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Hybrid Networks for Geodetic Data Collection toward Deformation Monitoring

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Introduction

Traditional Passive Geodetic Network

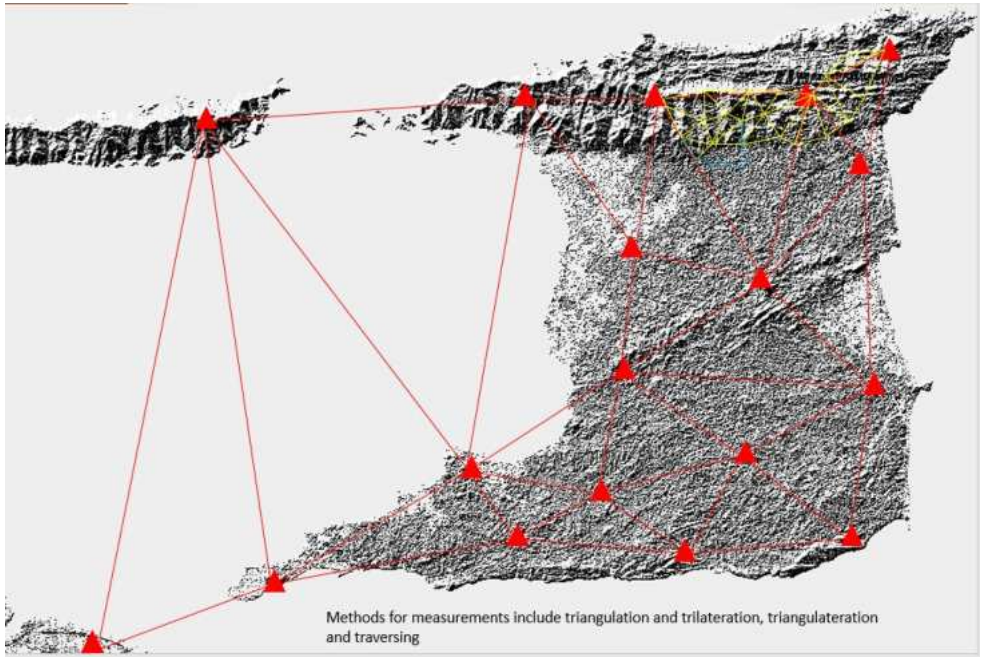

Figure 1 *Trinidad Primary Control Network (Surveys & Mapping Division)*

- Active Geodetic Network - TTAGN

Figure 2 *TTAGN (Surveys & Mapping Division)*

Introduction

Traditional Passive Geodetic Network

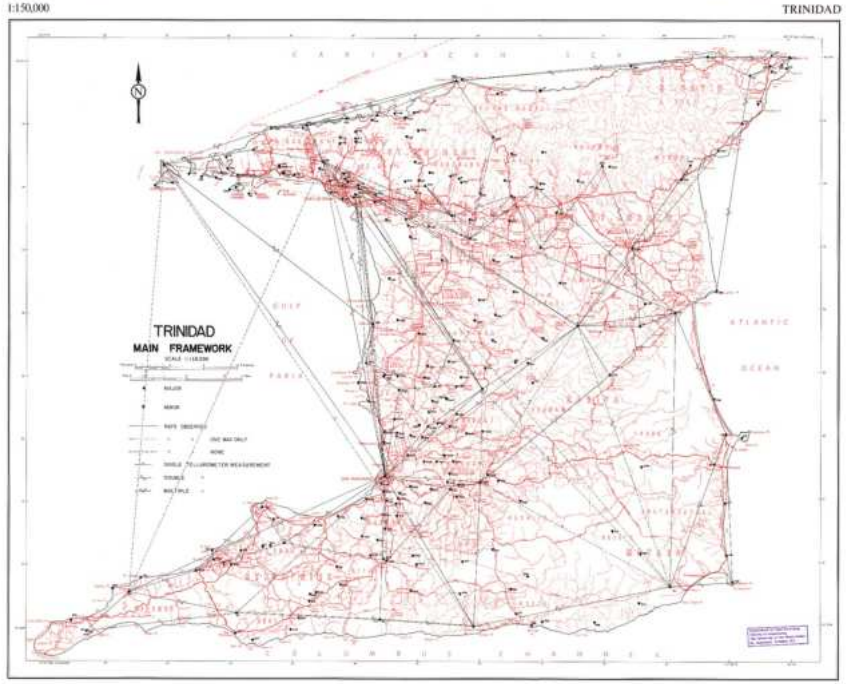

Figure 3 *Trinidad Passive Control Network (Surveys & Mapping Division)*

- Traditional Triangulation measurement
- Episodic observations – 1904, 1930s, 1960s, 1980s/90s
- Static coordinates in a dynamic environment
- Challenges of accuracy for deformation analysis

Introduction

TT Active Geodetic Network

- 8 stations – 7 in Trinidad & 1 in Tobago
- 5 TTAGN points
- 3 COCONet points
- Dynamic coordinates
- Challenges of resolution for deformation analysis

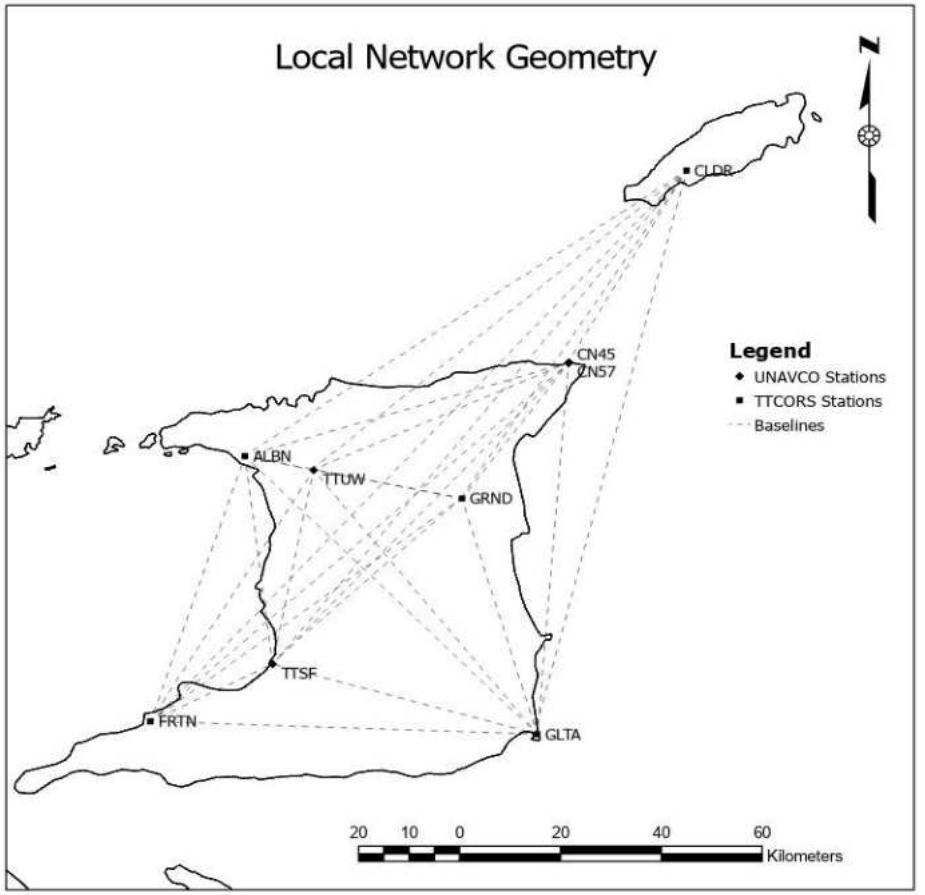

Figure 4 *Trinidad combined CORS Network*

Deformation context

If the area surveyed is actively deforming the quality of the passive control declines with time.

Monitoring surface deformation is integral to sustainable development

Modelling deformation caused by geodynamics requires a significant archive of data

Deformation context

Trinidad & Tobago located in an active fault zone

At least 3 known fault lines

Unknown geodynamics between Trinidad and Tobago

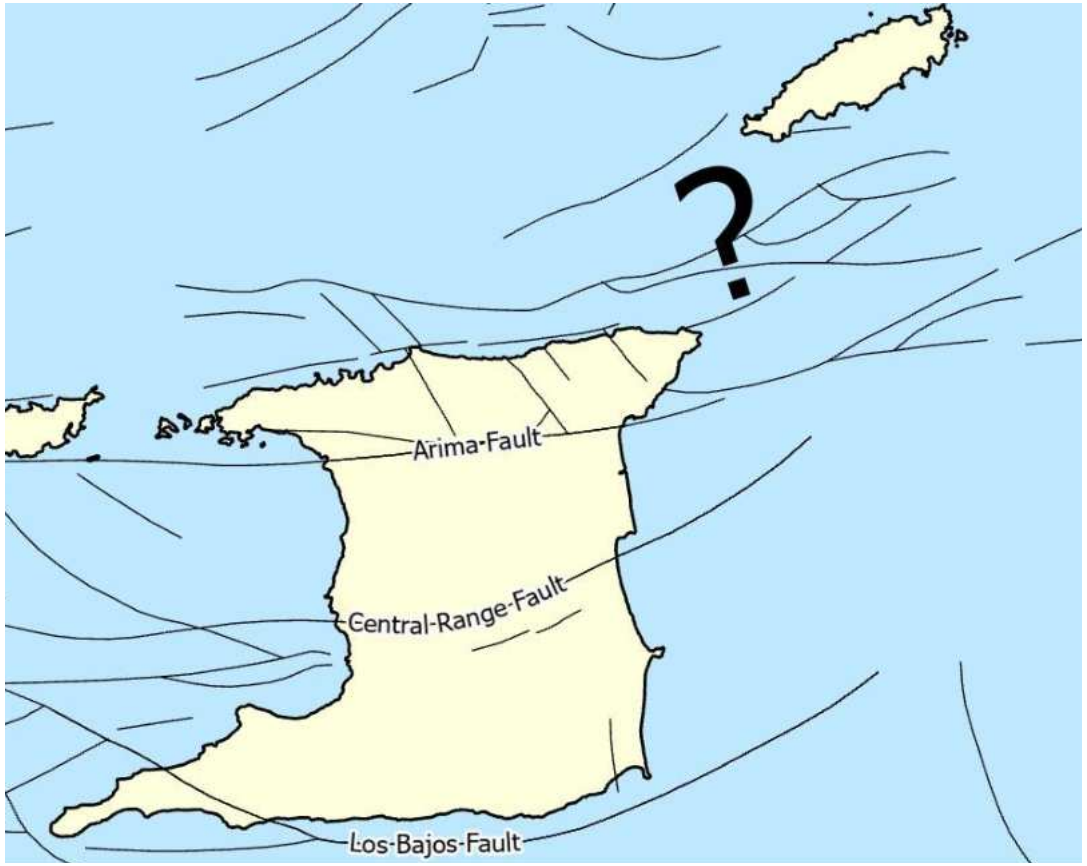

Figure 5 *Known Major Faults of Trinidad (U.S. Geological Survey, Central Energy Resources Team 2000)*

Background

For emerging nations, it is not uncommon for CORS to be unreliable

For temporal and spatial densification of GPS data nationally, static observations on passive points can be used.

In the absence of portable GNSS receivers, traditional triangulation field methods may be used.

However, keeping up with regular episodic campaigns for data collection can be a significant challenge

Geodetic Data Processing

Geodetic data is pre-processed, then post-processed, and then analyzed

Post-processing platforms exist in three main forms: online platforms, proprietary software from manufacturers and research-grade software

Regardless of the post-processing method to be used, the geometry of the processing network, and the lengths of the observation periods can significantly impact the positions obtained

Attainable Accuracies – Observation times

Table 1(a) *Active vs Passive Point Uncertainties*

Station	Type of control	σN (mm)	σE (mm)	σU (mm)	Length of Obs (hours)
CN57	Active	1.350	1.940	6.310	24
TTSF		1.560	2.140	6.970	
TTUW		1.320	1.880	5.960	
CATH	Passive	9.690	12.320	69.250	4
GASP		5.670	6.960	26.300	
FPRT		6.210	7.800	27.290	
MNLA		7.300	8.120	35.190	
LIRO		5.350	6.490	23.040	

Table 1(b) *Active Point Uncertainties 1 day vs 10 days*

Station	24 hours			10 days		
	σN (mm)	**σE (mm)**	**σU (mm)**	**σN (mm)**	**σE (mm)**	**σU (mm)**
CN57	1.350	1.940	6.310	0.880	1.120	4.080
TTSF	1.560	2.140	6.970	0.910	1.180	4.120
TTUW	1.320	1.880	5.960	0.840	1.090	3.830

Velocity Modelling

Table 2 *Velocities for Active vs Passive Stations*

Station	Type of control	σN (mm)	σE (mm)	σU (mm)	Span of Obs (yrs)	# of Epochs
TTSF	Active	0.100	0.110	0.430	16	11
TTUW		0.120	0.130	0.480		
CATH	Passive	2.790	3.400	0	6	4
GASP		1.110	1.340	19.370		
FPRT		1.140	1.400	23.300		
MNLA		1.350	1.480	33.630		
LIRO		1.200	1.420	24.500		

Integration Considerations

Despite the possibility of introducing more errors into the model, combining observational data from different collection methods provides values that would otherwise be unavailable.

The integration of static episodic GNSS data into a deformation monitoring network with CORS and traditionally collected requires a level of standardization

Procedures for data collection, the type(s) of data to be collected, storage method to be used, and procedures for the collection and storage of metadata all need to be standardized.

Conclusions

Where traditional surveying methods are still preferred over GNSS surveying, it may not always be easy to obtain positions that are suitable for use in geodetic work

When combining GNSS data, it is possible to utilize data from multiple separate observation sessions to derive geodetic quality positions at a given epoch

With longer episodic GNSS observation sessions and more regular campaigns, sub-millimeter accuracies are attainable

The retention of raw data contributes to the sustainability of the infrastructure

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