Conferência de GESTÃO DE DADOS PETROLÍFEROS 2021.

ANPG
AGÊNCIA NACIONAL DE PETRÓLEO, GÁS E BIOCOMBUSTÍVEIS

eni

Sessão: Coordenadas geográficas, transformação de coordenadas e sistemas de georreferenciação

Title: How to define a topographic benchmark in the new geodetic system RSA013

A possible application to the Cabinda Centro 2D Seismic Survey

Luanda, May 2021

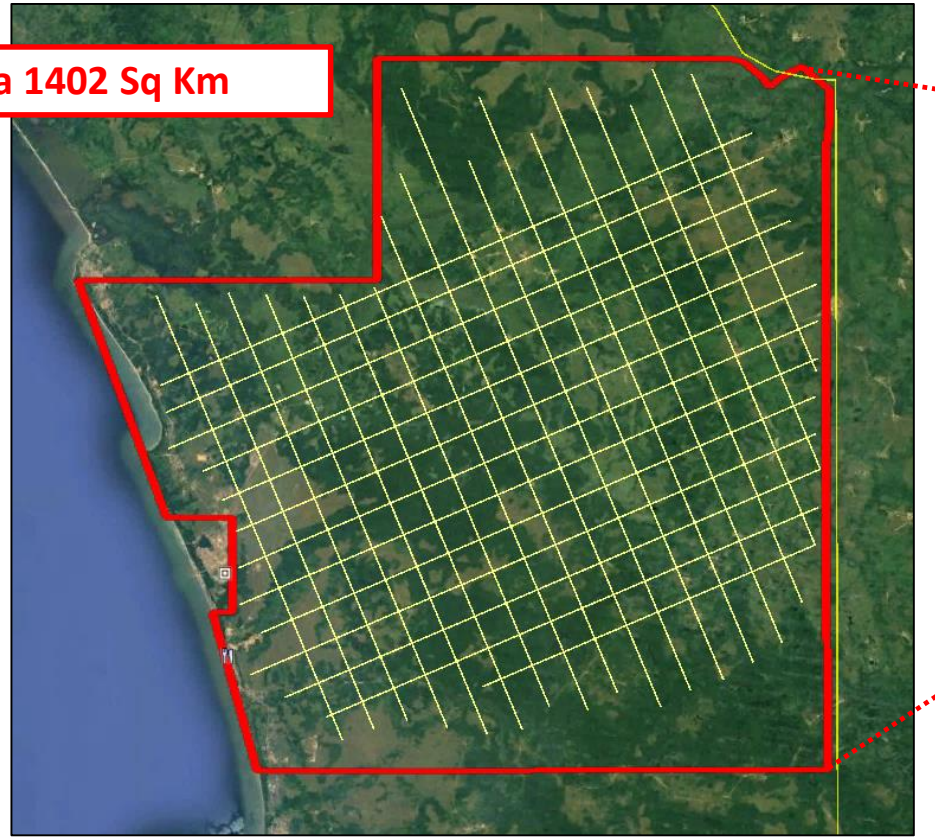
AGENDA

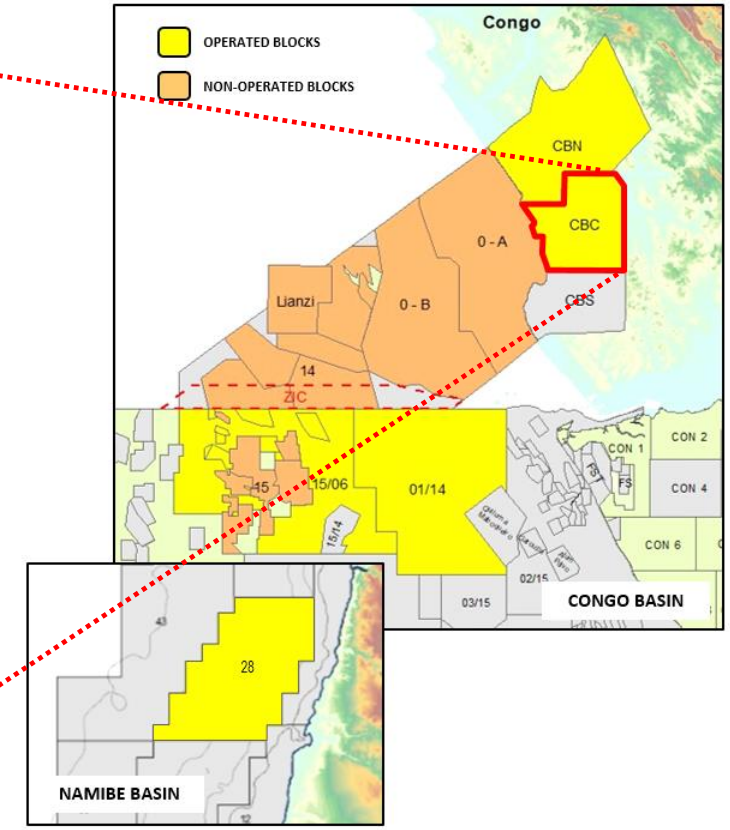
- Introduction
- Cabinda Centro: 2D Seismic Program Overview
- Control Survey in RSA013 (how to generate it)
- Control Grids – The Cabinda Centro example
- The recent IOGP guideline for CRS transformation
- Eni's CRS Management System
- Final Considerations

Introduction: The 2D Seismic Project in Cabinda Centro

Cabinda Centro – Eni Angola (Operator, 42.5%), ExxonMobil (32.5%), Sonangol P&P S.A (25%)

Cabinda Block Area 1402 Sq Km

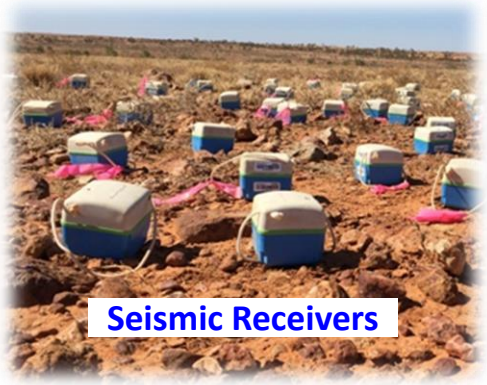




The 2D Seismic Program

- ✓ About 1000 km of 2D Seismic Lines
- ✓ More than 30 2D seismic lines regularly spaced
- ✓ Over than 20.000 Total Shot Points
- ✓ Explosive source type

Introduction: The Importance of a Topographic Survey



- **Logistic Constraints**
  - A significant portion of the seismic lines are located in woodlands/trees, hills, mountains and swamps near the river, with topography 0-250m.
- **Obstructions**
  - Through SAR imagines we were able to estimate of amount of flooded areas, villages, farms, existing O&G installations

The **Topographic survey** plays a **crucial role** for a **precise seismic survey**

Topographic Survey: Control Point or Geodetic Benchmark

- To create topographic map, the data and information obtained by the surveyor must be **horizontally and vertically accurate**.
- A single point of reference, called a **benchmark** or **Control Point** is used as a basis for the horizontal or vertical data collection.
- A geodetic benchmark or control point (survey point) is established for the purpose of providing geodetic reference for mapping and charting activities. It can be a random point determined by the surveyor or it could be something permanent in nature such as the corner of a concrete pad.
- ***Establish geodetic benchmarks (or control points) is the first step to perform a topographic survey.***

Example of topographic benchmarks

How to find topographic benchmarks…the Control Survey

- Benchmarks (or Control Points, Reference Monument) are typically placed by a government agency or private survey firm
- Governments maintain a register of these marks so that the records are available to all (e.g. database including maps, diagrams, photos of the marks, and any other technical details)
- Old benchmarks in local datum geodesy are not suitable for new topographic projects since it is difficult to recover all necessary information for the conversions

What happen if no benchmarks are available in a Project Area?

New benchmarks (or Control Points) can be created performing a ***Geodetic Control Survey***

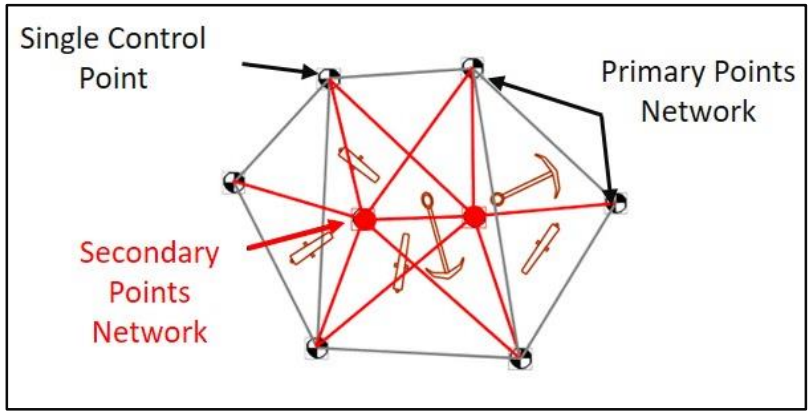
- **The Control Surveys** aims to set new benchmark positions, to generate a geodetic network or Project Control over a determined area.

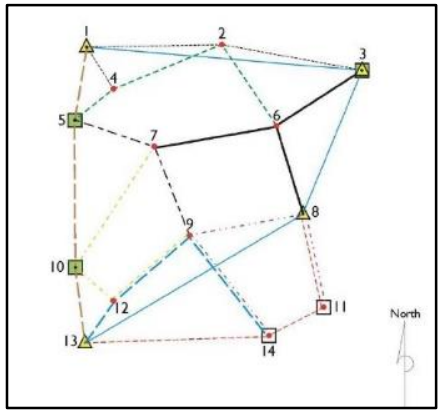
Generate a Control Point Grid in RSA013

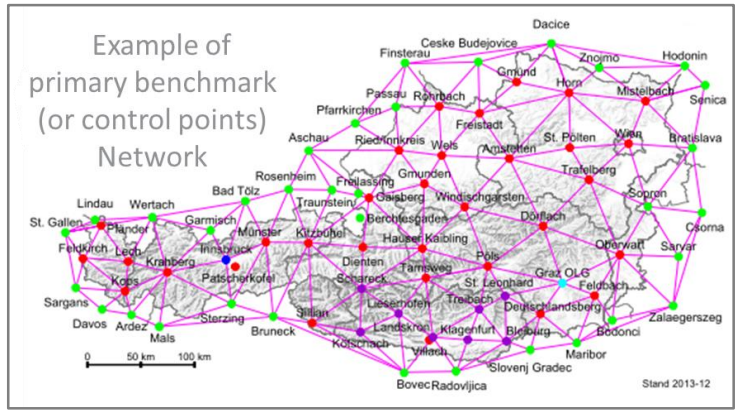
- The *"**Instrutivo n.º 1/21 de 17 de Março**"* requests that RSA013 (Reference System para Angola 2013) geodetic system shall be applied for all the seismic data acquired in exploration concessions assigned after 2015

Concerning the **Cabinda Centro seismic project**, a **Control Survey** will be performed following the IOGP Procedure and to set the new Primary Benchmarks in the **new RSA013 geodesy**

Geodetic Control Point → **Geodetic Control Network (Primary)** → **Secondary Network**







Set a Control Point in practice

1

24 hrs of the recording taking a measurement every 30 s

2

RINEX file (Raw data)

3

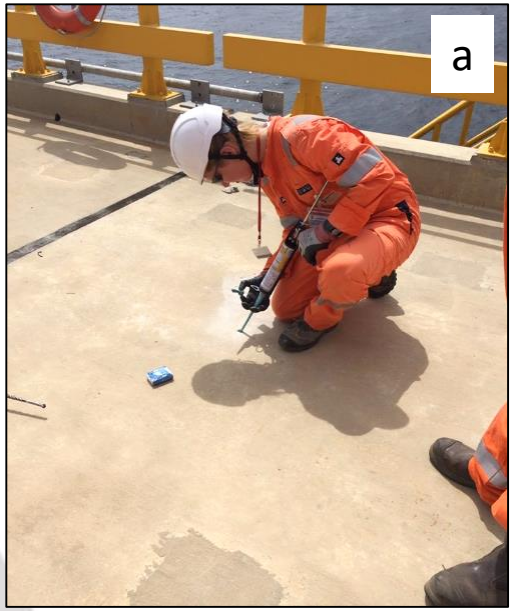
Sent to a dedicate Survey Center (e.g. AUSPOS, NRCan, ect.)

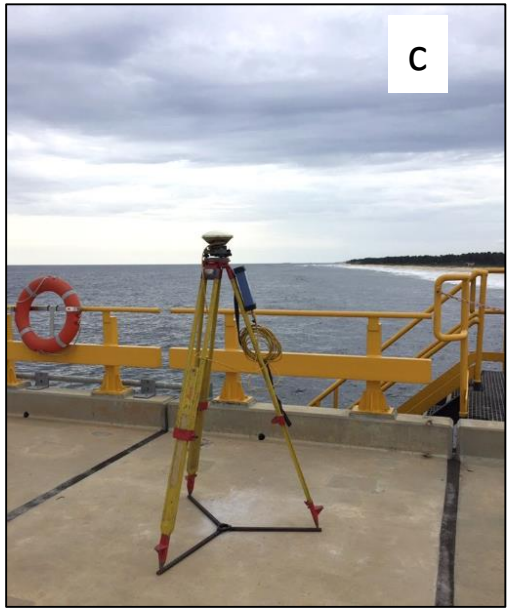
4

Final Point Coordinates in WGS84 corrected by the geodynamic transformation

5

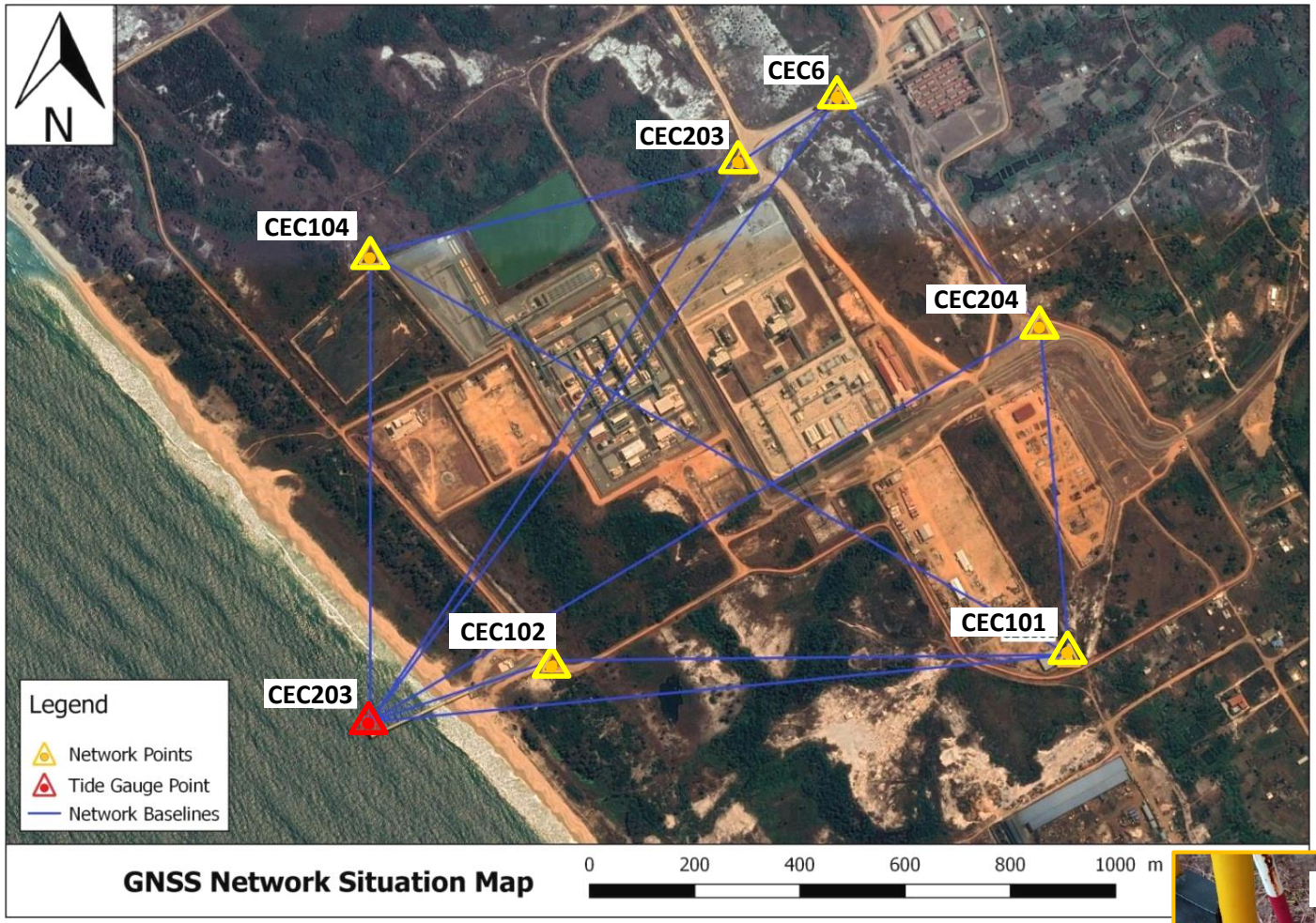
Apply the correction to the second Control Point

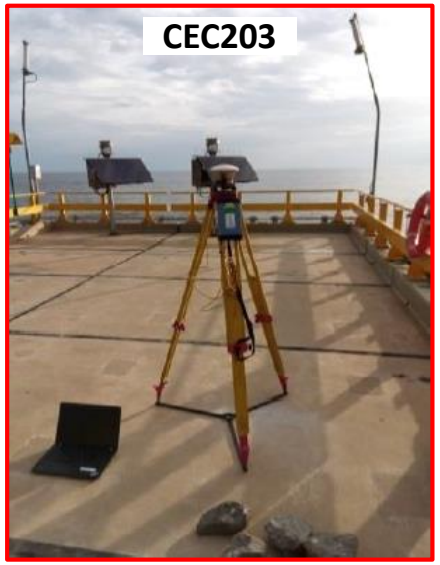




Example of Control Network Design

- ✓ Control Survey performed for a *Tide Gauge* installation
- ✓ 7 geodetic markers were set to create a geometrically strong network
- ✓ Max dist. between the CP is 1 km





Example: Control Points Grid Design for Cabinda Seismic Project

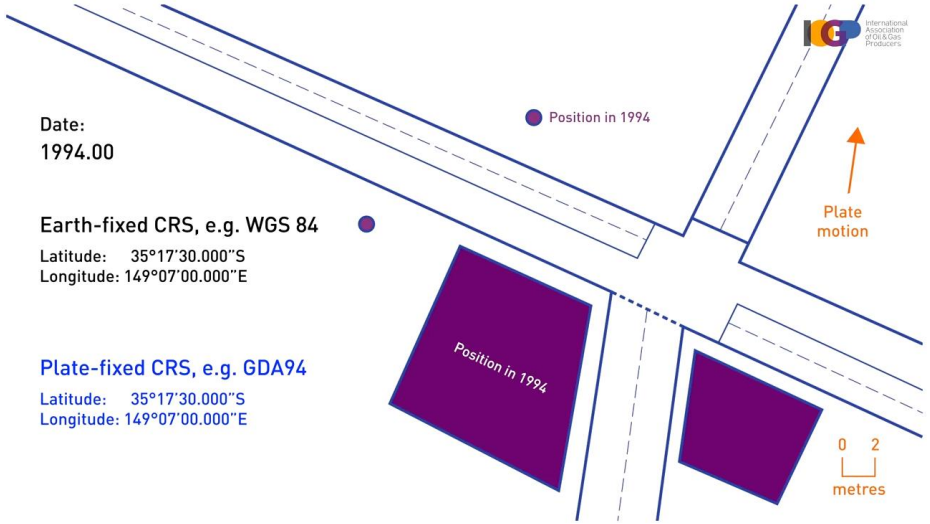
- ✓ Control Grid Design for the 2D Seismic Acquisition
- ✓ Max dist. between adjacent control points (or permanent markers) shall not exceed 10 km
- ✓ All source/receiver positions will be referred to permanent markers
- ✓ Either kinematic or real-time kinematic (i.e., RTK) observations will be used for source/receiver locations
- ✓ The control networks should be collected using either static or fast static observations

Difference between dynamic and static CRS

- **A static CRS** is a CRS in which tectonic **deformation is ignored** and the **coordinates of a physical point feature do not change over time**. A static CRS is usually anchored to a particular tectonic plate and its validity is constrained to an area on that plate.

- **A dynamic CRS** is a CRS in which the **coordinates** on or near the surface of the Earth **change with time**. Examples of global dynamic CRSs are ITRF2008 and ITRF2014, or any CRS used by a satellite navigation system, such as WGS 84.

- A static reference frame or static datum has no time-dependent parameters in its definition. A dynamic reference frame includes in its definition time-dependent parameters.



Coordinate transformation methods for dynamic CRSs

DYNAMIC (WGS 84) CRS TO STATIC (RSO13) CRS

For the transformation of coordinates from a dynamic CRS to a static CRS or vice versa it is mandatory to account for the **motion of the tectonic plate** to which the static CRS is anchored. Two types of coordinate transformation methods may be followed:

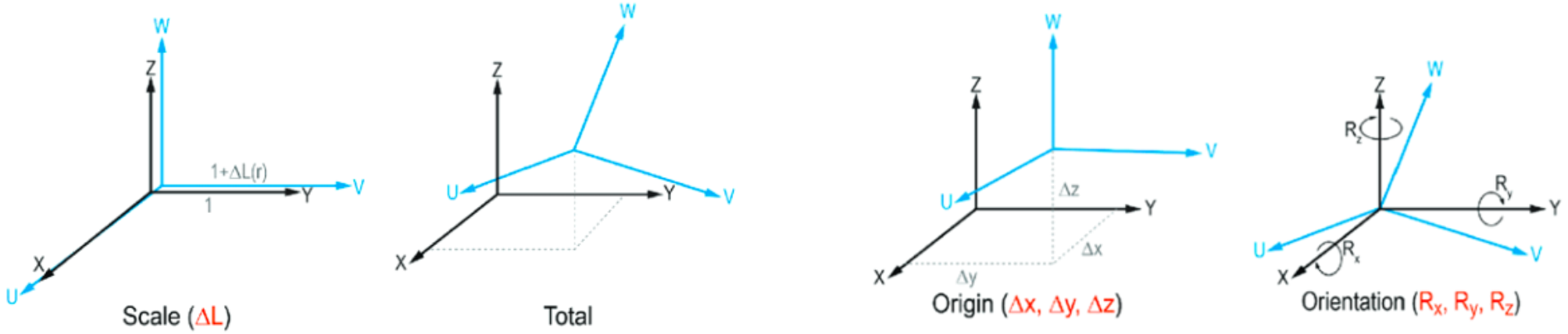
2 – A Time-specific Helmert Transformation

It may be applied as a regular 7-parameters Helmert transformation, but it is only valid for the specified transformation reference epoch. It is therefore necessary to change coordinates to this epoch before applying the transformation. Velocity models or deformation grids may be needed for this.

1 – A Time-dependent Helmert Transformation (introduction of epochs)

It is a transformation method within a three-dimensional space. It is frequently used in geodesy to produce distortion-free transformations from one datum to another. This transformation is a **15-parameters transformation** since it includes seven rates of change and the parameter reference epoch.

tXi' = tXi + tXi_rate X (coordinate epoch **– parameter reference epoch;** i = 1,…,7)



Geospatial Data Management

It is the process for obtaining, organizing, storing, sharing, and visualizing geospatial data

The variety of formats and data structures, as well as the disparate quality, of geospatial data can result in a dizzying accumulation of useful and useless pieces of spatially explicit information that must be poked, prodded, and wrangled into a single, unified dataset.

Geographic Data Acquisition

- Analog Maps
- Aerial Photos
- Satelites images
- Ground survey with GPS
- Reports

Data Quality

- Temporal, positional and attribute accuracy.
- Completeness

File Formats

- Vector Files (Shapes Files)
- Raster Files (Jpeg, Tiff,..)
- Hybrid File Frma or Geodatabase Files (ArcSDE geodatabase, geospatial PDF)

Geospatial Database Management

- Flat
- Hierarchical
- Network,
- Relational system

Eni's CRS Management System

Problem

Currently, numerous systems need to perform coordinate conversions, but each of them uses both proprietary algorithms and third-party libraries. Therefore, different configurations lead to inhomogeneous conversions among those systems.

Solution

To standardize the coordinate conversion between different systems, Eni is developing a centralized service that carries out the conversion between both the standard EPSG dataset and internally defined CRSs.

Centralized CRS Management System

- ✓ *Single repository of information related to CRS and transformations*
- ✓ *Centralized Coordinate Conversion Service (A Web Service using GDAL and PROJ libraries)*
- ✓ *List of available transformations, given a CRS input and a CRS output*
- ✓ *CRS list (It provides all available CRSs, constantly updated)*

Final Considerations

Eni is fully committed *to apply the "**Instrutivo n.º 1/21 de 17 de Março**" and RSA013 (Reference System para Angola 2013) geodetic system, implementing the most appropriate Control Survey in Cabinda Centro Block to grant a precise seismic survey location. As general recommendations:*

- *Use the national CRS when there is no need or requirement for using a global dynamic CRS such as ITRFyyyy or WGS 84.*
- *When using GNSS survey techniques, ascertain the CRS to which coordinates produced by the positioning service are referenced and whether the CRS is dynamic or static.*
- *When using coordinates referenced to a dynamic CRS, the coordinate epoch ('time stamp' of the coordinates) must be recorded and kept with the coordinates. The approximate middle of the observation period of the survey is adequate.*
- *Maintain an audit trail, documenting details of all coordinate operations that have been applied to the data and that led to the final coordinates as reported.*