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Global geodetic reference frame

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Note by the Secretariat

Summary

The present paper contains the report prepared by the Subcommittee on Geodesy for consideration by the Committee of Experts on Global Geospatial Information Management.

At its twelfth session, held from 3 to 5 August 2022, the Committee of Experts adopted decision 12/106, in which it welcomed the progress made during the intersessional period, including the Subcommittee's considerable efforts to grow the critical understanding, awareness and advocacy for the importance of the global geodetic reference frame as a vital global infrastructure that is of benefit to society and needs to be maintained. The Committee recognized the important collective efforts of the Subcommittee to address the complex issues facing the global geodetic community and to ensure the quality and long-term sustainability of the global geodetic reference frame in the areas of sustainable geodetic infrastructure; education, training and capacity development; geodetic standards and guidelines; outreach and communication; and suitable governance mechanisms to sustain the global geodetic reference frame. In addition, it welcomed the progress made by the Government of Germany and the United Nations to host and establish a Global Geodetic Centre of Excellence at the United Nations Campus in Bonn, Germany, which will provide dedicated resources to address some of the immediate and ongoing challenges in sustaining the global geodetic reference frame, and invited Member States to actively contribute to the work of the Centre.

The Committee of Experts supported the Subcommittee's plans to contribute to the formation of an efficient and competent international advisory committee and governance model to support and guide the establishment and strategic operations of the United Nations Global Geodetic Centre of Excellence, welcomed the offers by Member States and relevant geodetic stakeholders to contribute to the Centre and to foster greater planning and international coordination in pursuit of strengthening partnerships and opportunities enabled by global geodesy and urged a greater contribution from relevant technical experts in Member States. The Committee of Experts also noted the Subcommittee's desire to convene its third plenary meeting at the United Nations Campus in Bonn once the Centre was established.

In this present report, the Subcommittee provides information on its progress and activities, including its efforts to continue to implement General Assembly resolution 69/266. During the intersessional period, the Subcommittee worked on and revised its terms of reference and structure to align these with the future working arrangements outlined in the position paper on sustaining the global geodetic reference frame and the concept paper on establishing a global geodetic centre of excellence adopted by the Committee of Experts. The terms of reference were agreed by the Subcommittee at its fifth virtual meeting, on 13 December 2022. The Subcommittee met at its sixth virtual meeting, on 21 March 2023, which allowed its global membership to consider and discuss items related to the Subcommittee's design and development of a detailed action plan

* E/C.20/2023/1

to sustain the global geodetic reference frame ahead of the in-person third plenary meeting of the Subcommittee.

In the report, the Subcommittee reports on the outcomes from the third plenary meeting of the Subcommittee, hosted by the Federal Agency for Cartography and Geodesy of Germany (BKG) at the United Nations Campus in Bonn from 29 to 31 March 2023. The meeting was attended by 41 participants: 27 representatives from 17 Member States that are members of the Subcommittee, 3 representatives from three participating Member States, 10 participants from international and regional organizations and geodetic research institutions and relevant stakeholders. Participants also attended the opening ceremony of the United Nations Global Geodetic Centre of Excellence, held on 29 March 2023. At its third plenary meeting, the Subcommittee considered, worked on and designed a detailed action plan to sustain the global geodetic reference frame with seven agreed strategic actions. The participants considered related matters that impacted its action plan, including the implementation of Economic and Social Council resolution 2022/24, as well as General Assembly resolution 69/266, and how to leverage the Integrated Geospatial Information Framework (and contribute to its implementation at the country level. The Subcommittee welcomed the availability of implementation guidance and resource materials for the Framework that are presently available or will be available online. The Subcommittee, at its third plenary meeting, dissolved its five working groups, prioritized three strategic actions and established three new working groups to: (a) undertake, document and communicate a global geodesy needs assessment; (b) prepare a state of geodesy report; and (c) further engage in capacity and capability development. The third plenary meeting, affirmed by acclamation its two co-Chairs together with a bureau with geographic diversity in accordance with its terms of reference.

Also in the report, the international advisory committee of the Global Geodetic Centre of Excellence, jointly with the Secretariat, provides information and progress on the establishment and operationalization of the United Nations Global Geodetic Centre of Excellence at the United Nations Campus in Bonn. The Centre's overarching goal is to assist Member States and geodetic organizations to coordinate and collaborate to sustain, enhance, access and utilize an accurate, accessible and sustainable global geodetic reference frame to support science, society and global development. The objective is to support, within available resources, the implementation of General Assembly resolution 69/266 through strengthening and advancing: global geodetic cooperation and coordination; worldwide geodetic infrastructure; standards and policies; education, training and capacity development; and communication and awareness, while also coordinating measures and overseeing their implementation.

In the report, the international advisory committee, jointly with the Secretariat, reports on its first meeting at the United Nations Campus in Bonn, from 29 to 31 March 2023. The report highlights the opening ceremony organized by the United Nations and the Federal Government of Germany, on 29 March 2023, also at the United Nations Campus in Bonn, where the Global Geodetic Centre of Excellence is housed. At its first meeting, the international advisory committee welcomed its inaugural membership, adopted its terms of reference, noted its responsibility to provide strategic guidance and advice on the implementation of the Centre's priorities and programme of work and affirmed by acclamation its two Co-Chairs. The international advisory committee, cognizant of the agreed framework plan of the Centre, recommended seven strategic actions for the Centre to consider and pursue.

I. Introduction

1. The Global Geodetic Reference Frame (GGRF) is an authoritative, reliable, highly accurate, and global, spatial referencing infrastructure. It includes the celestial and terrestrial reference frame products, the infrastructure used to create it, and the data, analysis and product generation systems. The GGRF also includes gravimetric observations, products and height systems, which underpin measurements of elevation. The GGRF is fundamental to supporting the collection, integration and utilization of all other geospatial data. It is relied upon for social, environmental and economic initiatives, Earth science, the measuring and monitoring of progress of the 2030 Agenda for Sustainable Development, the Sendai Framework for Disaster Risk Reduction, the Small Island Developing States Accelerated Modalities of Action (SAMOA) Pathway, and other global, regional and national development agenda and initiatives.

2. The GGRF enables accurate and robust alignment of geospatial datasets – a key requirement for sustainable development in fields such as land use planning and administration, construction and hazard assessment. The GGRF is also an essential foundation for national height systems, which enable sustainable water management and monitoring of climate change and its impacts, such as sea-level rise, droughts, glacial retreat and icesheet melting. The coordinates used in these applications are ideally referred to a mathematically well-defined geodetic reference frame.

3. Recognizing the growing demand for an accurate and stable GGRF and the importance of international cooperation, the General Assembly of the United Nations adopted Resolution 69/266 in February 2015, entitled 'A Global Geodetic Reference Frame for Sustainable Development'[1] (Resolution 69/266). The Resolution reflects that the GGRF is the foundation required for the collection, integration, and utilisation of all geospatial information. Furthermore, it supports precise positioning from Global Navigation Satellite Systems (GNSS), which is becoming an important tool for informed decision making, supporting the three pillars of sustainable development – the society, economy and environment.

4. As the foundation for accurate and reliable geospatial data collection and integration for decision making, the GGRF has a significant impact on many activities within the programme of work of the Committee of Experts. The GGRF is one of 14 Global Fundamental Geospatial Data Themes and underpins the quality and usefulness of the other 13. It is a prerequisite for the accurate collection, integration and use of all other geospatial data. Analysis of the Global Indicator Framework for Sustainable Development Goals (SDGs) through a 'geographic-location' lens shown that geospatial information has a direct or significant contribution to the production of SDGs indicators.

5. At its twelfth session, held from 3 to 5 August 2022, the Committee of Experts adopted decision 12/106, in which it recognized the important collective efforts of the Subcommittee to address the complex issues facing the global geodetic community and to ensure the quality and long-term sustainability of the GGRF. Furthermore, it welcomed the progress made by the Government of Germany and the United Nations to host and establish a United Nations Global Geodetic Centre of Excellence (UN-GGCE) at the United Nations Campus in Bonn, Germany, which will provide dedicated resources to address some of the immediate and ongoing challenges in sustaining the GGRF, and invited Member States to actively contribute to the work of the UN-GGCE.

6. Furthermore, the Committee of Experts supported the Subcommittee's plans to contribute to the formation of an efficient and competent international advisory committee and governance model to support and guide the establishment and strategic operations of the UN-GGCE. The Committee welcomed offers by Member States and relevant geodetic stakeholders to contribute to the Centre, and to foster greater planning and international coordination in

[1] https://ggim.un.org/documents/A_RES_69_266_E.pdf

pursuit of strengthening partnerships and opportunities enabled by geodesy. Finally, the Committee noted the Subcommittee's desire to convene its third plenary meeting at the GGCE in Bonn once the Centre is established and urged a greater contribution from relevant technical experts in Member States.

7. During this intersessional period, the Subcommittee revised its terms of reference and structure to align with the future working arrangements outlined in the Position Paper on Sustaining the Global Geodetic Reference Frame and the Concept Paper on Establishing a Global Geodetic Centre of Excellence adopted by the Committee of Experts. Guided by the revised terms of reference, at its third plenary meeting, the Subcommittee affirmed by acclamation its two co-Chairs from Australia (until the fourteenth session of the Committee of Experts) and Cote d'Ivoire (for a four-year term).

8. The Committee of Experts is invited to take note of the present report and to express its views on the activities and next steps of the Subcommittee, as well as on the way forward. Points for discussion and decision are provided in paragraph 48.

II. Activities of the Subcommittee during the intersessional period

Third Plenary Meeting

9. The Third Plenary Meeting of the Subcommittee on Geodesy was hosted by the Federal Agency for Cartography and Geodesy of Germany (BKG) and convened at the United Nations Campus in Bonn, Germany from 29 to 31 March 2023. The meeting was attended by forty-one participants: twenty-seven representatives from seventeen Member States members of the Subcommittee, three representatives from three additional Member States, and ten participants from international and regional organizations, geodetic research institutions, and relevant stakeholders. One staff member from the UN-GGIM Secretariat substantively facilitated the Plenary Meeting.

10. The Subcommittee also attended the opening ceremony of the United Nations Global Geodetic Centre of Excellence (UN-GGCE) on 29 March 2023. Plenary meeting participants were joined by a further seventy plus invited guests at the opening ceremony. The impressive gathering had invited guests from every continent, except Antarctica. Representatives from each of the five regional committees of UN-GGIM, the four thematic networks and the eight functional groups reporting into UN-GGIM were in attendance.

11. The focus of the Third Plenary Meeting of the Subcommittee was on global geodesy for the betterment of humanity and leaving no one behind. Participants were encouraged to 'think global and act local', the importance of global efforts to explain the importance of geodesy and the need to translate that messaging at a national scale for effective national geodetic arrangements and investment that benefits society and science to influence policy developers and political masters.

12. Participants were provided with an update on the development of the Subcommittee's draft Action Plan to sustain the GGRF and were requested to continue working on the Action Plan, with a focus on strategic objectives and priority tasks. The meeting considered related matters that impacted the Action Plan, including the implementation of E/RES/2022/24 as well as A/RES/69/266, and how to leverage the United Nations Integrated Geospatial Information Framework (UN-IGIF) and contribute to its implementation at the country-level. Participants were made aware of the availability of UN-IGIF implementation guidance and resource materials that are presently, or soon will be, available on the UN-IGIF web pages.

13. The Subcommittee worked in teams to continue development of the draft Action Plan to sustain the GGRF and outlined various roles and responsibilities, including those for partnering international geodetic organizations. This allowed participants to collectively consider the draft Action Plan and to identify appropriate roles, responsibilities, and timelines. In this regard, the Subcommittee agreed on seven strategic actions:

(a) Strategic Action #1: Conduct a global geodesy needs assessment (supported by the International Association of Geodesy and the International Federation of Surveyors Commission 5 – Positioning and Measurement).

(b) Strategic Action #2: Prepare a State of Geodesy Report (supported by the International Association of Geodesy and the International Federation of Surveyors Commission 5 – Positioning and Measurement).

(c) Strategic Action #3: Support the United Nations Global Geodetic Centre of Excellence in its development of a Global Geodesy Development Plan.

(d) Strategic Action #4: Support and promote global coordination, coherence, and partnerships for a sustainable Global Geodetic Reference Frame.

(e) Strategic Action #5: Raise awareness and advocate for global geodesy.

(f) Strategic Action #6: Engage in capacity and capability development.

(g) Strategic Action #7: Develop branding and communicate.

14. To concentrate the efforts of the Subcommittee on the strategic actions, the Subcommittee discussed steps towards implementing the Action Plan, including the establishment of new working groups as a first step. It was noted that the Action Plan will still need more work before it is finalized at future (virtual) meeting(s) of the Subcommittee. However, as an immediate way to get started, three strategic actions were identified and prioritised by the Subcommittee, to: 1) undertake, document and communicate a global geodesy needs assessment; 2) prepare a State of Geodesy Report; and 3) further engage in capacity and capability development.

15. The Subcommittee agreed to dissolve the existing working groups (Governance; Geodetic Infrastructure; Communication and Outreach; Education, Training and Capacity Development; and Standards, Policies and Conventions) and to establish three new working groups focussed on delivering against the three prioritised strategic actions. The working groups are as follows:

(a) Working Group on Global Geodesy Needs Assessment (France – Lead);

(b) Working Group on State of Geodesy Report (Norway – Lead); and

(c) Working Group on Capacity and Education (United States of America – Lead).

The Subcommittee agreed to develop a mechanism to enable relevant stakeholders to participate in the work of the working groups established by the Subcommittee.

16. At its Plenary Meeting, the Subcommittee also considered the composition of its bureau, which includes its two co-Chairs, four additional Member States, and the Leads of the three working groups of the Subcommittee as described in the previous paragraph. The Subcommittee affirmed its bureau members as:

(a) Australia (co-Chair), Canada and Saudi Arabia (until the fourteenth session);

(b) Argentina, Cote d'Ivoire (co-Chair), and Germany (for four years, until the sixteenth session); and

(c) France, Norway and the United States of America (working group Leads).

17. The bureau shall lead and guide the Subcommittee, including assisting in meeting its objectives and performing its functions. The Subcommittee expressed its appreciation to the members of the bureau who have stepped aside (Mexico, Sweden and Tonga) for their tireless and productive efforts over many years.

Revised terms of reference

18. At its fifth online meeting on 13 December 2022, the Subcommittee supported revised terms of reference[2] which were subsequently endorsed by the Bureau of the Committee of Experts. The Subcommittee, supported by the Secretariat, proceeded to refresh its membership based on the updated terms of reference. Members of the Subcommittee are nominated by the bureau of each of the five regional committees of UN-GGIM and are encouraged to actively liaise with and serve as a bridge between the Subcommittee and the regional committees, including their regional working groups on geodesy. Four of the five regional committees responded to a request to review the participation and contribution of their nominees. The fifth response is forthcoming.

19. The updated terms of reference provide for partners to be invited to join the Subcommittee. At its Third Plenary Meeting, the Subcommittee agreed to invite the following partners as members of the Subcommittee:

(a) The International Association of Geodesy;

(b) The International Federation of Surveyors (Commission 5 – Positioning and Measurement);

(c) The International Union of Geodesy and Geophysics;

(d) The Technical Committee 211 of the International Organization for Standardization;

(e) The National Aeronautics and Space Administration of the United States of America; and

(f) The International Committee on Global Navigation Satellite Systems.

Five of the six invited partners have responded positively. The Subcommittee awaits an appropriate response from the remaining invited partner.

Summaries of the activities of the (past) working groups

Governance

20. The Working Group on Governance was established in August 2016 with the objective to identify possible governance mechanisms to improve the sustainability and enhance the quality of the global geodetic reference frame. During the first two years the working group made thorough research, mapped the current situation, described the needed attributes of governance, and wrote its first position paper - Appropriate governance arrangement, which was provided as a background document to the Subcommittee's report to the eighth session of the Committee of Experts held in New York in August 2018.

21. The Committee of Experts noted with interest the progress made on the position paper on governance and its use as a detailed discussion paper for addressing the need to fill the current gaps in governance arrangements for the global geodetic reference frame and requested the Subcommittee to initiate and undertake a broad and detailed consultation on the position paper.

22. The consultation process resulted in the draft position paper - 'Position Paper of the Subcommittee's Working Group on Governance' suggesting the establishment of a United Nations Global Geodetic Centre of Excellence to strengthen the governance arrangements for sustaining the GGRF. The Committee of Experts at its ninth session commended the efforts to revise through broad consultations the position paper and encouraged the Subcommittee to consult further on the practical implementation of the centre, including modalities, function,

[2] Subcommittee on Geodesy Terms of Reference (January 2023)

financial arrangements, and programme of work in direct coordination with the Committee of Experts and in coordination with other relevant stakeholders.

23. In the following intersessional period, the working group on governance worked to address decision 9/104 by developing a draft Position Paper on Sustaining the Global Geodetic Reference Frame, which explored the modalities to balance the longer-term vision, stability, and operational requirements of the GGRF. The working group also led the development of a draft Concept Paper on Establishing a Global Geodetic Centre of Excellence seeking to harness the spirit and momentum of global cooperation in geodesy. The draft papers were presented to the Committee of Experts at its tenth session for broader consultation so that Member States and relevant geodetic stakeholders could ensure alignment with the practical and operational requirements proposed by the Subcommittee.

24. At the tenth session, Germany offered to host a Global Geodetic Centre of Excellence with the key overarching goal to achieve the long-term sustainability, accessibility, and accuracy of the GGRF by addressing many of the critical gaps in capacity and capability and through a programme of works that prioritizes and delivers improvements in the five focus areas: governance; geodetic infrastructure; policies, standards, and conventions; education, training and capacity building; and communication and outreach.

25. During the following intersessional period, the working group on governance was engaged in the consultation of the draft Position Paper and the draft Concept Paper. The working group members worked with the UN-GGIM regional committees to promote the understanding by Member States and relevant geodetic stakeholders of the complex issues facing the global geodetic community and to ensure alignment with the practical and operational requirements proposed by the Subcommittee.

26. The working group, cognizant of its impending and changing role arising from the operationalization of the UN-GGCE, also commenced internal discussions on the purpose of the governance working group vis-à-vis the implementation of the work packages of the Position Paper and an operational centre of excellence. To a large extent the working group on governance had fulfilled its primary objective with the establishment of the UN-GGCE, and at the third plenary of the Subcommittee, the working group was dissolved.

Geodetic Infrastructure

27. The Working Group on Geodetic Infrastructure was established in August 2016, together with the four other working groups. The two main objectives and guiding principles of the working group on geodetic infrastructure are twofold: (i) ensure the long-term sustainability and accuracy of the GGRF to meet science and societal requirements, by sustaining its geodetic infrastructure, and (ii) ensure accurate access to the GGRF by all Member States. This includes capacity building, data sharing, standards and conventions, but also regional and national geodetic infrastructure to allow accurate access to the GGRF, mainly using GNSS technology.

28. During the intersessional periods, members of the working group were involved in a number of scientific events organized by the International Association of Geodesy (IAG) and continued to raise the awareness and the importance of global geodesy activities, and in particular the work of the Subcommittee, emphasizing that this initiative to maintaining and improving the GGRF is a unique opportunity to sustain IAG, science, reference geodetic products and services, via sustaining the geodetic infrastructure that is the basis of all that is carried out within and for geodetic science.

29. The main recommendation from the working group is to start to review the responses received from the IAG Services to start developing a global geodesy need assessment. To that end, the working group recommended to establish a sub-working group to focus on the global geodesy need assessment, and more specifically, to list priorities and actions to be discussed with the UN-GGCE once it becomes fully functioning. This includes exploring mechanisms

to attract investments in the geodetic infrastructure by Member States and other possible donors. Members of the sub-working group could include experts from the Subcommittee, IAG and its Services, and the UN-GGCE.

30. The working group opined that, without commitment by Member States, as urged by the resolution A/RES/69/266, the GGRF will be in danger of degradation over time and consequently gradually lose its required and fundamental role in societal and scientific applications. The working group had accomplished all that can be done, including the responses received from IAG Services to its geodetic infrastructure questionnaire, and is waiting for the UN-GCCE to commence its operations. At the third plenary of the Subcommittee, the working group was then dissolved.

Policies, Standards and Conventions

31. The working group on Policies, Standards and Conventions has the objective to encourage Member States to continue to make their data Findable, Accessible, Interoperable and Reusable. Over the intersessional period, the working group have been actively involved with international standards related activities to make data access easier, more useful, more accurate and more efficient for users. This includes work within organizations such as: the Bureau of Products and Standards of the IAG's Global Geodetic Observing System (GGOS); the International Organization for Standardization (ISO) Technical Committee 211 (ISO/TC 211); and the Open Geospatial Consortium (OGC). Notable activities by the working group during the intersessional period include:

(a) Further development of the ISO Geodetic Register (ISOGR)[3] with the goal of facilitating the implementation of the GGRF and the interoperability of national geodetic data and products. The ISOGR is an online database of reference frames and transformations which is used to uniquely identify reference systems and transformations. It is the only authoritative source for reference frames and transformations where data is entered and/or validated by the agencies that define and maintain the frames and transformations. The Subcommittee has encouraged Member States to add their geodetic reference systems and transformations to the ISOGR and is looking to the UN-GGCE to become the next Registration Authority that manages the operation of the ISOGR to ensure a sustainable future aligned with the needs for the GGRF. Several members of the working group are also members (one the Chair) of the ISOGR Control Body which approves all content of the Register. During the past year, the ISOGR has seen increasing usage with an average of about 10,000 page views per year. A total of 186 new coordinate reference systems and associated transformations have been added to the ISOGR in the past year, including the latest IGS20 reference frame. Reference frames for the Republic of Korean, Sweden and Colombia are also in the process of being added, and work is nearing completion on migrating the ISOGR to a new, more modern platform using the latest versions of ISO standards to enable more reliable and efficient operation in a cloud environment. ISO, OGC and the International Association of Oil and Gas Producers (IOGP), owners of the EPSG registry, have published a guide to geodetic registries[4] that clarifies the roles of the different registries currently available. ISO/TC 211 and IOGP have also been collaborating on ways to link the content of both the ISOGR and EPSG registers more efficiently.

(b) ISO standards related to geodesy. This includes revisions to the following standards: (i) two minor revisions of the fundamental ISO 19111 for the representation of coordinate reference systems and transformations (a joint standard with OGC); (ii) a significant enhancement to ISO 19135 for procedures for registers of geographic information, such as the ISOGR; and (iii) revisions to ISO 19127 that defines the ISOGR to conform to the new ISO 19135. Future revisions may include an update to the

[3] https://geodetic.isotc211.org

[4] https://committee.iso.org/files/live/sites/tc211/files/Resources/GuideToCRSRegistries3.pdf

fundamental ISO 19161-1 for the International Terrestrial Reference System that incorporates the proposed annual updates to the ITRF. And finally, a standardized scheme for the unique identification of "active" geodetic stations is also being investigated as a future ISO standard. Other standards related to the use of GNSS include those within ISO/TC 20/SC 14 (Space Systems and Operations). The working group is monitoring standards such as ISO 24246 (Requirements for global navigation satellite system (GNSS) positioning augmentation centers), ISO 24245 (GNSS receiver class codes), ISO 13657 (Space-based services – positioning information exchange service), and ISO 16215-1 (Space-based positioning, navigation and timing (PNT) services). The objective is to ensure the development and revision of these standards includes feedback from national geodetic agencies and the IAG as required.

(c) Development of a standardized representation of geodetic deformation models. Under the auspices of the OGC Coordinate Reference System Domain Working Group in conjunction with the IAG working group 1.3.1 on time-dependent transformations, a standardized representation of geodetic deformation models has been developed. The draft specification[5] of the Deformation Model Functional Model is now in its final stage and comments from a review by OGC members are presently being considered for incorporation into the final version for publication. This standard will allow deformation model producers, such as national geodetic agencies, to publish models in a standardized way. The specification defines a set of parameters and metadata that define the deformation model, and how they are used to help ensure they are correctly implemented in coordinate transformations by geospatial software developers and users. The specification is designed to enable gridding of such deformation models within the new Gridded Geodetic data eXchange Format (GGXF) also being developed by OGC.

(d) Development of a standardized format for geodetic grids. The OGC Coordinate Reference System Domain Working Group has also worked on defining a standardized format for grids of different types of geodetic data. The Gridded Geodetic data eXchange Format (GGXF) has also progressed to the final stage. A single, standard, grid file format offers the following advantages: (i) grid producers do not need to create file formats themselves, provide their own software to read and interpolate their gridded data or concern themselves with lack of take-up of their data due to its proprietary distribution format; (ii) geospatial software developers need to read only one grid file format, eliminating the need to repeatedly revise their software to import different grids; and (iii) and users can use a new grid file as soon as it becomes available, without having to wait for their application vendor to produce a software upgrade. The format is intended to accommodate any gridded geodetic data, in particular grids supporting geoid models, coordinate transformations, velocities and deformations. GGXF has been designed to support multiple levels of data resolution, computational efficiency, and be straightforward for grid producers and developers to use. As for the deformation model specification, comments from OGC members are presently being reviewed and considered for incorporation into the final version of the standard. The candidate specification[6] for GGXF is expected to eventually become a joint standard with ISO/TC 211.

(e) Based on discussions in international forums, the working group have found that data sharing is inconsistent or absent across regions. The barriers to data sharing include: legislative limitations, institutional and conflicting commercial concerns, lack of financial and technical resources, lack of regional collaboration and initiatives (often due to geographic isolation or cultural behaviour), sparseness of geodetic infrastructure and lack of data, and security concerns. The working group will continue to encourage Member States to: (i) more openly share their geodetic data by contributing to existing international

[5] https://portal.ogc.org/files/100988
[6] https://portal.ogc.org/files/103490

data portals or provide access to their own portal, (ii) use international metadata standards and metadata catalogues for their own portals, and (iii) continue to assist in data sharing workshops.

(f) The working group has noted the increasing reliance on space-based positioning standards (e.g., WGS84) to be interoperable with terrestrial based positioning standards (e.g., ITRS) and encourage all Member States to ensure standards are aligned to ensure applications will not be negatively affected. This particularly relates to the International Civil Aviation Organization (ICAO) but may also include the International Hydrographic Organization (IHO). Furthermore, European level working groups have developed regional standards for Intelligent Transport Systems (EN 16803-1:2020) that adopt similar space-based reference systems. This diverges from most applications reliant on terrestrial-based reference systems that account for earth surface movement. There is a need to homogenize efforts in developing standards to ensure interoperability of geospatial data across all domains and to avoid duplication.

Education, Training and Capacity Building

32. This Working Group on Education, Training and Capacity Building focused on building capacity and promoting education with regards to the GGRF in the context of one of the nine strategic pathways of the UN-IGIF. The working group was one of the five established when the Subcommittee on Geodesy was formed in 2015 and as with other working groups, was dissolved at the third plenary meeting of the Subcommittee. The activities discussed will now be subsumed by the new Working Group on Capacity and Education.

33. During this intersessional period, the working group coordinated its efforts with the regional committees of UN-GGIM and their respective working groups on geodesy and focused on implementing the GGRF. Four of the five regional committees already had such a working group. For UN-GGIM: Americas, critical steps were initiated, engaging the Sistema de Referencia Geodésico para las Américas (SIRGAS) and establishing a Working Group on Geodetic Reference Frame for the Americas (GRFA). This ensured appropriate reference frame capacity and capability advocacy in the Americas, as well as a regional forum to focus the activities of the Subcommittee and UN-GGCE.

34. The working group coordinated closely with the International Committee on GNSS (ICG), the International Federation of Surveyors (FIG) and International GNSS Service (IGS) of the IAG in capacity and education activities. Papers and presentations were delivered to socialize the outcomes and results of analyses on capacity needs at conferences of the FIG, IAG and EGU. Presentations were also made during the FIG Reference Frames in Practice seminars held in Santiago, Chile in November 2022. Updates were provided during the FIG Working Week in Orlando, Florida in the United States of America in May 2023. During the session, presentations and updates were provided at the Reference Frames in Practice Seminar, a Caribbean small island developing States (SIDS) workshop as well as during a session by the FIG Americas Capacity Development Network (CDN).

35. Two separate surveys were conducted in 2018 and 2021 to assess the worldwide geodetic educational needs. Analysis of the first survey was completed in 2020 and documented in FIG papers and reports. After this initial analysis, the working group worked to refine and expand the survey, with a second survey conducted during the 2021-2022 period. Preliminary results for the Americas were presented during the SIRGAS meeting in November 2022, in Santiago, Chile as well as during the FIG Working Week in May 2023, in Orlando. A more comprehensive report including the results for all regional committees is currently underway. Both surveys resulted in an expanded list of needs and requirements globally as it relates to geodetic networks, reference frames and datums. Capacity and education requirements have been compiled for countries to contribute to the planning of appropriate capacity development initiative including, and when appropriate, by the UN-GGCE. Additionally, a significant list of points of contact in each country has been compiled that could

provide a basis for coordination in any capacity development initiative as well as work on the global geodesy needs assessment and the state of geodesy report.

36. Core aspects of the working group will be subsumed by the new Working Group on Capacity and Education of the Subcommittee and will continue to engage the regional committees of the UN-GGIM as well as partners. This will support and promote global coordination, coherence, and partnerships for a sustainable global geodetic reference frame, raise awareness and advocate for global geodesy, as well as to engage in capacity and capability development, and develop branding and communication.

Communications and Outreach

37. General Assembly Resolution A/RES/69/266[7] invites Member States to develop outreach programmes that make the global geodetic reference frame more visible and understandable to society. It is acknowledged that geodesy often suffers from being a science which is difficult to describe. If decision makers and donors do not understand the value of geodesy and investment in the GGRF, then they are unlikely to prioritize investments in the GGRF and above other initiatives.

38. Since its establishment in 2016, the Working Group on Communication and Outreach has provided communication and outreach activities to the Subcommittee, to help to implement Resolution 69/266 and achieve the long-term sustainability, accessibility, quality, and accuracy of the GGRF for sustainable development. The working group has helped Member States to understand the value of geodesy by providing strategic messaging and communication measures related to the Subcommittee's Position Paper and to the planning and implementation of GGRF side events and global geodesy forums. The Subcommittee's newsletters, fact sheets, social media, and landing webpage8 have also been part of the toolbox provided by the working group. The working group have also engaged in regional and stakeholder meetings as part of the broader communications efforts.

39. The dedicated communication and outreach work from the working group has resulted in increased engagement and awareness of the importance of the GGRF and the work of the Subcommittee. At its twelfth session, the Committee of Experts welcomed the Subcommittee's considerable efforts to grow the critical understanding, awareness and advocacy for the importance of the global geodetic reference frame as a vital global infrastructure that is of benefit to society and needs to be maintained.

40. During this intersessional period, the working group discussed how communication resources can involve and support the Subcommittee's action plan, by embedding communication into the prioritized strategic actions of the Subcommittee. The working group also discussed how the Subcommittee could raise awareness of regional challenges towards sustaining the GGRF. The working group was dissolved at the third plenary meeting with an understanding that communication and outreach is embedded into the strategic actions and activities of the Subcommittee. In this regard, the Subcommittee will need to develop a mechanism to enable relevant stakeholders to participate in the work of the working groups established by the Subcommittee.

Coordination of efforts

41. In the intersessional period the Subcommittee discussed and consulted on the proposed governance and operational modalities of the Subcommittee and as they may relate to the UN-GGCE. The Subcommittee considered how to develop stronger working relationships between the Subcommittee, the UN-GGCE, partners and relevant international organisations. The

[7] https://ggim.un.org/documents/A_RES_69_266_E.pdf
[8] Sustaining the Global Geodetic Reference Frame (unggrf.org)

intent of this discussion is to improve collaboration and coordination and reduce duplication of effort as the Subcommittee strive to sustain the GGRF.

III. The United Nations Global Geodetic Centre of Excellence

42. The Agreement between the United Nations and the Federal Republic of Germany, formalized in November 2022, defines the modality for the operationalization of the UN-GGCE at the UN Campus in Bonn, Germany. This Agreement forms the foundation for the establishment and initial operations of the UN-GGCE, with an overarching goal to assist Member States and geodetic organizations to coordinate and collaborate to sustain, enhance, access and utilize an accurate, accessible and sustainable GGRF to support science, society and global development. The objective of the UN-GGCE is to support, within available resources, the implementation of General Assembly Resolution 69/266.

43. The UN-GGCE had its opening ceremony on 29 March 2023, convened the first meeting of its Steering Committee also on 29 March and its International Advisory Committee (IAC) from 29 – 31 March 2023 at the UN Campus in Bonn. The first meeting of the IAC was convened jointly with the Third Plenary Meeting of the Subcommittee. In its first meeting, the IAC adopted its terms of reference and confirmed its inaugural membership and co-Chairs, which was reported to the Steering Committee.

44. Pursuant to the Agreement for the operationalization of the UN-GGCE, the Federal Agency of Cartography and Geodesy (BKG) has seconded two technical advisors, full-time and in-person, to the UN-GGCE. Both advisors are expected to work from the UN-GGCE's premises at the UN Campus in Bonn from September 2023. In the lead up to the opening ceremony of the UN-GGCE, an arrangement was formalized with the Norwegian Mapping Authority for the virtual secondment arrangement for a communications advisor to the UN-GGCE on a full-time basis for approximately two years commencing May 2023. After the opening ceremony, another arrangement was formalized with the Instituto Geográfico Nacional of Spain for the virtual secondment of a geodetic advisor to the UN-GGCE on a part-time basis for nine months from September 2023. The arrangement may be extended by mutual agreement for further periods of six months. These secondment arrangements represent tangible contributions from Member States towards the implementation of Resolution 69/266, thus sustaining the GGRF and the UN-GGCE.

45. The report of the Secretariat, prepared with the assistance of the expanded Bureau of the Committee of Experts, on enhancing global geospatial information management arrangements (E/C.20/2023/5/Add.1), confirmed that the IAC and the UN-GGCE shall formally report on the implementation and progress of the programme of work of the Centre to the annual sessions of the Committee of Experts, through the preparation of written reports and background documents, under the standing agenda item 'Global geodetic reference frame', commencing with this thirteenth session. In this regard, a brief report from the IAC and the UN-GGCE on their initial implementation and progress, is attached as a background document to this present report.

IV. Next Steps

46. The Subcommittee intends to work collaboratively with the IAC and the UN-GGCE to identify priorities, develop work programs and enhance engagement and collaboration with the international geodetic community, and to avoid duplication. The Subcommittee will provide expert guidance through the IAC and work to ensure the UN-GGCE has the best start-up conditions possible. This includes helping to establish strategic liaisons with relevant Member States and relevant geodetic stakeholders and to provide appropriate GGRF 'institutional memory and history' and other relevant background information.

47. The Subcommittee will lead the development of a Global Geodesy Needs Assessment and support the UN-GGCE to translate the findings into a Global Geodesy Development Plan. The Subcommittee will also lead the development of the Status of Geodesy Report and

continue to develop stronger working relationships with the IAG, FIG, ISO and other relevant organisations.

48. To advance its objectives and functions, the Subcommittee will continue with its online meetings in the upcoming period. The Subcommittee has noted the value of, and welcomed, in-person exchanges and interactions amongst its members and relevant stakeholders. The Subcommittee looks to the possibility of convening its fourth plenary meeting back-to-back or jointly with the meeting of the IAC of the UN-GGCE.

V. Points for discussion

49. **The Committee of Experts is invited to:**

a) Take note of the present report and express its views on the work and progress of the Subcommittee, including its considerable efforts to grow the critical understanding, awareness and importance of the GGRF as a vital global infrastructure;

b) Express its views and guidance on the strategic actions and next steps of the Subcommittee and to encourage Member States and relevant geodetic stakeholders to contribute to sustain the GGRF;

c) Provide views and guidance towards developing stronger working relationships between the Subcommittee, the UN-GGCE, IAG, FIG, ISO and other relevant organisations;

d) Take note of the desirability of convening the next in-person plenary meeting of the Subcommittee in coordination with the meeting of the IAC of the UN-GGCE; and

e) Take note of and express its views on the progress and status of the operationalization of the UN-GGCE.