

# Center of a Territory: Definitions and Methods. The Case of Italy

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**Abstract**– It has analyzed the concept of ‘center of a territory’, highlighting the problems associated with the difficulty in defining what part of the territory should be taken into consideration and the characteristics of its limits (coasts and/or terrestrial boundaries). They are described and compared several methods for calculating the center of the Italian territory in its main parts (peninsular, politics, major islands with and without minor islands). The comparison between the calculations on the ellipsoid and medium centers is used to highlight the non-sphericity of the Earth. Results are compared with an application QGIS, too.

**Keywords**– Geographical Center, Territory, Topographical Distance, Datum and QGIS

## I. INTRODUCTION

IN 2008 Kadaster<sup>®</sup> ([www.orvietonews.it/cultura/2009/09/29/1-autorit-olandese-kadaster-individua-a-orvieto-l-esatto-centro-geografico-dell-italia-22155.html#.U2FSxrRqNpE](http://www.orvietonews.it/cultura/2009/09/29/1-autorit-olandese-kadaster-individua-a-orvieto-l-esatto-centro-geografico-dell-italia-22155.html#.U2FSxrRqNpE) 29 September 2009) calculated the geographical center of Italy identified it with a point in the industrial area of Fontanelle of Bardano (VT) at 42°44'39.80"N 12°04'51.38"E datum, we suppose, WGS84. In the same years, Kadaster<sup>®</sup> has also calculated the geographical center of each European state. The EU with 25 members has the center, calculated by the french Institut Géographique National (IGN) in 2004, at 50°31'03"N 7°35'50"E (most likely WGS84 datum) in the village of Kleinmaischeid (Germany) ([http://en.wikipedia.org/wiki/File:Kleinmaischeid\\_Zirkelschlag.jpg](http://en.wikipedia.org/wiki/File:Kleinmaischeid_Zirkelschlag.jpg)). Using the same technique, IGN has recently identified the center of EU with 15 members (1995-2005) in the municipality of Viroinval (Belgium) with coordinates 50°00'33"N 4°39'59"E. To make visible that point, there was built a monument. The center of the EU with 12 members was located in central France in Saint-André-le-Coq. This center was moved 25 km north-east of the village of Saint-Clément (France) when the two Germanies were reunified in 1991. Even in this place there is a small monument.

In Italy there are four places claiming to be the geographical center: Foligno (PG), Montelucio (PG), Rieti and Narni (TR). These last two ones have affixed a plaque or built a small monument to testify the location. In any case, none of the national mapping agencies (Istituto Geografico Militare (IGM), Istituto Idrografico della Marina (IIM), Sezione fotocartografica dello Stato Maggiore dell'Aeronautica,

Amministrazione del catasto e dei servizi tecnici erariali and Servizio geologico) confirmed this status and the used method.

Regarding Rieti, the ancient Roman scholar and writer Varro (116-27 BC) was the first historical figure to mention that Rieti Valley was in the middle of the peninsula. The ancient Roman poet Virgil (70-19 BC), in the VII book of the Aeneid, says: *Est locus Italiae in medio, sub montibus altis* where the term *locus* is interpreted by many scholars as the Rieti plain. During the Middle Age, Rieti continued to be held in Italy as its center. In fact, at that time, people said, with regard to the width of Italy by the Adriatic Sea to the Tyrrhenian Sea, it was 52 Italian miles (1 Italian mile = 1851.51 m) from both sides respect to Rieti; the same reasoning for the length north-south, 310 Italian miles to Augusta Pretoria (Aosta) and 310 miles to Cape dell'Armi (Calabria). The tradition, later, localized definitely the *Umbilicus* within the city of Rieti and precisely in the St. Rufus square. There was placed a column of granite that remained there until 1800, when it was buried in the same place where it was built and replaced with a stone with carved above *Medium Totius Italiae*. This stone was replaced, in turn, by the current headstone at March 29<sup>th</sup>, 1950 with the inscription CENTRE OF ITALY in 20 languages (Fig. 1).



Fig. 1. The Italy's center inside Rieti (source: [www.orvietonews.it](http://www.orvietonews.it))

Near Narni the Italy's center is localized in the Roman bridge Cardona or, more exactly, in an arch of the aqueduct Formina (I century BC) (Fig. 2). Coordinates of this center are, with poor precision, 42°30'11"N 12°34'24"E without the indication of the datum (maybe WGS84, but it could be ROMA1940, too). In a paper, we read that the center of Narni

was certified by the Military Geographic Institute (IGM), but any reference is readable on the site of the IGM ([www.igmi.it](http://www.igmi.it)).

In 2013, a national newspaper [4] published an article alleging that the center was near Narni. The real center, in fact, should be placed in Torre Spaccata (RM) in via Marcio Rutilio. Even in this case, the used calculation method was not stated.



Fig. 2. The small monument indicating the center of Italy at Narni (TR). Note that over signs are not written coordinates. Source: <http://www.panoramio.com/photo/57608219>

## II. CENTER: ONE OR MANY DEFINITIONS?

The concept of the center of an area may have different interpretations and implementations. One of the few texts on this issue is [2] where he mentions the problem of the Qibla and the curvature of the Earth's surface. In addition to, [3] considers the centers of the states that make up the US, highlighting the need for a scientific review of their location in comparison of some historical 'centers'.

One interpretation could be 'physical', i.e. the identification of the center with the center of gravity. Switzerland has calculated its geographical center in this way ([www.swisstopo.admin.ch/internet/swisstopo/en/home/topics/knowledge/center\\_ch.html](http://www.swisstopo.admin.ch/internet/swisstopo/en/home/topics/knowledge/center_ch.html)), another interpretation might be 'geometrical', i.e. identifying with the center of the spherical rectangle coincident with meridians and parallels of the extreme points of the territory. Another interpretation is the identification of the center as the farthest point from the political boundary and/or coastline.

However you choose one of the above interpretations, you must define the type and/or the part of the State to be taken into account: only the mainland? the largest island when considering an archipelagic State? all parties, even the small islands, as in the case of Italy? the mainland along with the so-called internal waters, i.e. the surfaces of water between the shoreline at low tide and the set of segments (straight line basis) defined by the State in accordance with articles 2.1 and 5 of the United Nations Convention on the Law of the Sea

(UNCLOS, 1982: *Except where otherwise provided in this Convention, the normal baseline for measuring the breadth of the territorial sea is the low-water line along the coast as marked on large-scale charts officially Recognized by the coastal State;*

[www.un.org/Depts/los/convention\\_agreements/texts/UNCLOS/unclos\\_e.pdf](http://www.un.org/Depts/los/convention_agreements/texts/UNCLOS/unclos_e.pdf))? Speaking of inland waters and the straight baseline, we must take in account that a State may determine by law the drawing of them and with the same legal instrument can change it in whole or in part.

The 'barycentric' interpretation requires detailed outline (border more shoreline and/or straight line basis) localization of the territory, and the assumption of a uniform density.

The 'physical' interpretation should not consider States with concave shape territory because of the possibility that the center of gravity, by definition a geometric point and not a physical one, coincides with a point outside the State itself. States such as Croatia, Somalia, Vietnam, Norway, to mention the most obvious examples, may have the center of gravity in another State or outside internal waters.

The 'geometric' definition, too, does not guarantee that the point falls within the State, as evidenced by Croatia.

The 'the farthest point from the boundary of the State' definition, called the pole of inaccessibility ([5] pp. 227-233), might give ambiguous results, according to the choice of end points, or may give more than a point depending on the shape of the area. In [5] are given maps with only the results of processing for continental areas as Eurasia or oceans.

Ultimately, those definitions do not seem to have an objective scale of priorities. Regarding the position of the center, however calculated, we must consider that the center of the State should exist because mentally we have the idea of space around us, but it becomes 'official' only if it falls on the mainland or in inland waters as only these areas are under its full sovereignty.

## III. THE GEOGRAPHICAL CENTER

The Italian territory is divided into a peninsula (the largest surface) with many other islands of varying extension around it and more or less distant from the coast. The shape of the peninsula is not markedly concave, but almost linear and tilted with respect to the meridians along north-west / south-east. The two largest islands, Sicily and Sardinia, have, respectively, a triangular and rectangular shape. Based on these considerations, we cannot exclude the possibility that the geographical center of Italy may fall on land.

As for the alpine border, we must consider that the changing climate is melting glaciers between Italy and Switzerland. For this reason, the two governments have agreed to adopt a tolerance on the path of the border along the ridge of mountains (the concept of 'moving boundary'). This is important because in the minutes of demarcation of the border is written words as 'ridge' or other orographic features, without having ever seen them because of the presence of glaciers. Recent measurements confirm that the border has shifted in some areas, since 1940, between 100 and 150 m.

As follow, we will use the WGS84 datum. If we got the coordinates from other reference systems, we have transformed them with the software CARTLAB1<sup>®</sup> 1.2.2.

As you will calculate distances between points on an ellipsoid and not on a sphere, the midpoint between two parallel have not got a latitude resulted from an operation of average value. The classical mean value will be used instead, with the longitude as the ellipsoid of the WGS84 datum is rotationally symmetrical relative to the axis of rotation of the Earth. In any case, we must also consider that the meridians are not parallel to each other, but converge toward the Pole, for which the distance between two of these varies according to the latitude.

What we define the distance between two points A and B on the Earth's surface, is the topographical one, i.e., the length of the geodesic line  $A_e B_e$  lying on the ellipsoid (Fig. 3). The above two points are projected on the reference surface (*datum*) along the ellipsoidal normal. This type of definition is very different from the straight-line distance in euclidean cartesian space with the origin, p. eg., in the center of gravity of the Earth, or from what we are accustomed to consider the distance along the physical surface. An example is the distance in kilometers indicated by the milestones along the roads. This kind of distance was measured by the Romans with the odometer, which is the modern odometer wheel.

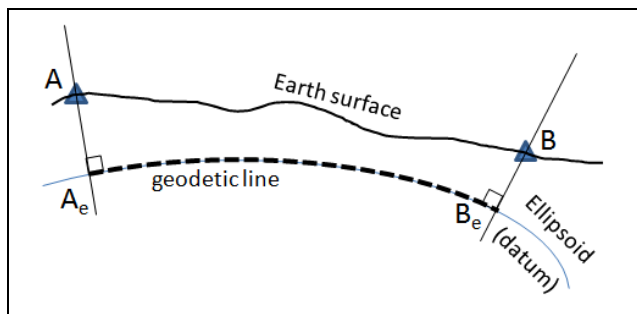


Fig. 3. The topographical distance between A and B is the length of the geodesic line  $A_e B_e$  lying on the ellipsoid (drawing by the Author)

The calculation of the distance between points, given their geographical coordinates in WGS84 datum, you run with the formula of Vincenty ([6] pp. 88-93). For this work we used the 'online calculator' at the URL [www.movable-type.co.uk/scripts/latlong-vincenty.html](http://www.movable-type.co.uk/scripts/latlong-vincenty.html).

#### A) Italian Peninsula

The center of the Italian peninsula is located at  $42^{\circ}30'22.28''N$   $12^{\circ}34'24.83''E$ , equidistant from the extreme north-south parallels 509627.41 m and from extreme east-west meridians 488381.42 m. This point falls in a forest south of the road SP64 in the town of Narni (TR), 766 m (azimut  $126^{\circ}$ ) from Erpabigia (TR).

The average of the extreme latitudes gives a point at  $42^{\circ}30'15.66''N$   $12^{\circ}34'24.83''E$  placed further south than  $6.62''$ , that is 204.27 m.

The center calculated by Kadaster<sup>®</sup> is far about 48.3 km (azimut  $303^{\circ}$ ). On the contrary, this center is located near the Roman Bridge of Narni. The average latitude is very close to that found on the Net, what allows us to suppose that this coordinate is calculated, most likely, by the erroneous method of the average.

The coordinates of extremities of the Italian peninsula used for the calculations are:

Extreme N: Zwillingsköpfe (Twin Peaks West) east of the Vetta d'Italia (BZ): UTM-WGS84 741796.13E 5220330.51N zone 32N =  $47^{\circ}05'31.72''N$   $12^{\circ}11'09.81''E$  from Provincial Geoportal Alto Adige, Autonomous Province of Bolzano - Alto Adige, Informatica 9 ([http://gis2.provinz.bz.it/geobrowser/?project=geobrowser\\_pro\\_o&view=geobrowser\\_pro\\_atlas-b&locale=it](http://gis2.provinz.bz.it/geobrowser/?project=geobrowser_pro_o&view=geobrowser_pro_atlas-b&locale=it)).

Extreme S: beach of Melito di Porto Salvo (RC): ROMA1940:  $37^{\circ}54'57.31''N$   $3^{\circ}19'29.61''E$  = WGS84  $37^{\circ}54'59.6''N$   $15^{\circ}46'38.1''E$  from the Geological Map of Calabria sheet 263 NO (Melito di Porto Salvo, scale 1:25000 (<http://www.egeo.unisi.it/carte.php?idserie=209>, paper CCAL 162));

Extreme W: north of Roche Bernaude and north-west of Bardonecchia (TO): UTM-WGS84 313280E 4997182N zone 32N =  $45^{\circ}06'12.40''N$   $6^{\circ}37'35.91''E$  from the Geoportal of the Piedmont Region ([www.geoportale.piemonte.it/geocatalogorp/main/?SEZIONE=catalogo](http://www.geoportale.piemonte.it/geocatalogorp/main/?SEZIONE=catalogo));

Extreme E: Cape of Otranto / Cape Palascia (LE): WGS84 UTM = 800069.96E 4445590.05N zone 33N =  $40^{\circ}06'25.65''N$   $18^{\circ}31'13.75''E$  from the Geoportal of the Puglia region (<http://www.sit.puglia.it>).

#### B) Political Italy

For the political Italy, extremes N, W and E are the same as in peninsular Italy, while the extreme S moves on the island of Lampedusa (AG).

In this context, the center is positioned at  $41^{\circ}17'43.67''N$   $12^{\circ}34'24.83''E$  and equidistant from the extreme north-south parallels 644104.41 m and from extreme east-west meridians 497714.01 m. This center is located in the Tyrrhenian Sea about 17.3 km (azimut  $198^{\circ}$ ) from the eastern end of the meridional pier of the harbour of Anzio, outside the Italian inland waters, but within the territorial sea (amplitude 12 nm = 22.2 km).

The average of the extreme latitudes N and S gives a point at  $41^{\circ}17'33.15''N$   $12^{\circ}34'24.83''E$  placed further south to  $10.52''$ , i.e. of 324.54 m.

The center calculated by Kadaster<sup>®</sup> is far about 166.1 km (azimut  $346^{\circ}$ ).

The coordinates of the extreme points of the political Italy used for the calculations are:

Extreme N: the same as in peninsular;

Extreme S: Head Swordfish or White Horse Head south of the western end of the runway of the airport of Lampedusa: UTM-WGS84 282816.69E 3930345.92N zone 33N =  $35^{\circ}29'34.58''N$   $12^{\circ}36'20.64''E$  from the Geoportal by the Region of Sicily IDT-SITR Department of Land and Environment, Department of City Planning, Area 2 Interdepartmental ([www.sitr.regione.sicilia.it/geoportale/it/Home/GeoViewer](http://www.sitr.regione.sicilia.it/geoportale/it/Home/GeoViewer) with orthophotos 2007/2008);

Extreme W: the same as in peninsular Italy;

Extreme E: the same as the peninsula.

### C) Sardinia

For the calculation of the center are considered two cases. In the first one it is considered the only area of the main island; in the second one we have included the smaller islands belonging to the region.

The coordinates of the extreme points of Sardinia used for the calculations are taken from the Geoportal of Sardinia Region ([www.sardegna.geoportale.it/webgis/fotoeree](http://www.sardegna.geoportale.it/webgis/fotoeree) with orthophotos dated 2008).

#### 1) Sardinia: Main Island

The center has coordinates 40°03'42.37"N 8°58'46.60"E, equidistant from the extreme north-south parallel 132972.98 m and from the extreme east-west meridians 72419.77 m. The point is located in the vicinity of a building on via Melis in Ortuero (NU).

The average of the extreme latitudes gives a point at 40°03'41.93"N 8°58'46.60"E placed further south 0.44", i.e. 13.57 m.

The extreme points are:

Extreme N: between Cape Falcon and Cape Marmorata, north-east of Santa Teresa di Gallura (OT): Gauss-Boaga 1519117E 4567566N = UTM-WGS84 519088E 4567558N zone 32N = 41°15'33.17"N 9°13'40.29"E;

Extreme S: Capo Teulada (CA): Gauss-Boaga 1469269E 4301759N = UTM-WGS84 469237E 4301753N zone 32N = 38°51'50.68"N 8°38'43.49"E;

Extreme W: Head of Argentiera (SS): Gauss-Boaga 1426631E 4509469N = UTM-WGS84 426601E 4509460N zone 32N = 40°43'58.10"N 8°07'50.75"E;

Extreme E: Capo Comino (NU): Gauss-Boaga 1570199E 4486744N = UTM-WGS84 570169E 4486737N zone 32N = 40°31'42.25"N 9°49'42.44"E.

#### 2) Sardinia: All the Islands

The center has coordinates 40°05'10.87"N 8°58'46.60"E, equidistant from the extreme north-south parallels 136229.23 m and from extreme east-west meridians 72419.77 m. The point is located in a wooded area at 2825 m (azimut 128°) from Nughedu Santa Vittoria (OR).

The average of the extreme latitudes gives a point at 40°05'10.40"N 8°58'46.60"E placed further south 0.47", i.e. 14.50 m.

The extreme points are:

Extreme N: coast islet 0.6 km north-west of La Presa (archipelago of La Maddalena) (OT): Gauss-Boaga 530927N 1530958E = UTM-WGS84 530927E 4573582N zone 32N = 41°18'47.2"N 9°22'10.16"E;

Extreme S: islet 20.5 km (azimut 269°) from Capo Teulada (CA): Gauss-Boaga 1448696E 4301339N = UTM-WGS84 448664E 4301333N zone 32N = 38°51'33.60"N 8°24'29.96"E;

Extreme W: same as Sardinia main island;

Extreme E: same as Sardinia main island.

### D) Sicily

For the calculation of the center we have considered two cases. In the first, it is considered the only area of the main

island; in the second one, the smaller islands belonging to the region, too.

The coordinates of the extreme points of Sicily used for the calculations are taken from the Geoportal of the Sicily Region IDT-SITR Department of Land and Environment, Dip. City Planning, Interdepartmental Area 2 ([www.sitr.regione.sicilia.it/geoportale/it/Home/GeoViewer](http://www.sitr.regione.sicilia.it/geoportale/it/Home/GeoViewer) with orthophotos dated 2007/2008).

#### 1) Sicily: Main Island

The center of the island is at 37°28'22.32"N 14°02'25.95"E and it is located near the road SP1, 2.8 km south-west from Caltanissetta. It is equidistant from the extreme north-south parallels 91974.70 m and from the extreme east-west meridians 142649.55 m.

The average of the extreme latitudes gives a point at 37°28'21.12"N 14°02'25.95"E placed further south of 1.20", i.e., of 37.00 m.

The extreme points are:

Extreme N: beach north of Spartà (ME): UTM-WGS84 547384.99E 4239408.07N zone 33N = 38°18'05.44"N 15°32'30.96"E;

Extreme S: Island of the Tides (SR) (during the syzygyal tide, it is connected to the mainland by an isthmus): UTM-WGS84 506956.97E 4055396.27N zone 33N = 36°38'38.79"N 15°04'40.18"E;

Extreme W: Cape Boeo or Lilibeo, west of Marsala (TP): UTM-WGS84 273215.91E 4186980.86N zone 33N = 37°48'07.46"N 12°25'40.18"E;

Extreme E: beach east of Torre Faro and Capo Peloro (ME): UTM-WGS84 557145.45E 4235695.13N zone 33N = 38°16'02.93"N 15°39'11.72"E.

#### 2) Sicily: All the Islands

The center is at 37°09'09.69"N 13°47'23.33"E and is located at 5097 m (azimut 151°) from Palma de Lichtenberg (AG) in an agriculture. It is equidistant from the extreme north-south parallels 184174.45 m and from extreme east-west meridians 165525.15 m.

The average of the extreme latitudes gives a point at 37°09'08.85"N 13°47'23.33"E placed further south than 0.84", i.e. of 25.90 m.

The extreme points are:

Extreme N: coast to 1.9 km (azimut 304°) from the island Stromboli (ME): UTM-WGS84 519159.35E 4295934.93N zone 33N = 38°48'43.12"N 15°13'14.44"E;

Extreme S: the same as political Italy;

Extreme W: islet 0.5 km (azimut 300°) from Punta Fram (TP): UTM-WGS84 225779.15E 4077421.55N zone 33N = 36°48'10.60"N 11°55'34.94"E;

Extreme E: same as Sicily main island.

## IV. POLYGONAL CENTROIDS WITH QGIS

QGIS (ver. 2.2 Valmiera) has a geometric tool called 'center of gravity polygonal' (polygon centroid) that operates on a vector layer returning a point with its coordinates.

For our purpose, we used the shapefile (*shp*) of the Italian regions downloaded from the website of the National Institute of Statistics (ISTAT;

www.istat.it/it/files/2011/04/reg2011\_g.zip (January 1<sup>st</sup>, 2011 and with datum UTM zone 32-ED1950)). From this shapefile, we have selected a single *shp* file for each region. Subsequently, with an operation of geoprocessing, we did the union of the various regions to creating a single shapefile named the peninsula of the political Italy. In this way, it was possible to calculate the center of each region, of the political and peninsular Italy.

Table 1 shows, for each main area in which it has been divided Italy, the coordinates of the QGIS centers, both in comparison with those calculated with the average method and with the formula of Vincenty. The locations have been identified on GOOGLE EARTH<sup>®</sup> and are approximate until a measurement on site.

TABLE 1

Zone Mean Vincenty QGIS (ver. 2.2) Location of the QGIS center
Peninsular 42°30'15.66"N 12°34'24.83"E 42°30'22.28"N 12°34'24.83"E 43°28'34.39"N 12°19'05.45"E 6434 m (azimut 78°) from Città di Castello (PG): wooded area
Political 41°17'33.15"N 12°34'24.83"E 41°17'43.67"N 12°34'24.83"E 42°42'26.24"N 12°12'45.32"E 6918 m (azimut 103°) from Orvieto Scalo (TR): wooded area west from the Corbara dam
Sardinia (only main island) 40°03'41.93"N 8°58'46.60"E 40°03'42.37"N 8°58'46.60"E --- ---
Sardinia 40°05'10.40"N 8°58'46.60"E 40°05'10.87"N 8°58'46.60"E 40°05'02.33"N 9°01'48.07"E 5068 m (azimut 287°) from Austis (NU): wooded area
Sicily (only main island) 37°28'21.12"N 14°02'25.95"E 37°28'22.32"N 14°02'25.95"E --- ---
Sicily 37°09'08.85"N 13°47'23.33"E 37°09'09.69"N 13°47'23.33"E 37°35'20.98"N 14°08'58.20"E 2142 m (azimut 278°) from Villarosa (EN): agriculture near the road SS21

The centers of the main areas of Italy with the three methods discussed (Mean, Vincenty, QGIS (ver. 2.2)). Source administrative limits of the regions: ISTAT, 2011.

The centers of each region are shown in Table 2 and depicted in Fig. 4.

QGIS's centers. The centers of each region with its location. Source administrative limits of the regions: ISTAT, 2011.

TABLE 2

Region: QGIS center (ver. 2.2) Location of the center from GOOGLE EARTH <sup>®</sup>
Abruzzo: 42°13'36.37"N 13°51'21.06"E 817 m (azimut 213°) from Dogli (PE): wooded area
Basilicata: 40°29'56.22"N 16°04'58.40"E 2546 m (azimut 139°) from Pietrapertosa (PZ): wooded area
Calabria: 39°03'50.15"N 16°20'45.13"E 1115 m (azimut 201°) from Adami (CZ): wooded area
Campania: 40°51'30.31"N 14°50'39.70"E 1581 m (azimut 267°) from Serino (AV): wooded area
Emilia Romagna: 44°31'38.86"N 11°02'37.14"E 1034 m (azimut 126°) from Altolà (MO): agriculture near the road SP14
Friuli Venezia Giulia: 46°09'03.28"N 13°03'22.46"E 3653 m (azimut 102°) from San Daniele del Friuli (UD): wooded area
Lazio: 41°58'48.43"N 12°46'00.98"E 174 m (azimut 188°) from La Botte (RM): building, via Colle Nocello
Liguria: 44°15'57.82"N 8°42'06.73"E 14360 m (azimut 136°) off the coast of Varazze (SV): sea
Lombardy: 45°37'09.05"N 9°46'08.47"E 920 (azimut 75°) from the Malpaga castle (BS): agriculture
Marche: 43°20'49.27"N 13°08'25.40"E 591 m (azimut 193°) from Moscosi (MC): agriculture
Molise: 41°41'03.30"N 14°35'41.96"E 1232 m (azimut 218°) from Sant'Angelo Limosano (CB): agriculture
Piedmont: 45°03'25.45"N 7°55'12.04"E 915 m (azimut 141°) from Barbaso (AT): lawn
Puglia: 40°58'57.61"N 16°38'12.91"E 3952 m (azimut 245°) from Toritto (BA): agriculture near the road SP72
Sardinia: 40°05'02.33"N 9°01'48.07"E 5068 m (azimut 287°) from Austis (NU): wooded area
Sicily: 37°35'20.98"N 14°08'58.20"E 2142 m (azimut 278°) from Villarosa (EN): agriculture near the road SS21
Toscana: 43°26'53.84"N 11°07'46.49"E 3038 m (azimut 207°) from Poggibonsi (SI): agriculture
Trentino-Alto Adige: 46°26'25.91"N 11°16'47.42"E 2532 m (azimut 182°) from Cornaiano (BZ): wooded area
Umbria: 42°57'54.40"N 12°29'26.56"E 2977 m (azimut 235°) from Collemancio (PG): wooded area
Valle d'Aosta: 45°43'49.22"N 7°23'13.16"E 641 m (azimut 326°) from Brissogne (AO): wooded area
Veneto: 45°38'57.91"N 11°51'21.17"E 245 m (azimut 245°) from San Martino di Lupari (PD): lawn

The center of Liguria, only case, falls outside of the mainland and, in particular, in the open sea beyond the inland waters, but within the territorial sea. This allows to state that the center calculated with QGIS corresponds to the centroid as the Liguria has a pronounced concave shape that is not present in other regions.

The error on the location of the center using QGIS and the shapefile ISTAT, can be estimated at  $\pm 1.5$  m in latitude and  $\pm 1.2$  m in longitude.



Fig. 4. The centers of each Italian region (black dots) calculated with QGIS 2.2. Note the center of Liguria in the sea. Source administrative limits of the regions: ISTAT, 2011.

## V. ANALYSIS OF RESULTS

As for longitude, from the N to the S extremes of the political Italy, 0.1" are metrically equivalent between 2.11 and 2.52 m. So, we have an average error of  $\pm 1.16$  m. The difference between the largest and the smaller due to the convergence of the meridians to the Pole.

For latitude, from the N to the S extremes of the political Italy, 0.1" are metrically equivalent between 3.09 and 3.08 m. So, we have an average error of  $\pm 1.54$  m. This value is independent of longitude because the used ellipsoid has a rotational shape around the NS axis, i.e. parallels are arches of circumference.

As for the extreme S of the Peninsula, error is graphically equivalent to  $\pm 2.50$  m due to the scale 1:25000 used in the Geological Map.

Therefore, we can reasonably say that with regard to the position of the center of the two largest Italian islands, the absolute metric error is: latitude  $\pm 1.54$  m and longitude  $\pm 1.16$  m. The peninsular and political centers have the following errors metric absolute: longitude  $\pm 2.79$  m and latitude  $\pm 4.04$  m. These errors are compatible with those of the orthophotos used by regional and provincial geographical websites. Furthermore, they are less than the difference between the calculated center with the ellipsoidal distance and the method of the average for the latitude.

## VI. CONCLUSIONS

The analysis of the concept of 'the center of a State' has highlighted the difficulties of his unambiguous definition. Further difficulties are highlighted in the choice of the national territory to be considered. Furthermore, the present work has allowed to better analyze the peculiarities of the concept of distance mapping, i.e. the distance calculated on a

reference surface called datum, different from that intuitive processes that everyone does in his relationship with reality, i.e., distance equal the path on the physical surface of the Earth.

It is clear that our calculation done in WGS84 datum must give the same results, less the value of the coordinates, on the ground, unless the value of the coordinates, if you use one of the other historical references used in Italy (BESSEL 1841 or ROMA1940) since the center depends on the territorial limits and not by the cartographic representation.

Our results, especially with a country like Italy with its profile consists of ribs, may be subject to change due to astronomical (tides), meteorological or geological phenomena. The shift can also be of the order of meters. For this reason, if you want to adopt the method of gravity for Italy, it is necessary to know with high resolution the trend of the coast and the location of the boundary line. Costs can be deducted from orthophotos satellite processed by geomatics applications ([1] pp. 183-193). About the border, the situation is more difficult because of its non-visibility on the ground unless it follows well-defined and known topographical features. Moreover, for the identification of the boundary line, unfortunately, is not enough to know the exact position of the terms/pillars for two reasons:

- a) it is possible that the border does not pass for a term/pillar;
- b) not always the path between two terms/pillars is linear.

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