

Session 5: Country Presentations: summary notes

GGOS-Africa 2026 Workshop, Nairobi · Tuesday 6 October 2026 · 11:07–13:04 EAT

Moderator: Hussein Farah (Technical University of Kenya), standing in for Bruno Kyamulesire

Written from the Zoom transcript, cross-checked against the speakers' slides where the transcript was unclear. Audience speakers' names are given only where they could be identified with reasonable confidence. Figures are as presented. Please check against the recording before quoting anyone. Yap Loudi's GNSS-IR talk was moved here from Session 6 to save time in the afternoon.

Key points

- **Every country has CORS, but each has several operators that are not joined up.** Government, space agency, utility, university and private networks run side by side, often in different frames, and private networks cluster where there is a return on investment.
- **Funding models vary:** a public–private partnership in Ghana (52 CORS, self-financed by the private partners, 20-year MoU); free-trial-then-subscription in Zimbabwe; fully government-run networks in Tunisia and Uganda.
- **Nigeria's VGOS-type VLBI antenna at Toro is built** with the Shanghai Astronomical Observatory, has made test observations, and is awaiting commissioning (planned December). SLR is under discussion, with the aim of becoming a full GGOS core site.
- **Geodesy capacity is very thin.** A show of hands found roughly 10 university lecturers with geodesy PhDs in the room, and none in North Africa among those present.
- **Uganda contributes several stations to IGS**, one of the few African countries to do so.
- **Low-cost GNSS-IR sensors (about US\$150–200)** are monitoring river, dam and coastal water levels in Cameroon at 1–2 cm accuracy.

Talks

Yao Yevenyo Ziggah: Public–Private Partnership in Establishing a CORS Network in Ghana

(Head, Geomatic Engineering, University of Mines and Technology, Ghana)

- **Background:** Ghana's legacy datum was built in separate south (triangulation) and north (traverse) adjustments joined together, so it is distorted. Control monuments are being destroyed. Five standalone CORS from the Land Administration Projects (LAP I and II, 2003 and 2011) were not networked and had connectivity problems. Funding stopped after LAP, and private and institutional CORS filled the gap without common standards or a link to the national grid.
- **The PPP (from 2021):**
 - *Lands Commission* (Survey and Mapping Division): regulator, standards, quality control and adoption.
 - *GMX Systems Ghana* (subsidiary of an Israeli firm) with *Geo-Tech Systems* (local): technical lead, investment and risk.
 - *Ghana Water Company*: hosts stations at its facilities, cutting costs and supporting its own hydrological work.
 - A **20-year MoU**; about **US\$1.5M self-financed** by the private partners because bank loans were too expensive. They expect to recover their money in about five years.
- **Enabling conditions:** the Public Private Partnership Act, 2020 (Act 1039), and high-level political championing by the then Vice President.
- **Network:** **52 CORS** in three zones (south, middle belt, north), about 70 km coverage radius each, about 90% of the country covered; long-term target **100 stations**. GMX hosts the network software; both firms provide maintenance.
- **Access:** the Lands Commission has free access. Payment terms for other public and private users are still being negotiated.
- **Conclusion:** "Partnerships alone do not fix weak institutions." It worked because Ghana already had a PPP legal framework and institutional history; clear governance mandates should come before partnership design.

Zouheir Fatnassi: Geodetic Infrastructure in Tunisia

(Office de la Topographie et du Cadastre, OTC)

- **National networks:**
 - 28-point spatial reference network observed with dual-frequency GPS in 1998.
 - About 600-point first-order spatial network (2000–2003); a secondary network of 20,000+ points in progress.
 - 312-point primordial triangulation network (1978–1984) and about 19,000-point second-order terrestrial network (1980–2000).
 - First-, second- and third-order levelling; gravity network of 9 absolute and 67 relative points, with densification under way for an improved geoid.
- **Many legacy systems** (Carthage 1934, Carthage 1986, Carthage 1984, WGS84; Lambert North and South; UTM; 66 local “fiso” origins for old land registration). Paper map series exist in UTM and Lambert.
- **New Tunisian Terrestrial system (NTT):**
 - Built on the 1984 single-block adjustment (Clarke 1880, Carthage fundamental point). A national upgrade project started in 2004.
 - Mandated by a Ministry of Defence decree of **10 February 2009**.
 - Key requirement: no change to the shapes and areas of land parcels (“social peace is maintained”).
 - Third-order polynomial transformation parameters for each 1:50,000 map sheet, RMS about 4 cm, stored in a database.
- **Geomatica:** an in-house Excel-based suite of 54+ applications that converts between the four systems in use (STT, IGN, NTT, WGS84) and gives datasheets for every geodetic point and levelling benchmark. All levelling benchmarks were observed with GPS where possible. Fundamental levelling benchmark: 7 m orthometric, Port de France, Tunis.
- **CORS network: 23 stations** (none in the Sahara), fully operational since 2011, designed for a 50 km radius per station. They hope to reach 30, but funding is the limit. Each station has a meteorological sensor and a tiltmeter. The network is RTK-focused for land registration, managed with manufacturer-independent German software, and used by OTC plus about 200 private users and companies.

Joseph Dodo: Geodesy in Nigeria: Progress and Development

(Centre for Geodesy and Geodynamics, National Space Research and Development Agency, NASRDA)

- **Legacy:** the Minna datum (Clarke 1880 modified, observations 1940s–60s) has scale and origin inconsistencies, no geoid heights, and poorly determined transformations. The result is “circular confusion”: Nigeria’s 36 states use different origins and projections (UTM, NTM, Minna, WGS84).
- **Office of the Surveyor-General of the Federation (mapping agency):**
 - CORS grew from 9 (2008–09) to 11 (2012) to about 20 now, with 5 more proposed. Rooftop stations are on load-bearing columns; others are ground monuments.
 - 60+ old survey control points have been re-observed with GNSS as a passive first-order network.
- **NASRDA:**
 - 7 CORS since 2024, co-located with **13 seismic stations** as integrated geodynamic monitoring stations.
 - Pillars are cast up to 2 m deep to IGS standards, and all stations are solar powered.
 - A GNSS and seismic data and analysis centre produces a monthly seismic catalogue. Data are downloaded manually when networks fail.
- **Private sector and institutions** add many more stations, some selling RTK subscriptions. About **80+ CORS** can be confirmed nationwide (over 100 by other estimates).
- **Reference frame:** the Nigerian geocentric datum was realised in 2012 (11 CORS, 2 years of data, 11 IGS stations). It was re-realised as **NGD2023 in ITRF2020** using about 41 IGS stations plus passive points.
- **Challenges:**
 - Stations are not pooled.
 - The geocentric datum is not yet the adopted national datum.
 - States are not yet part of the frame.
 - Commercial owners see the data as theirs (“you are the king”).

- Poorly monumented stations (“a stick with an antenna”) would corrupt AFREF data. A regulatory policy is being prepared.
- **VLBI:**
 - Responded to the 2011 GGOS call; presented the site at NASA. **Toro was designated a GGOS candidate site in February 2012.**
 - MoU with the **Shanghai Astronomical Observatory** signed September 2022; site work started in 2023 (RFI measurements, rock testing); project flagged off 14 November 2024.
 - The antenna (a VGOS-type system per the slides; the transcript gives “30 metre”, likely a mis-hearing of 13 m, so please check) and buildings are complete. They include a hydrogen maser, a backend server room, a control building, GNSS, a weather station and a holography station.
 - Power: national grid plus two standby generators and a UPS; solar is being added because the grid is unreliable.
 - Trial observations with Sheshan (Shanghai) gave good results. **Commissioning is hoped for in December.**
 - Nigeria provides the site and will operate and maintain the system itself.
- **SLR is under discussion**, with the aim of becoming a full GGOS core site. The Nigerian Association of Geodesy conference in November will hold a stakeholder discussion.

Charles Paradzayi: Zimbabwe’s CORS Network

(Executive Dean, Built Environment, Art and Design, Midlands State University)

- The geodetic backbone came from the Cape-to-Cairo arc (30th Meridian) and is maintained by the Department of the Surveyor-General on the Arc 1950 datum. It underpins freehold title surveys; communal land is allocated by chiefs.
- **CORS operators:**
 - **ZINGSA** (Zimbabwe National Geospatial and Space Agency): 24 stations across all ten provinces.
 - **Surveyor-General:** 5 working, 10 more acquired in 2026 and awaiting deployment, and a tender for 10 more.
 - **City of Harare:** 1 station.
 - Together about 50 stations eventually, with spacing now about 50–100 km.
- **Access:**
 - ZINGSA offers a free trial (20 July – 31 December 2026), then a subscription from January 2027.
 - The Surveyor-General charges about US\$5 per day per survey, which funds maintenance.
 - A live status website showed about 20 stations reporting that morning.
- **Gaps:** no national geoid; decades of data on Excel spreadsheets on Arc 1950 still to be migrated (the Surveyor-General’s database is not yet public); three operators perhaps not on the same frame; **too few geodesists**. His department has no geodesist with a master’s or PhD.
- **Show of hands in the room:** about 10 university staff with a geodesy PhD and about 5–6 with a master’s. By region: SADC about 7, East Africa about 3, West Africa about 4–5, North Africa (Tunisia) none. Very few were under 30.
- **Asks of GGOS-Africa:** a technical partnership on a national geoid, help linking stations to AFREF and the global frame, and a **Pan-African Geodetic Research Consortium** to train geodesists, with Zimbabwe as a node. Geodesists should bring solutions, not just science, to government.

Robert Wafula: Geodetic Networks in Uganda

(President, Institution of Surveyors of Uganda)

- Horizontal datums: Arc 1960 (static, from the Cape-to-Cairo arc, Clarke 1880) and the **Uganda Geodetic Reference Frame (UGRF)**, aligned to **ITRF2005 epoch 2010.0**.
- UGRF has 9 zero-order sites (2010), 129 first-order and 297 second-order points (2019), **40 government CORS** built in two phases and open to all users, and the geoid model UGEIOD2020.
- Private CORS: Eagle CORS 19 (plus two in Kenya, at Eldoret and Kisumu) and Survnet 16, so **about 75 stations in total**. Private networks avoid the north, where returns are low; the government network covers the whole country.

- **Several UGRF stations (about four to five) are accepted into IGS** and still streaming: Uganda's main contribution to the international community.
- Recurring challenges heard over the two days: data sharing, politics and human capacity.

Yap Loudi: GNSS-IR monitoring of coastal and inland water levels in Cameroon

(Head of Geodesy Research Laboratory, National Institute of Cartography, Cameroon)

- **CAMEO-WAGST project** with the University of Bonn, funded by the EO Africa R&D Facility (ESA and AU Commission): about €30,000 over 15 months from December 2024.
- **Aims:** a low-cost, low-maintenance prototype for flood and drought early warning that can be adopted across Africa; testing Fully Focused SAR altimetry for coasts and estuaries; validating SWOT, Sentinel-3 and Sentinel-6 water levels.
- **Raspberry Pi Reflector (RPR):**
 - Uses a single-frequency L1 receiver and reflections from water surfaces near the antenna.
 - Open-source hardware and software, about US\$150–200, solar powered, installed in a single visit.
 - Data are sent by GSM or LoRa; accuracy is 1–2 cm.
- **Network of 8 RPRs:** Sanaga River (Song Mbengué, a planned hydropower dam site, and the Edea dam), the Wouri estuary near Douala, and the coast (Limbé, Kribi).
- **Results:**
 - Good agreement with staff and pressure gauges. A daily cycle in the river level comes from upstream hydropower regulation at the Nachtigal dam.
 - The RPR kept recording above the ceiling at which one gauge saturated.
 - Tidal constituents were resolved at Douala (M_2 about 0.78 m).
 - Comparisons with SWOT are under way.
- **Next:** remove tide predictions to isolate storm, wind and current effects, and tie the coastal observations to tide gauges to help harmonise Cameroon's levelling network. A dual-frequency version is being developed to also study subsidence.

Interactive discussion

- **Which WGS84/ITRF realisation does Tunisia use, and does it update? (Bruno Kyamulesire). Fatnassi:** the network is for RTK land registration, so coordinates are deliberately held fixed to the 1998 realisation of the 28 base points rather than updated to each new ITRF. Newer ITRFs are processed to check differences. Ties use nearby IGS stations (Matera, San Fernando, Rabat and others).
- **ITRF2008 – ITRF2020 in Nigeria (Bruno). Dodo:** differences are at the millimetre level, so users were not asked to change. The aim of the recomputation was to bring control up to date.
- **Why are CORS not part of Nigeria's national network, and how are state systems unified? (Simon, participant). Dodo:** states have GNSS stations being tied to ITRF, but transformation parameters are still local. A national set is being developed.
- **Student access to Nigerian VLBI data (participant).** Not yet decided ("we will cross that bridge when we get to it").
- **GNSS-IR signals (participant from Malawi). Yap:** single-frequency L1; dual-frequency units are the next generation.
- **Zimbabwe receivers and data access (participant from Malawi). Paradzayi:** the Surveyor-General uses Trimble and ZINGSA uses Leica. Free-trial access is by registration; he offered a contact for research access. The moderator noted that the receiver brand should not matter once data are standardised.
- **Tunisia paper maps (participant). Fatnassi:** the paper sheets were scanned with high-precision scanners and layers extracted into digital form.
- **Cross-border data access (André Nonguierma).** Asked whether neighbouring countries can get each other's data without bilateral negotiation. **Dodo:** a real problem. Data are treated commercially ("how much are you paying?"). Nigeria's geodesy community, including retired professors, is working on getting data to the mapping agency. Not all stations should contribute: quality matters.
- **Nigerian VLBI and the wider supply chain (Jack Radcliffe).** Offered help, with South African colleagues, to build a VLBI research group, and suggested engaging the astronomy community (e.g. SKA Observatory's

Pan-African plans). Asked whether Nigeria has considered other parts of the VLBI supply chain, such as a **geodetic VLBI correlation centre** (highlighted in the UN-GGCE report; South Africa has “half of one”).

- **Dodo:** capacity building is the next phase. Correlation will initially be with Shanghai (disks shipped), with training in operations and data analysis. Nigeria will not be “just a gatekeeper” and wants to work with South Africa and others.
- **Collect all data and filter later (Nigerian participant).** Station checks and site analysis can filter poor stations afterwards. Data not good enough for AFREF can still serve research, so send everything to the AFREF data centre.
- **The Nigerian data centre (Elifuraha Saria).** Asked why Nigeria’s earlier NIGNET data centre is now offline. Cut short for time; to be continued between the two.

Session closed at about 13:04 for lunch, resuming 14:00.

Actions and follow-ups mentioned

- Zimbabwe asks GGOS-Africa for geoid support, AFREF linkage and a **Pan-African Geodetic Research Consortium**.
- Offer from Jack Radcliffe and South African colleagues to support Nigerian VLBI research capacity; follow up on correlation-centre ideas.
- Nigerian Association of Geodesy conference (November) to hold a stakeholder discussion; Toro VLBI commissioning planned for December.
- Contact for Zimbabwe CORS research access via Charles Paradzayi (ZINGSA: cors@zingsa.ac.zw).
- Saria–Dodo follow-up on the status of NIGNET data.