Authors: Nicholas Brown and Sarah Kowal, United Nations Global Geodetic Centre of Excellence, UN DESA.

1. Hidden Risk: How weaknesses in the global geodesy supply chain could have catastrophic impacts on critical infrastructure and national economies.
2. Reliance on the global geodesy supply chain for climate science.
3. Need to protect parts of the radio frequency spectrum (in collaboration with the International Telecommunications Union).

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Industry Engagement

“In a Joint Working Group discussion, the United Nations Global Geodetic Centre of Excellence (UN-GGCE) highlighted weaknesses in the global geodesy supply chain1; in particular issues relating to the reliability of geodetic products such as Earth Orientation Parameters (EOP) and future realisations of the International Terrestrial Reference Frame which are essential to the operation of GNSS satellites. ICG members openly acknowledged the risks highlighted by the UN-GGCE and recognized strengthening the global geodesy supply chain should be prioritised to ensure GNSS services are more robust.”

-- 18th meeting of the International Committee on GNSS (2024)

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Policy and Defence Engagement

Defence (USA, UK, Germany, Iraq)

Policy (USA, Germany Iraq, Norway, UK, Finland, Spain, France)

Science

"Member States acknowledge the risks associated with failure, or degradation in the Global Geodesy Supply Chain (GGSC)."

-- Draft Decisions from the Expert Consultation meeting on Strengthening the Global Geodesy Supply Chain (22-23 April 2024)

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Stronger governance arrangements

1. **Multilateral Memorandum of Understanding [led by UN-GGCE]**
   - Government agencies / departments, organizations, associations, private sector
   - Non-binding
   - Draft has been sent
   - Operational on 10 March 2025
2. **Bilaterial / Regional Agreements**
3. **Intergovernmental Organization**

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Newsletters

Newsletter
September 2024
5

United Nations Global Geodetic Centre of Excellence

Stronger. Together.
The United Nations Global Geodetic Centre of Excellence (UN-GGCE) vision is a future where all countries have strong political support for geodesy which enables them to – together – implement the General Assembly Resolution 69/266 'A Global Geodetic Reference Frame for Sustainable Development', and accelerate the achievements of the Sustainable Development Goals to derive social, environmental and economic benefits.

ggim.un.org/UNGGCE

GLOBAL GEODESY SUPPLY CHAIN

Steps towards international commitments

The UN-GGCE outlines new opportunities for government agencies around the world. "We propose they join together and take steps towards strengthening international cooperation and commitments for the global geodesy supply chain", says Nick Brown, UN-GGCE Head of Office.

The UN-GGCE envisions a future where Member States collaborate on the global geodesy supply chain and ensure it is operated in a sustainable manner for the benefit of all people.

World geodetic organization
In this vision Nick Brown sees a United Nations world geodetic organization or an equivalent governance structure, like the World Meteorological Organization (WMO), as a long-term objective.
"This is ambitious, and we recognize this will take time and money," says Nick Brown, "however, it is necessary to start taking steps in this direction to enhance the governance of the global geodesy supply chain; in particular, raising awareness of the issues to senior leaders in government agencies."

Record breaking geodesy interventions
When the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM) held its 14th session this summer, from 6-8 August, there were a record breaking 40 interventions. Member States, regional committees and observers praised the successful work of UN-GGCE and the UN-GGIM Subcommittee on Geodesy on agenda item 8 – Global geodetic reference frame.
In its decisions the Committee of Experts among others requested the Subcommittee with support from the UN-GGCE; to identify options to strengthen international cooperation and commitment and mechanisms for appropriate resource mobilization – and to investigate the opportunities to bring the status of, and the need for, a more sustainable geodesy supply chain to the attention of the greater United Nations community.
UN-GGIM 14th session decisions: https://ggim.un.org/meetings/GGIM-committee/14th-Session/documents/.

Opportunities to strengthen geodesy
In response to these decisions the UN-GGCE is prepared to guide the way forward with small steps designed to grow awareness and build trust.
"We first propose two opportunities which can be considered by government agencies now," says Brown. The objective is to strengthen international cooperation and commitment and provide resource mobilization in 1) a Multilateral Memorandum of Understanding and 2) a Multilateral Memorandum of Agreement.
The UN-GGCE will also assist the Subcommittee on Geodesy in its work to investigate other opportunities related growing awareness throughout the greater UN community, as requested by the Committee of Experts.

Forum on First Joint Development Plan

In the margins of the UN-GGIM 14th session in New York the UN-GGIM Subcommittee on Geodesy and the UN-GGCE jointly convened a Forum on the First Joint Development Plan for Global Geodesy. The objective of this forum in the UN General Assembly Building was to bring representatives from space agencies, industry, defense and science together to discuss options on how representatives will take responsibility for activities outlined in the First Joint Development Plan.

NEW YORK: JN Markiel (from right), Albert Morro, Alison Rose and Richard Gross. Photo: Liubov Poshyvailo-Strube

The panel members provided excellent insights into how to convince decision makers to fund geodetic programs, described the weaknesses in the global geodesy supply chain that keep them awake at night and explained governance models in other international organizations that the geodesy community could learn from.

The draft plan is out now for consultation and can me found here: https://ggim.un.org/meetings/GGIM-committee/14th-Session/documents/Draft_Joint_development_Plan_v0.2.pdf.

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- Seven newsletters available
  - https://ggim.un.org/UNGGCE/#documents
- Growing mailing list
- Stronger following on LinkedIn
  - Over 2,300 followers in 12 months
  - Primary communication source

YouTube (evidence and training)

UN-GGCE

@UN-GGCE · 123 subscribers · 5 videos

Geodesy - the most amazing science you have never heard of! ...more

Customize channel Manage videos

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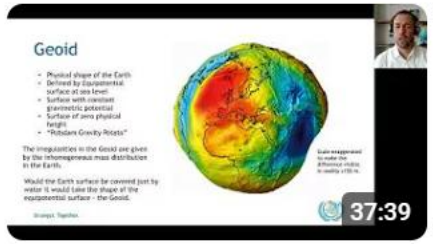
Videos



Modernizing your Geospatial Reference System - Part 4 -...

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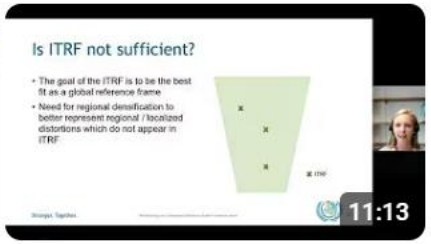

Modernizing your Geospatial Reference System - Part 3 -...

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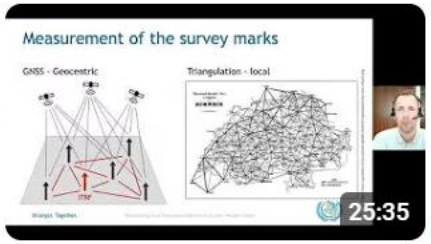

Modernizing your Geospatial Reference System - Part 2 -...

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Modernizing your Geospatial Reference System - Part 1 -...

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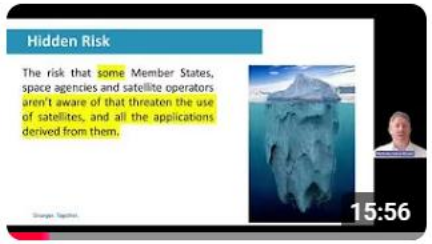

Hidden Risk - The importance of geodesy in our everyday...

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Capacity Development

Joining Land and Sea workshop (Indonesia, Dec, 2024)

- Development of practical guidance on how to align land and sea data for improved decision making
- Addresses a common request of Member State interventions over the last 10 years to bring together the work from:
  - Expert Group on Land Administration and Management
  - Working Group on Geospatial Information for Disaster Risk Management
  - Working Group on Policy and Legal Frameworks for Geospatial Information Management
  - Working Group on Marine Geospatial Information
  - Subcommittee on Geodesy
  - ISO/TC211, Open Geospatial Consortium
  - Academia

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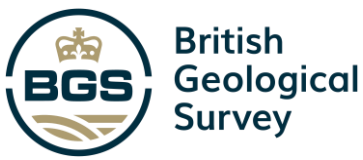
Capacity Development

- Member States identified a need for more tailored geodetic assistance which is specific to Member States capacity, capability and requirements.
- Build geodetic capacity across Member States with a particular focus on Least Developed Countries (LDCs) and Small Island Developing States (SIDS).
- 5 Capacity Development workshops
  - Europe | 17-21 February 2025 (Bonn, Germany)
  - Africa | 19-23 May 2025 (Nairobi, Kenya)
  - Asia-Pacific | 30 June-4 July 2025 (Bangkok, Thailand)
  - Americas| 3-7 November 2025 (Santiago, Chile)
  - Arab States | TBA 2025 (Riyadh, Kingdom of Saudi Arabia)

Partners (30 and growing)

Kartverket

Australian Government
Geoscience Australia



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