The Land Cadastre, between historicity and modernity. An operative evaluation done with GNSS techniques in the provinces of Roma, Latina, Frosinone and Rieti, Italy.

Adriano ANGELINI, Italy
Ciro SUGAMELI, Italy
Collegio dei Geometri e dei Geometri Laureati della provincia di Roma
Commissione Topografia

Key Words: GPS, GNSS, Collegio Geometri Roma, Catasto

Summary: The idea for the project "Return to Origins" was conceived in the frame of the activities for training and promotion of geo-mapping matters, as an exercise for the continuous search for solutions, and for the understanding of the history of topography. The measuring process, developed according to the rules of the satellite technology GNSS, is closely connected to some of the most important national historical trigonometrical points, such as the master vertex of Italian cartography, the geodetic benchmark 'Rome Monte Mario' and the trigonometric vertex placed on Mount Soratte. In one day of measurements, 12 IGM95 vertexes have been detected, where 9 belong to the network defined by geodesy Rome 1940 and two are cadastral origin of great extent. The project concludes with a survey of trigonometric (cadastral) points for tests and inspections. During the calculation of the measurements, the survey was framed in the reference system RDN (Rete Dinamica Nazionale).

Riassunto: Nell'ambito delle attività orientate alla formazione continua e allo sviluppo della materia geo-topo-cartografica, come esercizio continuo di ricerca di soluzioni, ma anche di comprensione della storia della topografia, nasce l'idea del progetto "Ritorno alle Origini". Il progetto di misura, sviluppato secondo i canoni delle tecnologie satellitari GNSS, interessa alcuni dei vertici trigonometrici storici nazionali più importanti, quali il punto nodale della cartografia italiana, il vertice geodetico di Roma Monte Mario, assieme al vertice trigonometrico posto sul Monte Soratte. In una giornata di sessioni di misura sono stati rilevati n. 12 vertici trigonometrici IGM95 di cui n. 9 appartengono alla rete trigonometrica nazionale definita con geodesia Roma 1940 e due medesimi sono origine catastale di grande estensione. Conclude il lavoro una ricognizione su vertici trigonometrici catastali di dettaglio per l'esecuzione di test e verifiche. Nella fase di elaborazione delle misure si è poi inquadrato il rilievo svolto nel sistema di riferimento RDN, Rete Dinamica Nazionale.

THE LAND CADASTRE, BETWEEN HISTORICITY AND MODERNITY. AN OPERATIVE EVALUATION DONE WITH GNSS TECHNIQUES IN THE PROVINCES OF ROMA, LATINA, FROSINONE AND RIETI, ITALY.

Adriano ANGELINI, Italy
Ciro SUGAMELI, Italy
Collegio dei Geometri e dei Geometri Laureati della provincia di Roma
Commissione Topografia

1. INTRODUCTION

The Topography Commission of the Provincial Board of Surveyors and Graduate Surveyors of Rome has many projects at his active; one in particular, in collaboration with the colleagues of other Latium provinces, consists in the digitalization of the first set of original cadastral maps archived at the Agencies of the Territory of the provinces of Latium. The project was carried out in accordance with the Memorandum of Understanding between the Land Cadastral Agency of Latium Region (Agenzia del Territorio), the Regional Committee of Surveyors and Graduate Surveyors and Town Planning Department and the Territory of the Latium Region. The acquisition of the original maps in digital form allowed us the electronically consultation, and moreover, the preservation of the historical patrimony of the Land Cadastre. After the achievement of this objective, the Topography Commission of the Provincial College of Rome, assisted by colleagues of the provinces of Latina and Rieti, had the idea to perform a topographic survey with GNSS satellite positioning techniques of the first order vertexes of the Italian trigonometric network, established by the Italian Military Geographic Institute (IGMI) in the Latium region.
The vertexes surveyed, were in many cases part of in other geodetic networks such as the IGM95, moreover, two of them were also cadastral main benchmarks as origin of great extent in the Cassini–Soldner projection. The idea was then to perform a survey with the current state-of the-art satellite technology, supported by the data of permanent GNSS stations and the pre-existing well-known trigonometric benchmarks used by the technicians during their work in the Latium region. Twelve vertexes have been detected in the IGM95 network, nine of these belonging to the “Rome 1940” trigonometric network and two are fully relevant as origin or center of “great extension” for the Cadastre Cassini-Soldner cartographical projection.

Table 1 - List of reference benchmark and their characteristics

N.	Nome IGM95	Nome Roma 1940	Nome Origine catastale
1	149801	149068 Monte Mario	Monte mario
2	149801 A1	-	-
3	149901	149069 Fiumicino	-
4	144904	144065 Monte Soratte	-
5	144902	144046 Monte Gennaro	-
6	150902		-
7	150701		-
8	171903	171019 Monte Petrella	Monte Petrella
9	151902	151101 Monte Maino	-
10	151904	151110 Monte Scalambra Est	-
11	151901	151094 Monte Autore	-
12	138901	138213 Monte Petano	-

Table 2 - List GNSS permanent stations used in the calculation

N.	Nome RDN	Nome Altre reti	Agency
1	MOSE	Rete RESNAP GPS	Univ. Studi 'La Sapienza' DITS
2	INGR	INGV (RING)	I.N.R.I.M.
3	LAT1	Leica Italpos	Collegio Geom Latina
4	UNPG	UNPG (Regione Umbria)	Univ. Studi Perugia
5	UNOV	UNOV (Regione Umbria)	Univ. Studi Perugia
6	RENO	RENO (Regione Umbria)	Univ. Studi Perugia
7	AQUI	AQUI (ASI)	ASI - Telespazio S.p.A.
8	ALRA	ALRA (Regione Abruzzo)	Regione Abruzzo
9	-	BLRA (Regione Abruzzo)	Regione Abruzzo
10	-	OCRA (Regione Abruzzo)	Regione Abruzzo
11	VAGA	VAGA (RING)	INGV
12	CARI	CARI (Regione Campania)	Regione Campania
13	-	TOFL (RING)	INGV

Table 3 - List of permanent GPS stations used in calculating proprietary

N.	Nome RDN	Nome Altre reti	Agency	Antenna Geodetica	Radome
1	-	ROMA (Leica Italpos)	geom ANGELINI	Leica AT504GG	LEIS
2	-	master Gagliardi (-)	geom SUGAMELI	Leica AT503	LEIS
3	-	master Tivoli (-)	geom URBANI	TRIMBLE ZEPHIR	NONE
4	-	master Portuense (-)	geom SANTICCIOLI	TRIMBLE ZEPHIR	Y

The measurement sessions on the trigonometric vertexes were performed on 8 November 2011, registering two GNSS sessions of approx. three hours . The set-up of the GPS receivers was designed to record observations every 5 seconds with the ° cut-off angle of 15 degrees.
For all benchmarks placed at ground, the survey has been made “in center” with tribrachs equipped with optical plummets on wooden tripods like GST20 Wild, and equipped with the height reader type Leica GZS4.
For all benchmarks placed on geodetic pillar (Monte Mario, Monte Gennaro, Fiumicino and Tusculum) the survey was always performed “in center”, but with the aid, under the topographic tribrach, of the classic pillar plate for forced centering WILD, now produced by the German company Goeche-Schwelm (model 14-GPF1). On the field, besides the usual

documents (sketches, form of survey details), the proper photographic documentation of instrument height measurements was carried out in order to confirm the readings. Thus, it is possible to reconstruct the various stages of the survey in the field and to control the numerical correspondences of the instrumental heights. There are no specific comments to be made about the access to the trigonometric benchmarks. As many sites have restricted access, all the necessary clearances were obtained in advance.

Table 4 - Table of the description of the access to top trigonometric

N.	Nome IGM95	Nome Roma 1940	ACCESSO	Tipo vincolo	difficoltà
1	149801	149068 Monte Mario	Ristretto	Zona Militare	-
2	149801 A1	-	Ristretto	Sito Osservatorio M.Mario	-
3	149901	149069 Fiumicino	Ristretto	Copertura serbatoio Fiumicino	accesso alla copertura disagevole
4	144904	144065 Monte Soratte	Ristretto	Sommità Torre Eremo	accesso alla copertura disagevole
5	144902	144046 Monte Gennaro	Ristretto	Interno a tenuta privata	30" cammino - percorso con dislivello
6	150902		Aperto al pubblico	-	-
7	150701		Ristretto	Sommità copertura distributore	accesso alla copertura disagevole
8	171903	171019 Monte Petrella	Aperto al pubblico	-	2 h cammino - percorso vario
9	151902	151101 Monte Maino	Aperto al pubblico	-	20 min cammino
10	151904	151110 Monte Scalambra Est	Aperto al pubblico	-	50 min cammino
11	151901	151094 Monte Autore	Aperto al pubblico	-	30 minuti di cammino - dislivello
12	138901	138213 Monte Petano	Aperto al pubblico	-	40 min cammino dislivello

Fig. 1,2 Benchmark " Monte Mario "(Nodal Point of the Italian datum Roma 1940)

Fig 3,4 Benchmark " Monte Gennaro already named Monte Zappi"

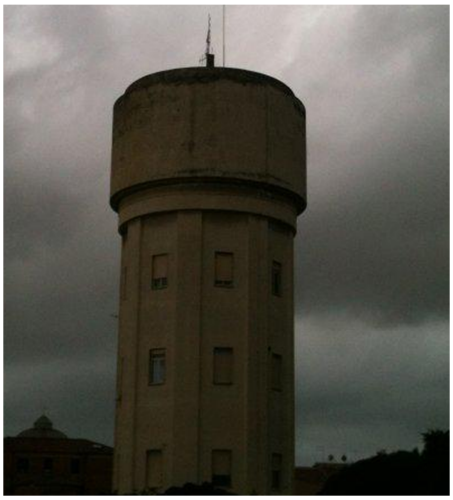


Fig. 5,6 Benchmark "Fiumicino"

Fig. 7
Benchmark “Monte Autore”

Fig.8
Detail of the old style IGMI benchmark plate

Fig. 9 Benchmark “Monte Petano”

Fig. 10 Benchmark “Monte Petrella”

As a conclusion of the introduction, Fig. 11 shows the layout of the geodetic network of the project as extended to the vertexes of the permanent GNSS stations available; most of them

belong to the RDN/ETRF2000.

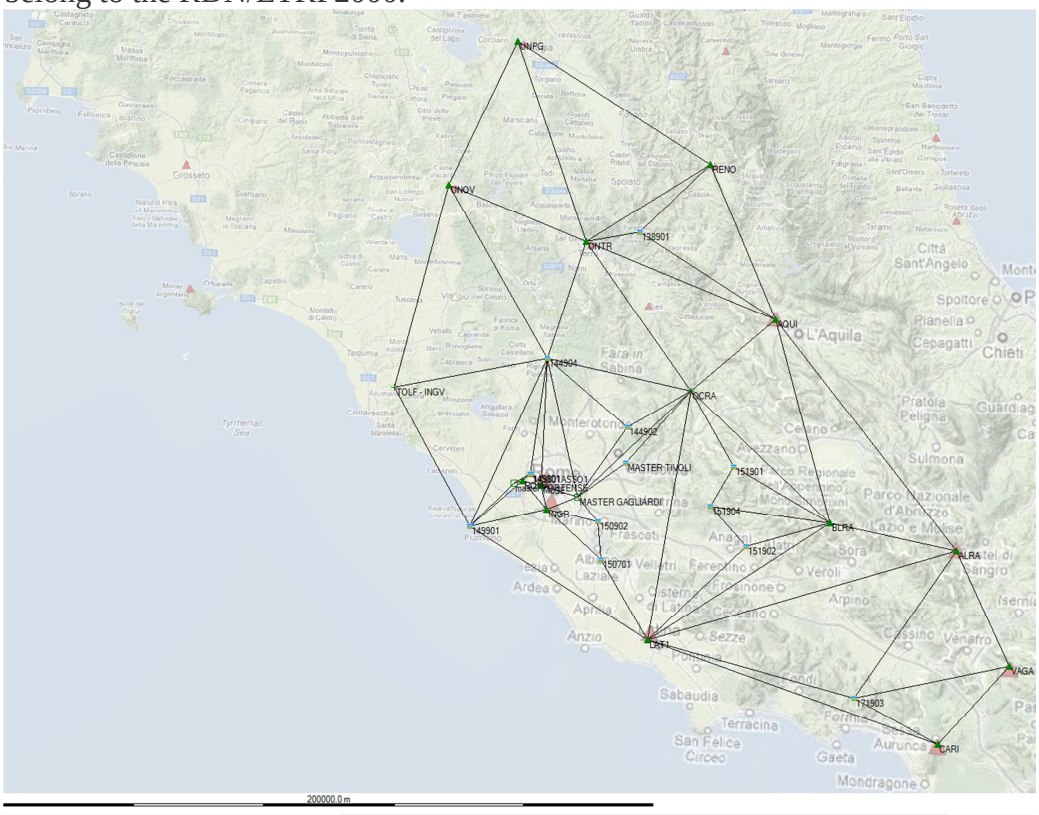
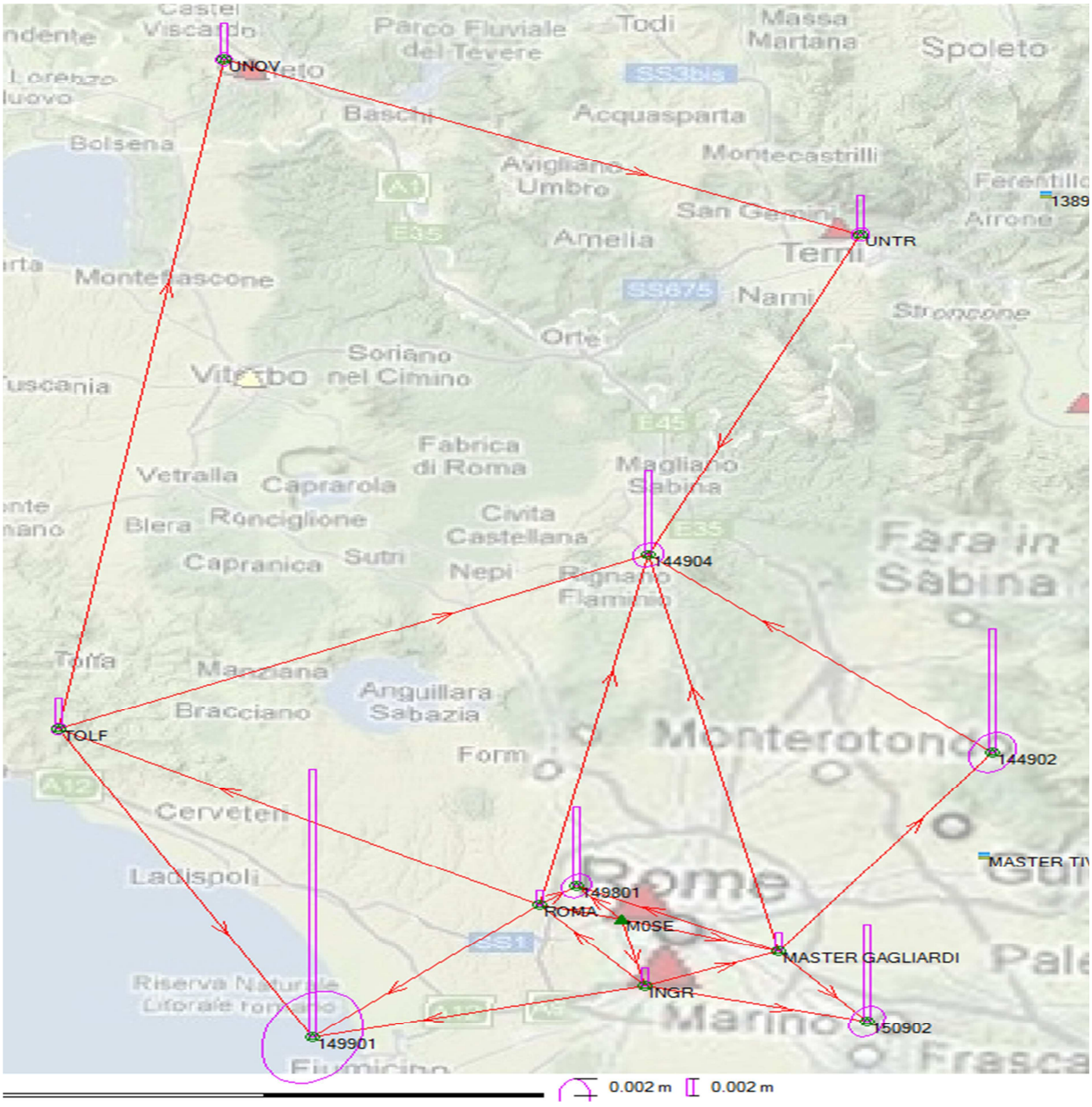


Fig. 11 "Back to the Origin" geodetic network layout

From the GNSS station, raw measurements with 30s rate have been downloaded for a time span of more than one week . It is also expected to lead to four of the main Benchmarks that are cadastral origins of great extension, like the top of Mount Pennino and Mount Ocre in Umbria and Abruzzi in order to provide a redundant number of benchmark in the datum Bessel 1841 (that is still the Datum associated with the catastral cartography in the Latium region. A further continuation, where implementable, will be done on other two large extension vertex like Torre del Mangia in Siena and the benchmark Valley Palombo.
In this way the Latium region will be completely contained in the polygon build on the cadastral origin of great extent as indicated.

1. Current status of the work of the geodetic network calculation.

Actually, as work have started only recently, the geodetic network is not calculated for the whole extension as designed and described in fig.8. However, it is possible to show a part of the network which includes the vertexes of the fundamental geodetic network Italian (Geodesy Rome 1940) and many GNSS stations boundary for almost all belonging to the National Network Dynamics RDN
Follow the partial network included in a minimally constrained adjustment process with a one fixed vertex (The station M0SE).



← 10 Km → Fig. 12 The geodetic network of “Back to the Origin” project (At the actual stage of calculation process).

Fig. 13 Project information and preliminary adjustment process information

Project Information

Project name:	CNG RITORNO ALLE ORIGINI - 2012 - REV 01
Processing kernel:	MOVE3 4.0

General Information

Type:	3D free network -- Projection : None -- Ellipsoid : WGS 84
Stations	
Number of (partly) known stations:	1
Number of unknown stations:	8
Total:	9
Observations	
GPS coordinate differences:	240 (80 baselines)
Known coordinates:	3
Total:	243
Unknowns	
Coordinates:	27
Total:	27
Degrees of freedom:	216

General Information

Adjustment			
Type:	Minimally constrained		
Dimension:	3D		
Coordinate system:	WGS 1984		
Height mode:	Ellipsoidal		
Number of iterations:	1		
Maximum coord correction in last iteration:	0.0000 m	✓	(tolerance is met)
Stations			
Number of (partly) known stations:	1		
Number of unknown stations:	9		
Total:	10		
Observations			
GPS coordinate differences:	279 (93 baselines)		
Known coordinates:	3		
Total:	282		
Unknowns			
Coordinates:	30		
Total:	30		
Degrees of freedom:	252		
Testing			
Alfa (multi dimensional):	0.6931		
Alfa 0 (one dimensional):	5.0 %		
Beta:	80.0 %		
Sigma a-priori (GPS):	10.0		
Critical value W-test:	1.96		
Critical value T-test (2-dimensional):	2.42		
Critical value T-test (3-dimensional):	1.89		
Critical value F-test:	0.95		
F-test:	1.95	⚠	(rejected)

Results based on a-posteriori variance factor

Fig. 14 Minimally constrained adjustment process report

Adjustment Results

Coordinates

Station		Coordinate	Corr	Sd
144902	Latitude	42° 03' 38.02583" N	-0.0001 m	0.0024 m
	Longitude	12° 48' 23.76983" E	-0.0002 m	0.0019 m
	Height	1323.4691 m	0.0001 m	0.0150 m
144904	Latitude	42° 14' 44.07983" N	-0.0001 m	0.0015 m
	Longitude	12° 30' 07.26519" E	-0.0003 m	0.0012 m
	Height	747.3139 m	0.0002 m	0.0101 m
149801	Latitude	41° 55' 27.85128" N	0.0000 m	0.0014 m
	Longitude	12° 27' 07.66359" E	0.0002 m	0.0012 m
	Height	194.7312 m	0.0000 m	0.0094 m
149901	Latitude	41° 46' 21.13857" N	0.0000 m	0.0055 m
	Longitude	12° 13' 53.76772" E	0.0003 m	0.0040 m
	Height	84.5713 m	0.0000 m	0.0322 m
150902	Latitude	41° 47' 51.95801" N	0.0000 m	0.0018 m
	Longitude	12° 42' 25.83991" E	0.0001 m	0.0014 m
	Height	671.6003 m	0.0000 m	0.0117 m
INGR	Latitude	41° 49' 41.09241" N	0.0000 m	0.0003 m
	Longitude	12° 30' 53.26543" E	0.0002 m	0.0003 m
	Height	104.4745 m	0.0000 m	0.0022 m
M0SE	Latitude	41° 53' 35.19873" N	0.0000 m	-
	Longitude	12° 29' 35.71688" E	0.0000 m	-
	Height	120.5847 m	0.0000 m	-
MASTER GAGLIARDI	Latitude	41° 51' 50.42791" N	0.0000 m	0.0003 m
	Longitude	12° 37' 46.37169" E	0.0002 m	0.0003 m
	Height	126.5965 m	0.0000 m	0.0023 m
ROMA	Latitude	41° 54' 17.47670" N	0.0000 m	0.0003 m
	Longitude	12° 25' 19.12526" E	0.0002 m	0.0002 m
	Height	146.0588 m	0.0000 m	0.0017 m
TOLF	Latitude	42° 03' 50.43617" N	0.0000 m	0.0007 m
	Longitude	11° 59' 59.82166" E	0.0005 m	0.0005 m
	Height	362.7861 m	-0.0001 m	0.0037 m
UNOV	Latitude	42° 42' 57.07251" N	0.0083 m	0.0008 m
	Longitude	12° 06' 47.24597" E	0.0106 m	0.0006 m
	Height	379.5816 m	0.0147 m	0.0043 m
UNTR	Latitude	42° 33' 31.23498" N	0.0151 m	0.0009 m
	Longitude	12° 40' 25.62576" E	0.0032 m	0.0007 m
	Height	219.2622 m	-0.0055 m	0.0046 m

The test run for the closure of the polygons shows an error of closure variable from 0.1 to 0.8 ppm. Are listed below two tables, one of the results relative to the largest polygon and the summary diagram .

Fig. 15 Loop closure of the polygon n.5 (Length 123 km Closing error 0.1 ppm)

Loop 5

From	To	dX[m]	dY[m]	dZ[m]	
ROMA	144904	-25758.4254	1091.1447	28496.4273	
ROMA	144904	-25758.4432	1091.1397	28496.4145	
		-25758.4343	1091.1422	28496.4209	Average
144904	TOLF	21755.4781	-37742.2333	-15210.5037	
144904	TOLF	21755.4885	-37742.2420	-15210.4991	
		21755.4833	-37742.2376	-15210.5014	Average
TOLF	ROMA	4002.9498	36651.0920	-13285.9236	
TOLF	ROMA	4002.9460	36651.0897	-13285.9248	
TOLF	ROMA	4002.9446	36651.0924	-13285.9250	
TOLF	ROMA	4002.9513	36651.0941	-13285.9219	
TOLF	ROMA	4002.9480	36651.0937	-13285.9239	
TOLF	ROMA	4002.9456	36651.0921	-13285.9250	
TOLF	ROMA	4002.9509	36651.0967	-13285.9204	
TOLF	ROMA	4002.9492	36651.0949	-13285.9233	
TOLF	ROMA	4002.9419	36651.0890	-13285.9259	
TOLF	ROMA	4002.9475	36651.0894	-13285.9228	
		4002.9475	36651.0924	-13285.9237	Average
X:	-0.0035 m	W-Test:	-0.22		
Y:	-0.0030 m		-0.68		
Z:	-0.0042 m		-0.28		
Easting:	-0.0022 m	W-Test:	-0.40		
Northing:	-0.0004 m		-0.02		
Height:	-0.0059 m		-0.38		
Closing error:	0.0063 m	(0.1 ppm)	Ratio:(1:19735052)		
Length:	123760.6815 m				

Table n.5 Loop closure test summary

Poligono	Lunghezza (m)	Errore di chiusura (m)	ppm
1	102530.125	0.0212	0.2
2	36478.551	0.006	0.2
3	57413.118	0.012	0.2
4	98428.312	0.045	0.5
5	127760.982	0.006	0.1
6	14240.866	0.011	0.8
7	32818.037	0.02	0.6
8	29539.609	0.007	0.2

In order to get a direct evaluation of the network and before the constrained adjustment process will be executed, it is possible, in a direct way , compare the coordinates of two permanent stations (vertexes UNOR, UNTR) as derived from the process in fig.22 (minimally constrained adjustment) versus the coordinates derived from existing publications, see the IGMI website at page www \ igmi.org \ rdn or details at Table 8 and 9

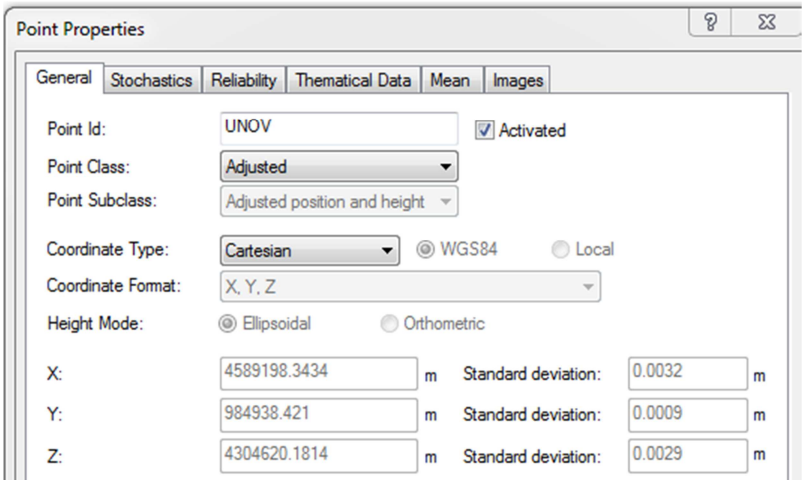
Table n. 6 Coordinates of the two CORS stations UNOR e UNTR

From the (preliminary) minimally constrained adjustment report

UNOV	Latitude	42° 42' 57.07251" N
	Longitude	12° 06' 47.24597" E
	Height	379.5816 m
UNTR	Latitude	42° 33' 31.23498" N
	Longitude	12° 40' 25.62576" E
	Height	219.2622 m

(UNOV Sd.0.0008, 0.0006,0.0043)
(UNTR Sd 0.0009,0.0007,0.0046)

Table n. 7 – Cartesian Co-ords for UNOV (Min Constr adj report)



At the next table are the corresponding coordinates of the final adjustment stage made by IGMI for RDN \ ETFR2000 Italian geodetic network .

Table n. 8– Table of co-ords for UNOR

ETRF2000 epoch 2008.0	
X	4589198.358 ± 0.002 m
Y	984938.421 ± 0.001 m
Z	4304620.174 ± 0.003 m
φ	42° 42' 57.0720" (± 0.7 mm)
λ	12° 06' 47.2458" (± 0.7 mm)
h	379.587 (± 3 mm)

from www \ igmi.org \ rdn

Table n. 9 – Table of co-ords for UNTR

ETRF2000 epoch 2008.0	
X	4590488.985 ± 0.006 m
Y	1029040.597 ± 0.003 m
Z	4292724.208 ± 0.007 m
φ	42° 34' 18.3556" (± 1.3 mm)
λ	12° 38' 06.0025" (± 0.3 mm)
h	199.996 (± 9.1 mm)

from www \ igmi.org \ rdn

We do not proceed beyond the comparison, as this is only useful for a first evaluation of the validity of the calculation portion of the network (at present) . The final calculation report will be completed as soon as possible (ongoing).

3. "Back to the Origin" project evaluation over a set of local trigonometric points in the Latium region

In parallel to the calculation of the geodetic network, a few colleagues in the Topography Commission have carried out a reconnaissance for the acquisition of GPS measurements of trigonometric landmarks, relevant for cadastral purposes. At present 5 vertexes of different importance have been surveyed.

Table 10. Summary of the reconnaissance

Nome Trigonometrico	Foglio Carta d'Italia	Comune	Materializzazione	Tipo Vertice
La Rocchetta	144	Fiano Romano	Triangolo scolpito su Roccia	Dettaglio catastale
Valle Spadana	144	Morlupo	Termine lapideo	Dettaglio catastale
Bersaglio	145	Arsoli - Oricola	Termine lapideo	Dettaglio catastale
Monte Folliettoso	144	Roccagiovane	Triangolo Inciso su roccia	Origine catastale minore
Sant'Antonio	144	Castel nuovo di Porto	Chiodo su rudere	*Demolito*

Fig. 16
Benchmark Monte Folliettoso

Fig. 17

(visible only the pile of rocks in this figure, as the benchmark is hidden underneath)
This vertex, located in a remote valley has been found in its original conditions and is very well preserved. (See the triangle incision on the rock, below the drawing tool)

(1) Folliettoso (Monte)

(2)

Comune di Raccagiovane

Registro Monografie N. 6 Pagina N. 121

ELENCO GENERALE

Fascicolo II Pagina 8

Foglio Carta d'Italia N. 144

ELEMENTI GEODETICI del VERTICE

Coordinate Geografiche (Elisse Internaz.)

Φ =

Λ =

Convergenza

t =

Coordinate Soldner

Origine:

x = +13 317,73

Y = +34 294,78

Coordinate Gauss-Boaga (Fuso di 6°)

x = 4 676 844,98

Y = 2 343 417,12

Quota altimetrica

z =

DATI DI COLLEGAMENTO

Vertici	LATI		Azimut
	Logaritmi	Valori numerici	

Riferimenti planimetrici: Triangolo inciso e pilastrino sulla punta rocciosa del monte

Riferimenti altimetrici:

Annotazioni:

(1) Denominazione del vertice trigonometrico.
(2) I. II. III. IV. Ordine I. G. M. - Rete - Sottorete - Dettaglio catastale.

Fig. 18 Cadastral monograph

Fig. 19
Survey in action over the benchmark “Monte Folliettoso” located in Rocca Giovane municipality, this vertex is a cadastral origin of a minor extension.

Fig. 20
Benchmark “Bersaglio”
Municipality of Arsoli-Oricola

Fig. 21
Benchmark “Valle Spadana”
Municipality of Fiano Romano

Fig. 22 Benchmark “La Rocchetta” Municipality of Fiano Romano

Fig. 23 Benchmark “La Rocchetta” Municipality of Fiano Romano
Detail of the “old style” benchmark

Before the final calculation of the project network, a preliminary test has been carried out over the geodetic element that is the core of the net in term of position and historical importance. About this triangle, the west side is made by two benchmarks that define the Italian geodic network with geodesy Roma 1940; the third vertex (on the east side) is the first order pillar “Mount Gennaro”. For the first two vertex mentioned, one at south is the origin “Roma Monte Mario”, and the other point at north is the vertex Mount Soratte , where was defined the main azimuth of the Italian geodetic network

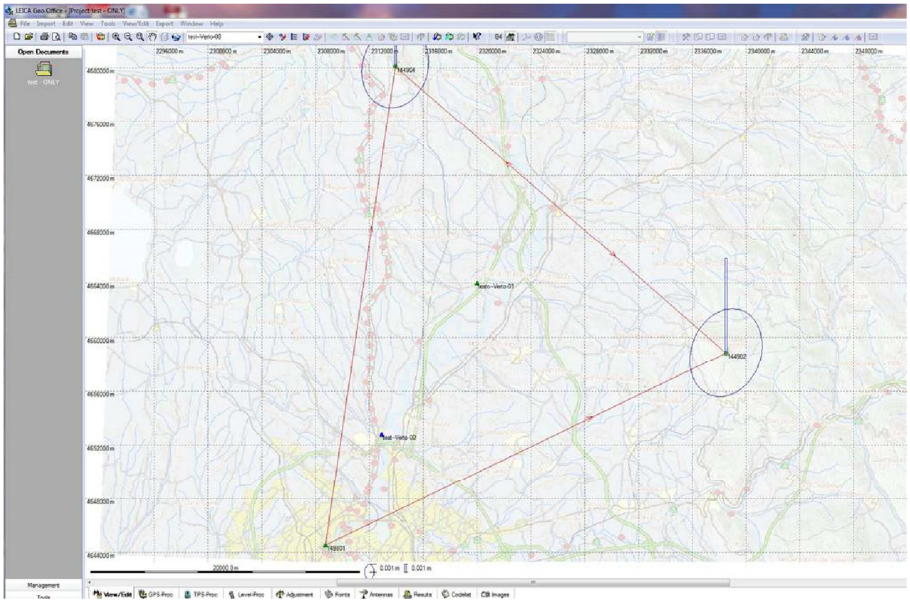


Fig. 24 Main geodetic triangle made by following benchmarks:
Rome Mount Mario (S), Mount Soratte (N), Mount Gennaro (E).
Fig. 25 The details of the 3D transformation with seven parameters and the center of rotation

Transformation details

Height mode:	Ellipsoidal		
3D-Helmert transformation			
Number of common points:	3		
Sigma a priori:	1.0000		
Sigma a posteriori:	0.1540		
Transformation model:	Molodensky-Badekas		
Rotation origin:	X0:	4627851.1106 m	
	Y0:	1033337.3644 m	
	Z0:	4252438.6567 m	

No.	Parameter	Value	rms
1	Shift dX	-520.6105 m	0.0889 m
2	Shift dY	-133.5382 m	0.0889 m
3	Shift dZ	-536.7049 m	0.0889 m
4	Rotation about X	3.69312 "	1.18050 "
5	Rotation about Y	-0.20659 "	1.24566 "
6	Rotation about Z	5.32184 "	1.23037 "
7	Scale	24.7210 ppm	4.5490 ppm

Residuals

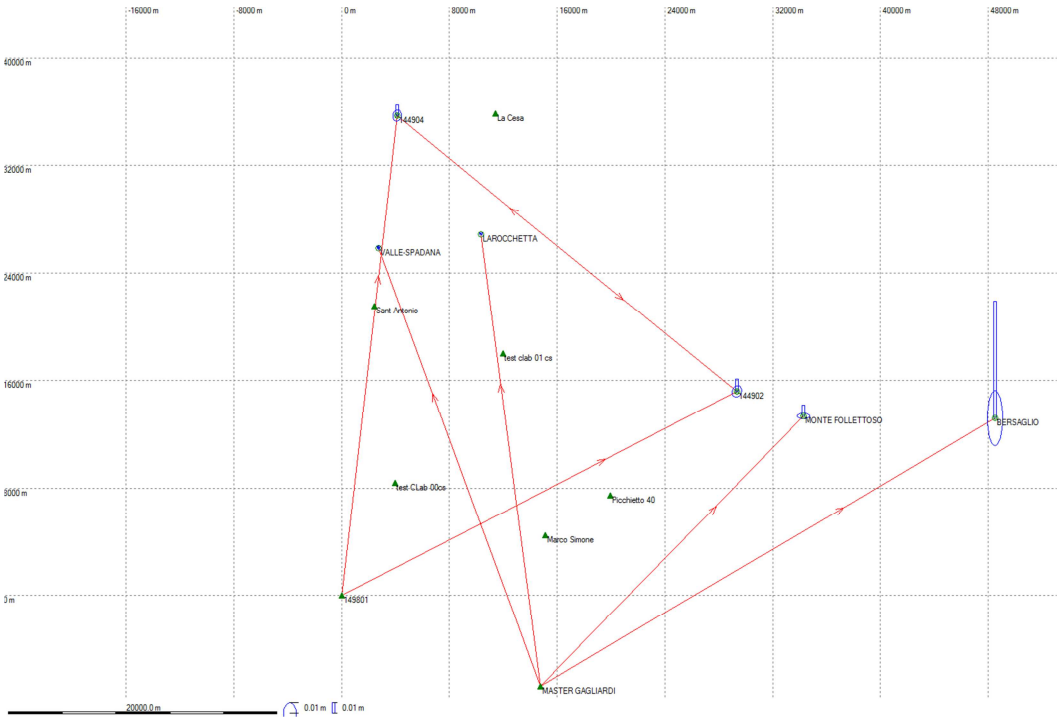
Cartesian:

System A	System B	Point type	dX [m]	dY [m]	dZ [m]
144902	144902	Position + height	-0.0739 m	-0.0587 m	0.0943 m
144904	144904	Position + height	-0.0011 m	0.1207 m	-0.0228 m
149801	149801	Position + height	0.0750 m	-0.0620 m	-0.0715 m

Grid:

System A	System B	Point type	dE [m]	dN [m]	dHgt [m]
144902	144902	Position + height	-0.0413 m	0.1268 m	0.0000 m
144904	144904	Position + height	0.1180 m	-0.0337 m	0.0032 m
149801	149801	Position + height	-0.0767 m	-0.0932 m	-0.0032 m

Fig. 26 Geodetic triangle and calculation of the vertexes of detail (temporary calculation in WGS84-Etrf89 made before the final stage in ETRF2000 " in itinere")



The "Master Gagliardi" CORS private station (at south in fig. n. 26) has been introduced in the network ETRF89_WGS84 with a previous work that was related to 8 vertexes IGM95 and the master station ROME (Italpos), executed with closed and redundant schemes. In the

picture fig.34 it appears as a stand-alone vertex, but refers to the same terrestrial frame Etrf89-Wgs84.

Hereafter is the summary :

vertice	CASSINI SOLDNER GEOROMA		CASSINI SOLDNER CARTLAB	monografia	DIFFERENZE
MONTE FOLLIETTOSO					
(ORIGINE MINORE CATASTALE	(non calcolata)	Y/E	34294.979	34294.78	0.199
		N/X	13317.87	13317.53	0.34
wgs84 etrf89	lat 42 02 36.8276				
	lon 12 51 58.7996				
	H 1053.57				

vertice	CASSINI SOLDNER GEOROMA		CASSINI SOLDNER CARTLAB	monografia	DIFFERENZE
VALLE SPADANA					
DETTAGLIO CATASTALE	2734.069	Y/E	2733.958	2733.87	0.088
	25873.612	N/X	25873.714	25874.33	-0.616
wgs84 etrf89	lat 42 09 26.3962				
	lon 12 29 06.722				
	H 340.025				
LA ROCCHETTA					
DETTAGLIO CATASTALE	10332.66	Y/E	10332.541	10331.63	0.911
	26889.604	N/X	26889.661	26889.63	0.031
wgs84 etrf89	lat 42 09 59.103				
	lon 12 34 37.762				
	278.144				

Fig. 27 Summary of cadastral coordinates derived from GPS processing of the preliminary work in fig.34 named GEOROMA.

The previous summary also shows the transformation of the WGS84-ETRF89 coordinates in the Cassini-Soldner projection (Bessel 1841) obtained with the software CartLab3 and a grid file of the *. Gr1 series that can be assumed as official procedure.

Now the coordinates placed to the right side, come from the monograph. Last column on the right indicate the differences between the coordinates of Cartlab3 and the corresponding on the monograph.

We omit the measures of the Benchmark in the City of Arsoli, since it appears from the results "probably" put back in place (the difference in E / Y is equal to 6.7 m). The Benchmark in “Castelnuovo di Porto” municipality is demolished.

In conclusion, although the test is not significant, allows us to highlight that:

- It is still possible in our time to find capital elements of the cadastral network such as “origins of minor extension” that usually are demolished
- The cadastral trigonometric vertexes of detail level, are less accurate of the origin of the local cadastral system
- Stone pillar benchmark, may exist but can have an altered location from the original position, and moreover, can be misleading in boundary disputes work. Other

trigonometric vertexes can be very often demolished, this according with their age.

4. Conclusions

The project "Return to Origins" is based on the use of latest technology for satellite surveying, with the support of GNSS stations that belong to the Italian National Dynamic Network (RDN) \ ETRF2000.
We felt an obligation, as Professional Surveyors, at work in our territory, to follow the path opened by our predecessors, to whom we think with our utmost respect and profound esteem.
We will continue in this direction, believing that this project could be a line of faith for further development of the profession of surveyor, in all areas of work , ties to the past, within an historical cartographic evolution review, or even in a modern way, related to engineering works.

5. Acknowledgments

We would like to thank all colleagues of the Topography Commission of the Surveyor Board in Rome, who have participated in this project. A special thanks goes to all GNSS network operators who are permanent suppliers of an extremely valuable free service.

6. References

L. Baroni, F. Cauli, D. Donatelli, G. Farolfi, R. Maseroli
La rete dinamica nazionale (RDN)
ed il nuovo sistema di riferimento ETRF2000
http://87.30.244.175/rdn/rdn_download/relazione.pdf
Alberto Caligaris , Mattia De Agostino, Ambrogio M. Manzino
L'uso della Rete Dinamica Nazionale per l'inquadramento delle reti regionali
Atti 14a Conferenza Nazionale ASITA - Brescia 9-12 novembre 2010
Antonio Avallone ,Gianpaolo Cecere , Luigi Falco ,Raffaele Moschillo ,
Maurizio Pignone , Elisabetta D'anastasio , Luigi Zarrilli ,
Grazia Pietrantonio ,Enrico Serpelloni , Nicola D'agostino ,
Marco Anzidei , Giuseppe Casula , Ciriaco D'ambrosio ,
Roberto Devoti , Giulio Selvaggi
La rete integrata nazionale GPS (RING): stato dell'arte a due anni dalla nascita
Atti 12a Conferenza Nazionale ASITA - L'Aquila 21-24 ottobre 2008

7. Contacts

Adriano ANGELINI
Ciro SUGAMELI
Commissione Topografia presso il Collegio dei Geometri e Geometri Laureati of Roma
P.le Val Fiorita 4/f
00144 Roma
Italy
e adrianoangelini@tiscali.it
e csugameli@tiscali.it
mob (AA) +39335329751

mob (CS) +393487822679