Geodetic heights determination of inaccessible points to GNSS signals using eccentric stations at the Historic Site of Olinda, Brazil

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IGS 2026 WORKSHOP
SANTIAGO DE CHILE
33°26' S 70°39' O

INTRODUCTION

- ✓ *Olinda has a local high-precision geodetic network*
- ✓ *21 leveling benchmarks were surveyed*
- ✓ *7 benchmarks had GNSS obstruction*
- ✓ *Eccentric stations were adopted*

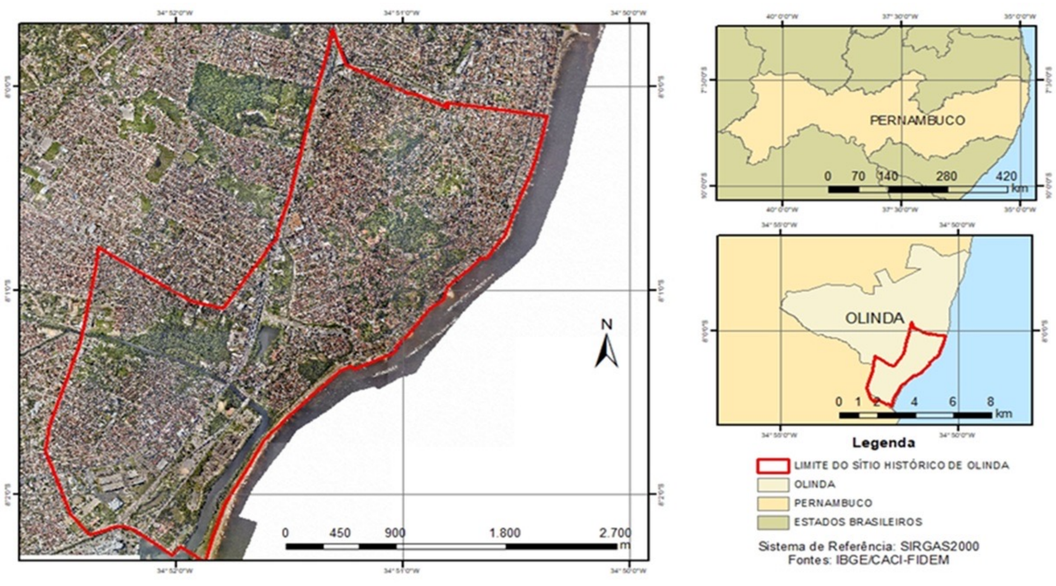


Fig. 1 - Location of the Historical Site of Olinda

WHY DOES THIS WORK MATTER?

- Helps preserve historic cities like Olinda with accurate height information.
- Improves mapping for floods, landslides, drainage, and climate-risk studies.
- Supports safer infrastructure, LiDAR surveys, and urban planning.
- Allows geodetic measurements even where GNSS signals are blocked by buildings.
- Makes future monitoring of environmental and geohazard changes more reliable.

In simple terms: this work helps engineers and scientists measure the Earth more accurately in difficult places.

OBJECTIVES

- ✓ *Develop local geoid support*
- ✓ *Establish 3D GNSS control*
- ✓ *Support LiDAR/UAV calibration*

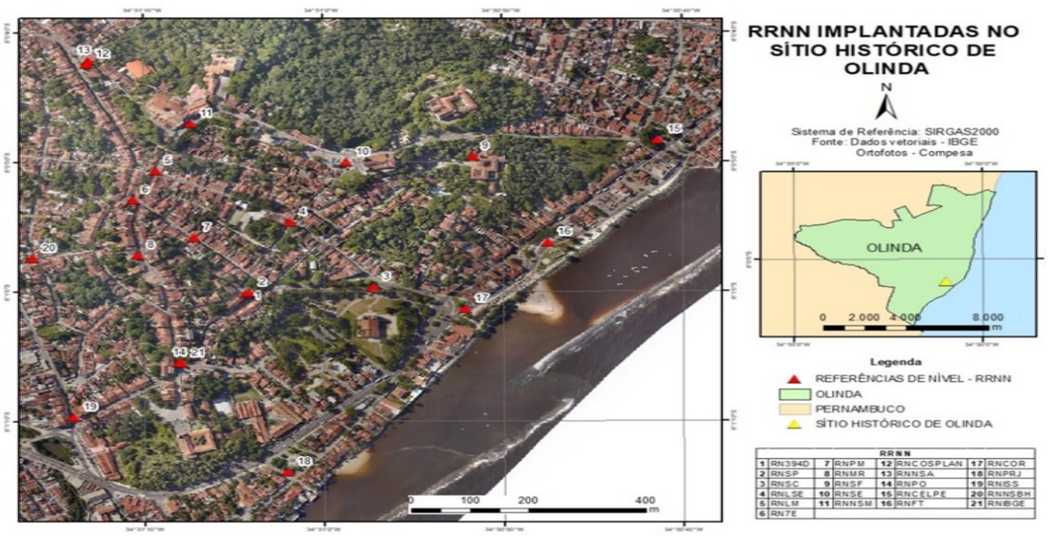


Fig. 2 – Benchmarks at the Historic Site of Olinda

METHODS

- ✓ *Existing geodetic infrastructure was identified and inspected*
- ✓ *The local altimetric network was readjusted*
- ✓ *GNSS observations and geometric leveling were performed*
- ✓ *Ellipsoidal heights were determined for obstructed benchmarks*
- ✓ *Nearby eccentric benchmarks were adopted*

Fig. 3 – Benchmarks deployed in places with GNSS signal obstruction

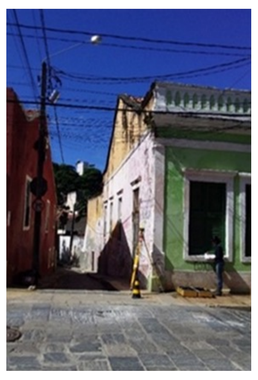
3a) RN394D

3b) RNCOSPLAN

3c) RNCELPE

3d) RNIBGE

Fig. 4 – Eccentric Level References

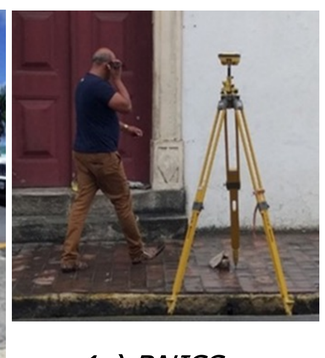


4a) RNPM

4b) RNLM

4c) RNPO

4d) RNFT



4e) RNISS

RESULTS

Final Geodetic Coordinates

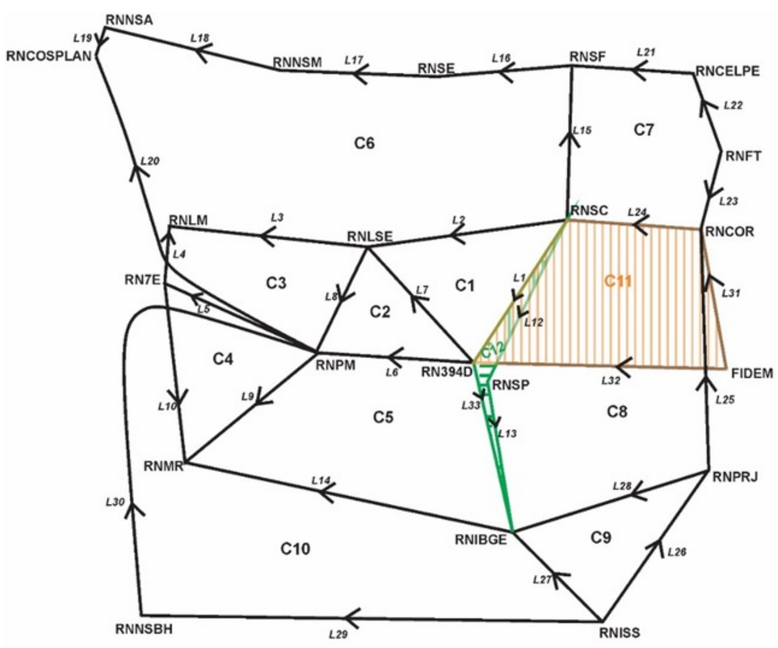
Ponto	Latitude	Longitude	Este(m)	Norte(m)	Alt. Elipsoidal(m)	Desv n(m)	Desv e(m)	Desv Hz(m)	Desv u(m)
RNISS	- 8° 01' 09,50239"	- 34° 51' 13,73442"	295686,21	9113106,58	-3,109	0,003	0,003	0,005	0,008
FIDEM	- 8° 01' 06,67594"	- 34° 50' 55,89296"	296232,21	9113195,89	-0,627	0,003	0,003	0,004	0,008
RNCOR	- 8° 01' 01,33251"	- 34° 50' 51,86640"	296354,79	9113360,62	-0,452	0,003	0,003	0,004	0,008
RNSF	- 8° 00' 49,55512"	- 34° 50' 51,37693"	296368,15	9113722,53	25,953	0,005	0,009	0,01	0,016
RNNSM	- 8° 00' 46,98011"	- 34° 51' 07,07553"	295887,02	9113799,48	49,511	0,004	0,004	0,005	0,01
RNMR	- 8° 00' 57,15616"	- 34° 51' 10,04172"	295797,59	9113486,42	26,371	0,003	0,003	0,004	0,008
RNPO	-8°01'05,35835"	-34°51'07,82627"	295866,57	9113234,72	18,002	0,003	0,003	0,004	0,007
RNFT	-8°00'56,18521"	-34°50'47,23787"	296495,82	9113519,4	-0,813	0,003	0,003	0,004	0,007
RNPM	8°00'55,75761"S	34°51'06,90982"W	295893,31	9113529,82	13,486	0,003	0,004	0,005	0,007
RNLSE	- 8° 00' 54,58662"	- 34° 51' 01,60387"	296055,64	9113566,54	13,019	0,007	0,01	0,012	0,012
RNLM	8°00'50,61707"S	34°51'09,06456"W	295826,61	9113687,47	22,034	0,003	0,003	0,004	0,006
RNSC	8°00'59,66718"S	34°50'56,91104"W	296200,06	9113411,09	3,156	0,003	0,004	0,005	0,007
RNNSA	8°00'42,09722"S	34°51'12,84118"W	295709,77	9113948,71	24,811	0,021	0,024	0,032	0,038
RNNSBH	8°00'57,34776"S	34°51'15,94453"W	295616,84	9113479,72	0,249	0,005	0,005	0,007	0,012
RNSE	8°00'50,00835"S	34°50'58,44842"W	296151,64	9113707,63	45,725	0,003	0,003	0,004	0,006

Local Geodetic Height Network Readjustment

Referência de Nível	Altitude Ortométrica ajustada	σ (mm)	Referência de Nível	Altitude Ortométrica ajustada	σ (mm)
RNSC	8,73437	±0,41	RNNSM	55,07986	±0,92
RNLSE	18,55143	±0,41	RNNSA	30,21634	±0,88
RNLM	27,58545	±0,55	RNCOSPLAN	30,76818	±0,87
RN7E	19,92425	±0,51	RNCELPE	5,35309	±0,83
RNPM	19,07264	±0,42	RNFT	4,78510	±0,71
RNMR	31,92194	±0,49	RNCOR	5,11921	±0,51
RNSP	12,73471	±0,56	RNPRJ	3,85920	±0,66
RNIBGE	23,50718	±0,45	RNISS	2,47763	±0,69
RNSF	31,52717	±0,72	RNNSBH	5,79411	±1,09
RNSE	51,26620	±0,87	FIDEM	4,94128	±0,58

Referência de Nível	Altitude Elipsoidal– h (m)	Excêntrica
RN394D	10,33462	*RNPM*
RN7E	14,37296	*RNLM*
RNCOSPLAN	25,362835	*RNNSA*
RNIBGE	17,9487375	*RNPO*
RNCELPE	-0,245042	*RNFT*
RNPRJ	-1,72786	*RNISS*
RNSP	7,1761	*RNPO*

Fig. 5 – Network Adjustment Precision: ±0.001283 m



CONCLUSIONS

We developed a practical methodology to recover geodetic heights of benchmarks with GNSS obstruction using nearby eccentric stations, preserving millimetric consistency in a historical urban environment.

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