REFERENCE FRAMES
CASE STUDY FOR VIETNAM

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REFERENCE FRAMES - CASE STUDY FOR VIETNAM

- In Vietnam, Survey, Mapping and Geoinformation Department (DOSM) is National Agency in this field. DOSM belong to Ministry of Natural Resources and Environment.
- Main functions of DOSM are to implement projects in survey, mapping and geoinformation across country, provide data for common use.
- Reference systems (Horizontal, Vertical, Gravity) are most important projects of DOSM, have been implementing for long time, with some periods.

1. HORIZONTAL REFERENCE FRAME

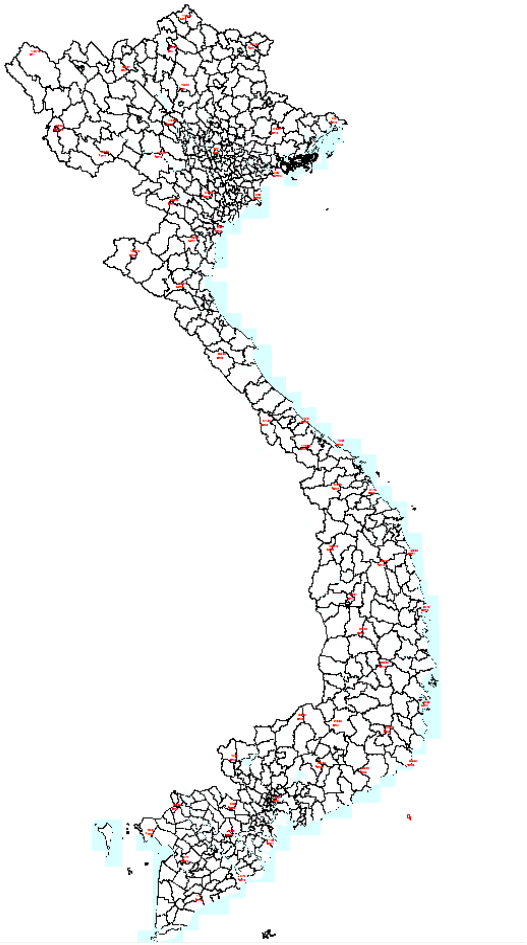
- Before year 1990, Vietnam used Coordinate system named HNOI-72 (Ellipsoid: Kvasovski, projection: Gauss) with horizontal control network established by triangle measurements, 4 Classes (I:338 pts, II: 3788 pts, III: 17.628 pts, IV: 433pts).
- After 1990, when GPS technology was imported, Vietnam started establishment horizontal control network using GPS technology, across country, and established new Coordinate System at year 2000, named VN2000 - the National Coordinate System, brought to use up to now.

HORIZONTAL REFERENCE FRAME

- The National Coordinate System VN2000 based on the ellipsoid which derived from fitting WGS84 ellipsoid to Vietnam. For flat projection, UTM method is applied. VN2000 is static coordinate system.
- VN2000 has 3 Classes:

- Class “0” : 71 points, space of 100-150km;
- Class I-II: 1505 points, space of 25-30km;
- Class III: 12.818 points, space of 5-15km.

HORIZONTAL REFERENCE FRAME



Class “0” Network:

- Is the National Base Frame Network, covered country.
- 71 points, space of 100-150km, used dual frequency GPS receivers, duration observation: 24h.
- Accuracy: 2cm in position, 3cm in Ellipsoid Hight.
- Permanent monuments.
- Have transfer calculation parameters with WGS84 coordinate System.

HORIZONTAL REFERENCE FRAME

Limitation of VN2000:

- Is a static coordinate system.
- Transfer calculation Parameters with WGS84 coordinate System now become not in high accuracy.
- A lot of Monuments of networks are lost or moved due to social economic development.
- The monuments are moved due to regional geology.
- Limited in regional and international integration.

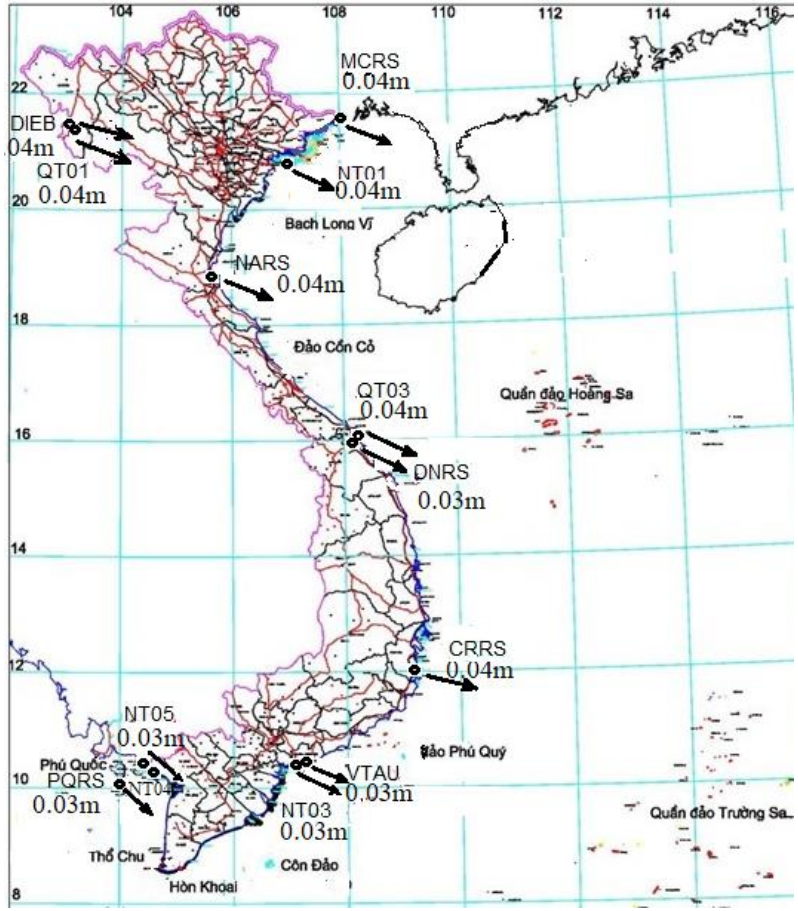
HORIZONTAL REFERENCE FRAME

NAME	From 2011-to 2016			From 2011- to 2017			VL (m/year)	AZ (Deg.)
	DX (m)	DY (m)	DP (m)	DX (m)	DY (m)	DP (m)		
DIEB	-0.044	0.176	0.181	-0.053	0.211	0.217	0.036	104°
QNAM	-0.044	0.156	0.162	-0.057	0.185	0.194	0.032	106°
VUNT	-0.035	0.144	0.149	-0.042	0.170	0.175	0.030	104°
DOSN	-0.054	0.175	0.183	-0.056	0.204	0.211	0.037	107°
NTOI	-0.044	0.169	0.175				0.035	105°
NT03	-0.041	0.145	0.151				0.030	106°
NT04	-0.043	0.164	0.169				0.034	105°
NT05	-0.038	0.161	0.165				0.033	103°
QTOI	-0.034	0.132	0.136				0.034	104°
QT03	-0.043	0.158	0.164				0.033	105°
BJFS	-0.055	0.192	0.199	-0.064	0.232	0.241	0.040	106°
DSMG	-0.051	0.174	0.181	-0.065	0.207	0.217	0.036	106°
COAL	-0.053	0.176	0.183	-0.066	0.209	0.219	0.037	107°
SHAO	-0.059	0.188	0.197	-0.073	0.223	0.235	0.039	107°

Moving monuments:

- Monuments are moving due to moving of regional geological blocks toward South-East.
- In the table, data calculated by GPS data-files received on monitoring monuments for periods.

HORIZONTAL REFERENCE FRAME



Sketch of moving monuments:

All monuments are moving toward S-E, due to regional geological blocks.

HORIZONTAL REFERENCE FRAME

Modernization of National Reference Frame:

- Limitations of VN2000 are found by DOSSM.
- DOSSM has been implementing National Reference Frame Modernization.
- The most Project is CORS Project of Vietnam.
- The CORS Network will be connected to VN2000-control points. And VN2000 will be connecting to ITRS, to become Dynamic Coordinate System.

HORIZONTAL REFERENCE FRAMES

CORS Project of Vietnam

Purpose:

- **Modernize** the infrastructure of survey and mapping, build up the Reference Frame of dynamic Coordinate System, participate in the International Geodetic Network.
- **Build up GNSS CORS Network**: Provide real-time correction signal for RTK survey with accuracy of cm level for popular use.
- **Provide raw data** for GNSS static survey, post-processing GNSS survey.
- **Provide data for scientific research:** like earth surface deformation and other study fields

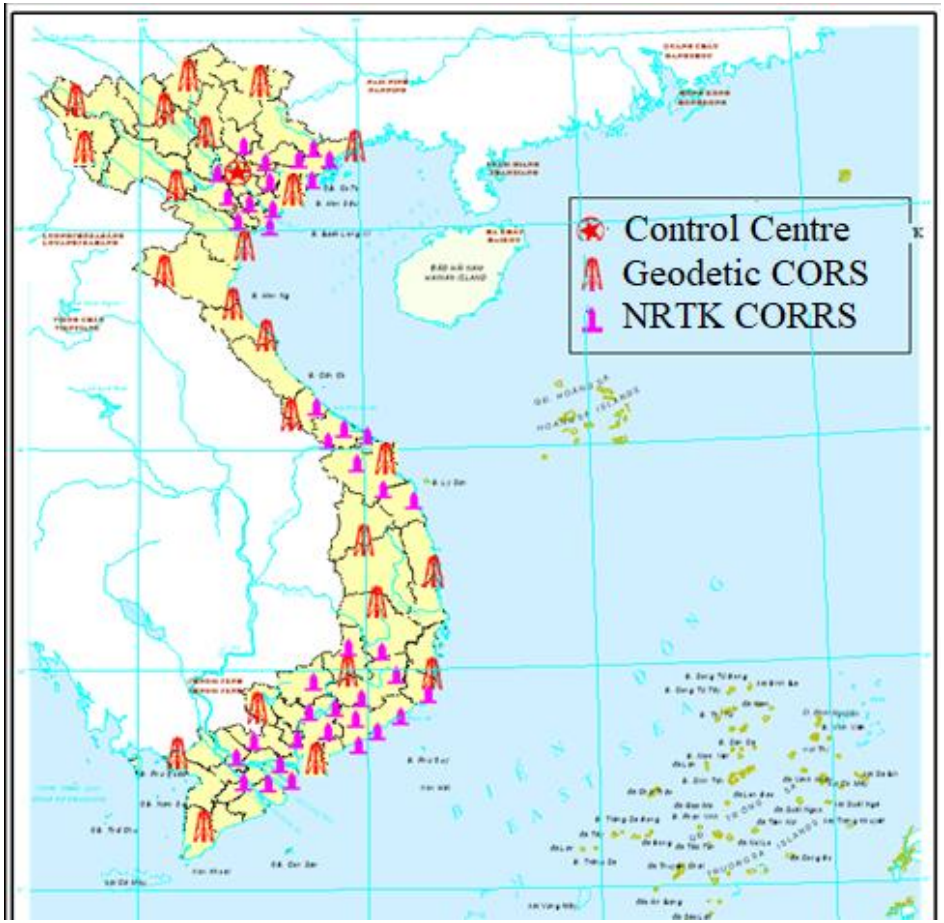
HORIZONTAL REFERENCE FRAME

CORS Project of Vietnam

Main contents:

- **Build up National CORS Network with 65 CORS Stations, including:**
- **24 Geodetic CORS stations** with space of 150-200Km.
- **41 NRTK CORS Stations:** 14 stations in North Part, 7 stations in Middle Part, 20 stations in South Part, make NRTK Networks with space of 50-70Km.
- **01 Processing and Control Center:** Locates in Hanoi for monitoring, receiving, processing, providing data.
- **Build up Standards, Guidelines** for data exploitation.

HORIZONTAL REFERENCE FRAME



CORS Project of Vietnam:

Location of CORS

HORIZONTAL REFERENCE FRAME

CORS Project - deployment plan:

- The Project has been implementing from 2016 to the end of 2019. After 2019 will be in the Expanding Period.
- The project deployment plan:

➢ 2016: Technical Design, bidding

➢2017: Construct monuments of CORS, Control Center, installation of equipment for 17 CORS at North Part.

➢2018: Installation of equipment for all CORS; Perform trial operations of the CORS system.

➢2019: Training, operation and technology transfer.

HORIZONTAL REFERENCE FRAME

CORS Project of Vietnam:

- Group 17 CORS at North Part is completed construction in 2017.
- 2018 start receiving GNSS data
- Providing GNSS data for trial operations and use.

HORIZONTAL REFERENCE FRAME
CORS Project of Vietnam:

Pictures on monument construction of CORS in Vietnam

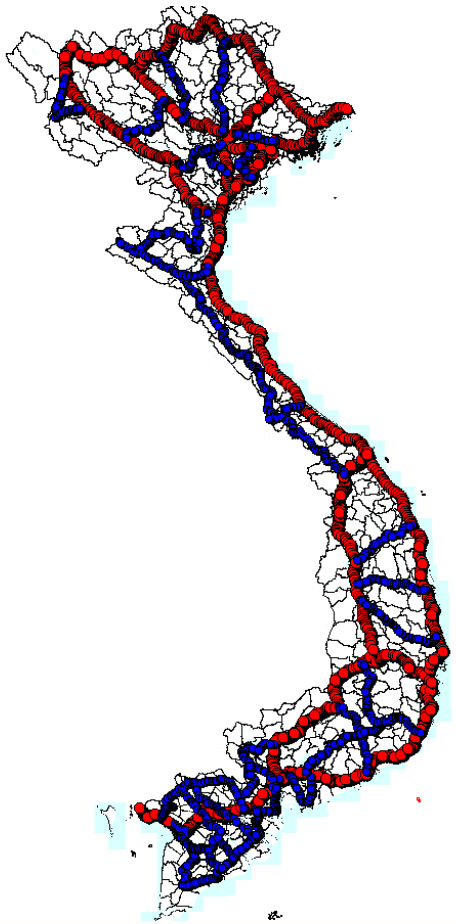
2. VERTICAL REFERENCE FRAME

- The National Vertical System was established over some periods, summarized as follows:
- Period 1959-1964: Building elevation network in the North Part. Elevation origin - the mean sea level at Hon Dau Tidal Station, announcing as Hai Phong high system - 1972. In the South Part, before 1975, elevation network established according to the mean sea level, recorded at Ha Tien Tidal Station.
- Period 1981-1991: Unified height network across the country, established with 2 Classes: I (5096 km) and II (4515km).
- Period 2001-2008: Complete National vertical network, 3 classes:

VERTICAL REFERENCE FRAME

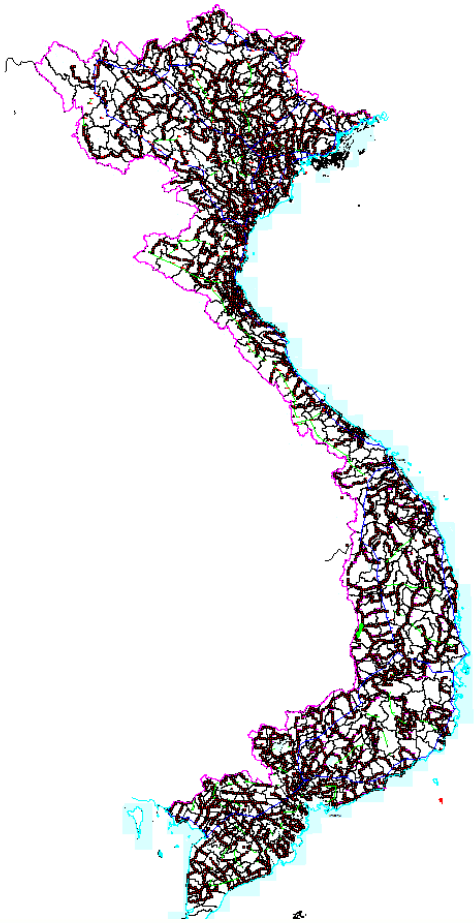
- Class I: 5667km long, 1211 points, space of 5km/pts, accuracy 1.04mm/km.
- Class II: 5334km, 1123 points, space of 5km/pts accuracy 2.60mm/km.
- Both 2 Classes were adjusted in one network, with 36 closed loops.
- Class III, 4640 points, space of 5km/pts developed from Classes I, II.
- Network measurement: Leveling method.
- All points were marked with permanent monument.
- Elevation origin - the mean sea level at Hon Dau Tidal Station, was re-determined with 43-years tidal monitoring data (1950-1992).
- National vertical network brought to use from 2008.

VERTICAL REFERENCE FRAME



- **National vertical network:**
- Class I: 5667km, 1211 points, along national roads.
- Class II: 5334km, 1123 points, along national roads.
- Both 2 Classes I, II were adjusted in one network, with 36 closed loops.

VERTICAL REFERENCE FRAME



National vertical network, Class III:

- Routes go mainly along local roads.
- Started and closed at points of Classes I or II, covered all land area of country
- 4640 points.
- The most popular use.

VERTICAL REFERENCE FRAME

Limitation of Vertical Frame:

- Using 1 Elevation origin point.
- Leveling in long distance (2000km) from elevation Origin point.
- Network travel crossing some wide weak-surfece area.
- Tide level change from North (21.5 Lat. deg.) to South (8.5 Lat. deg.).
- Monument afected by human activities and due to land subsidence.

VERTICAL REFERENCE FRAME

Limitation of Vertical Frame

Using only 1 Elevation origin point:

- Vietnamese sea shore is >3200km, running mainly from North to South.
- Mean sea elevation change: From 0.00m (at Elevation origin point - north-part) to +0.30m at the most south-part. It makes some inconvenient for use.
- DOSM has planned National Vertical Modernnization project.
- And planned to setup some elevation origin points for each different area.

VERTICAL REFERENCE FRAME

Limitation of Vertical Frame

Subsidence of Monuments:

- At river deltas, special at Mekong-river delta -Southern Part, land suface are weak, and being in subsidence. It is more seriously in case of World-wide sea level rise.
- Recently, with monitoring leveling data on monuments for 3 years at Mekong-river delta area, showing some large areas are being in subsidence, special at >10cm.
- At Ho Chi Minh City, found large area is being subsidance. It make flood when high-tide periods come and hevy rain.

VERTICAL REFERENCE FRAME

Limitation of Vertical Frame

National Vertical Modernnization project:

- Keep current I, II classes monuments, Build more permanent, stable and long-term monuments (drill to stable geological layer) along coastal and in big cities, about 50km space, to ensure long-term service.
- Remeasure national height network connecting to long-term monuments, CORS, national high-grade gravity points, tidal stations.
- Setup, measure the monitoring network in Hai Phong, Hanoi, Da Nang and Tp. Ho Chi Minh, Can Tho and the Mekong Delta area.

VERTICAL REFERENCE FRAME

Limitation of Vertical Frame

National Vertical Modernnization project:

- Survey (high accuracy GPS) on elevation monuments, long-term monuments, high-grade gravity points and tidal stations.
- Correct the Local Geoid Model based on the new gravity data, high-terrain model, GPS-Elevation measurements and global geoid model EGM2008 to ensure application of GNSS technology on elevation survey with accuracy 3÷5cm at plain areas and 5÷7cm at highland areas.
- Re calculate the mean sea level at National elevation original point based on new tidal data.
- Adjust the new national vertical network and announce the new National vertical System.

3. NATIONAL GRAVITY NETWORK

National gravity system:

- National gravity network was built at North Part from 1971 with Original Point in Hanoi, Class I (25 points), Class II (148 points), Class III (about 500 points). Now it has been rebuilt
- Year 2012, Vietnam has completed the project "Building and completing the National Gravity System", across country:

➢ Setup basic gravity network 12 points (used FG-5X absolute equipment, accuracy ± 0.1 µGal).

➢ Setup Grade I network with 29 gravity points and 120 sub-gravity points.

➢ Setup Grade III network of 548 gravity points.

➢ Detail gravity: 10,614point.

NATIONAL GRAVITY NETWORK

Completion of gravity point system:

- In next years, detail gravity survey will be performed fully country, using Turnkey Airborne Gravity System (TAGS).
- Complete system of Natioal Gravity Database for all classes, covering land, mountain areas, sea areas.
- Support for correction of Local Geoid Model, to get high accuracy in application of GNSS tecnology .

THANK YOU FOR ATTENTION!