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Differentials in the Regional Operational Program expenditure for public services and infrastructure in the coastal cities of Sardinia (Italy) analyzed in the ruling context of the Regional Landscape Plan

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DIFFERENTIALS IN THE REGIONAL OPERATIONAL PROGRAM EXPENDITURE FOR PUBLIC SERVICES AND INFRASTRUCTURE IN THE COASTAL CITIES OF SARDINIA (ITALY) ANALYZED IN THE RULING CONTEXT OF THE REGIONAL LANDSCAPE PLAN

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ABSTRACT

The planning activity of the regional administration of Sardinia (Italy) has undergone a deep change after the approval of the Regional Landscape Plan (RLP), which establishes the directions for nearly any future planning activity in Sardinia, and requires that actual sectoral and local plans, as well as plans for protected areas, be changed to comply with its directions. This mandatory adjustment process can be conflictual, if the administrations responsible for these plans disagree with the rules established by the RLP.

With regards to Sardinian coastal cities, this paper analyzes the investment policies for public services and infrastructure implemented by the Sardinian Region through the 2000-2006 Regional Operational Program (2000-2006 ROP-ERDF), in order to assess whether the RLP exerts a negative impact.

1. INTRODUCTION

The planning activity of the regional administration of Sardinia (Italy) is characterized by a deep change that followed the approval of the Regional Landscape Plan (RLP) (Resolution of the Regional Council of Sardinia no. 36/7 of September 5, 2006 entitled “L.R. n. 8 del 25.11.2004, articolo 1, comma 1. Approvazione del Piano Paesaggistico – Primo ambito omogeneo” [“Regional Law no. 8 of November 25, 2004, article 1, paragraph 1. Approval of the Landscape Plan – First homogeneous piece of territory”]). The RLP, ruled by the National Code of Cultural Heritage and Landscape (National Law Enacted by Decree no. 42/2004, also known as “Urbani Code” from the last name of the Minister who proposed the law), establishes the directions for future Sardinian regional planning. The actual sectoral, province and city plans, as well as plans for protected areas, have to be changed in order to comply with these directions. The adjustment process could be conflictual, since cities, provinces, and administrative bodies in charge of protected areas may possibly disagree with the regional administration about the rules established by the RLP, particularly restrictive for areas included in a well-defined portion of the island labeled as “Coastal strip.” Cities could suffer a sharp decline in building expansion rights, since they might lose financial resources for public services and infrastructure that would come from the impact fees paid by the developers. Another problem for municipal budgets could stem from decrease in payments of communal taxes for real estate, which include land property, since the value of land would dramatically drop without development rights. In other words, the investment attraction capacity of Sardinian coastal cities could possibly plummet as a consequence of the ruling framework of the RLP.

The Sardinian regional operational program 2007-2013 concerning the European Regional Development Fund (ERDF) (2007-2013 ROP-ERDF) respects the rules of the ERDF on investments for territorial cohesion (as defined by art. 8 and 10 of Regulation no. 1080/2006/EC) since it promotes their regional geographic concentration (Regione Autonoma della Sardegna, 2007). These investments are evenly shared between large- and medium-sized urban areas, and disadvantaged zones.

With regards to Sardinian coastal cities, this paper analyzes the investment policies for public services and infrastructure implemented by the Sardinian Region through the 2000-2006 Regional Operational Program (2000-2006 ROP), in order to assess whether the RLP exerts a negative impact (Regione Autonoma della Sardegna, 2006). The second section defines a territorial taxonomy of Sardinian coastal cities, by analyzing the spatial distribution of investment for public services and infrastructure and of other attributes, among which are residential population and density, urbanization and the RLP ruling framework. This taxonomy is represented by means of a geographic information system (GIS). The

third section analyzes the investment policies concerning public services and infrastructure, and identifies correlations between the variables represented by the GIS, by means of a multinomial logit model (MLM).

The methodological approach adopted in this paper can be used in regional planning processes to address the important issue of the often-conflictual relationship between the implementation of conservative planning policies and local economic development programs.

2. A GIS-BASED TAXONOMY OF SARDINIAN COASTAL CITIES

The aim of this paper is to investigate whether, and to what extent, the RLP has had an impact on the capability of Sardinian municipalities to spend those funds for public services and infrastructure they had been granted by the Regional Administration of Sardinia through the 2000-2006 Regional Operational Program. In order to perform such analysis by means of an MLM, a descriptive table was needed. Such table had to have as many rows as Sardinian municipalities are, and as many fields as relevant attributes are. Data from various sources and in various formats were collected; some data (e.g. those pertaining to demography and levels of expenditure) were available as spreadsheets; some others (e.g. spatial distribution of land uses and of urbanized areas) were available as spatial databases. Moreover, integration of available (both spatial and non-spatial) information was required to develop new knowledge and obtain new layers of either spatial or non-spatial information, which called for a GIS-based analysis.

As far as the geographic description of the municipalities is concerned, only one shapefile ("Municipal Administrative Boundaries", MAB) was used to implement the GIS. This shapefile, produced by the Regional Administration of Sardinia on the basis of their digital cartography,¹ contains 377 polygons, one for each municipality; each polygon in the map corresponds to the area included within a municipality's administrative boundary. The attribute table associated with this polygonal theme consisted therefore of 377 rows (records, as many as the municipalities are) and four columns (fields). The four fields in the original table contained only some basic information about each municipality: land area ("AREA_CITY"), length of the boundary ("PERIMETER"), name of the municipality ("NAME_CITY"), and an alphanumeric code ("ISTAT") which identifies uniquely each municipality in the Italian Census system. This table was therefore completed by means of a series of both "join" procedures² and spatial analysis techniques, leading to the addition of a number of fields whose labels are as follows: i. POP_2007, ii. DENS, iii. URBS, iv. in_CLUs, v. COASTAM, vi. PERC_in_CLUs, vii. in_CS, viii. COASTRIP, ix. PERC_in_CS, x. COASTURB, xi. PERC_UL_in_CS, xii. INVEST, xiii. INVEST_PC, xiv. INV_ERDF, xv. PERC_ERDF, xvi. INV_EAGGF, xvii. PERC_EAGGF, xviii. INV_FIFG, xix. PERC_FIFG.

The following paragraphs describe sources of information and procedures used to fill in the above additional fields.

2.1. Resident population and population density

As far as demographic data are concerned, a simple spreadsheet was downloaded from the official website of the Regional Administration of Sardinia³ and a "join" procedure was performed by using the census code as the key field. The numeric column "POP_2007", which provides information on resident population as of December 31st, 2007, was in this way added to the attribute table of the MAB shapefile. The numeric field "DENS" was then added, and its value was calculated by dividing, for each city, the number of citizens by the city's land area; this field gives information about population density in each municipality in 2007.

Figure 1 contains two choropleth maps in which Sardinian municipalities are classed according to the values of "POP_2007" and "DENS".

¹ Sardinian Regional Digital Cartography was produced between 1994 and 2000. It is a CAD-based cartography which covers the whole regional territory (approximately 24,000 square kilometers) and has a scale of 1:10,000. Coordinates are given with reference to the Italian national grid (also known as Rome 40 - Monte Mario) (<http://www.sardegna.territorio.it/j/v/241?s=15891&v=2&c=1938&t=1> [last-access date: March 3rd, 2010]).

² Chrisman (2002, p. 133) defines "join" as "a procedure that attaches values from a database table to another table based on matching a foreign key to its primary instance."

³ www.sardegna.territorio.it [last-access date: March 3rd, 2010].

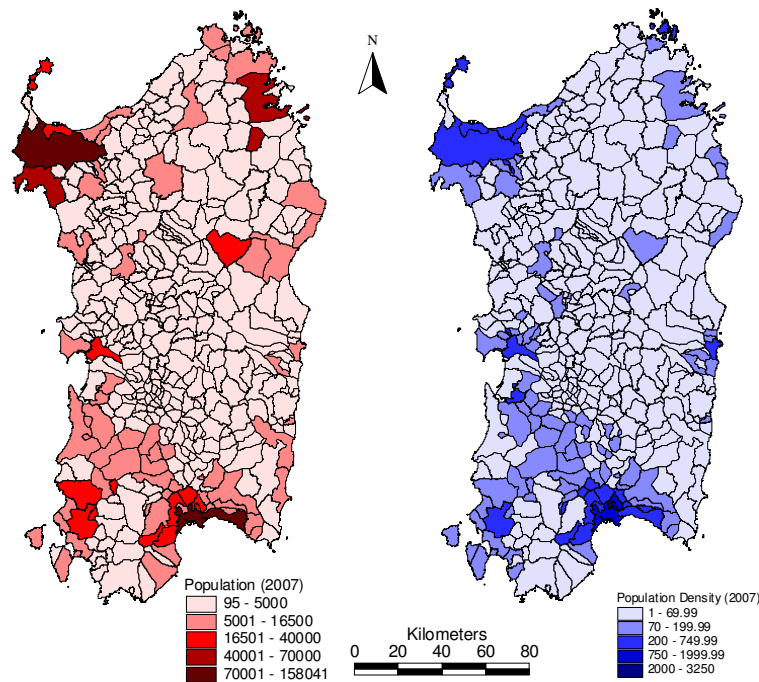


Figure 1. Resident population in 2007 (left) and population density in 2007 (residents per km², right).

2.2. A categorization of municipalities

The field “URBS” categorizes Sardinian municipalities into five groups, as defined by the Sardinian 2007-2013 ROP-ERDF (pages 151 and 152). These groups are as follows:

- Greater urban areas;
- Mid-dimensional urban areas;
- Mountain towns and cities;
- Municipalities included in a Local Work System (LWS) having a population density in 2001 greater than, or equal to, 50 inhabitants per km²;
- Municipalities included in a Local Work System (LWS) having a population density in 2001 smaller than 50 inhabitants per km².

As for “greater urban areas,” the Sardinian 2007-2013 ROP-ERDF lists 23 municipalities as belonging to this group for their importance at the regional level. Only municipalities very close to the two main cities in the island (that is, Cagliari and Sassari) are included in this group, which comprises, in addition to the aforementioned cities, Alghero, Assemini, Cagliari, Capoterra, Castelsardo, Decimomannu, Elmas, Maracalagonis, Monserrato, Porto Torres, Pula, Quartu Sant’Elena, Quartucciu, Sarroch, Sassari, Selargius, Sennori, Sestu, Settimo San Pietro, Sinnai, Sorso, Stintino, and Villa San Pietro. Ten municipalities (Carbonia, Iglesias, Lanusei, Nuoro, Olbia, Oristano, Sanluri, Tempio Pausania, Tortoli, and Villacidro) are listed as “mid-dimensional urban areas” in the Sardinian 2007-2013 ROP-ERDF. In contrast to cities belonging to the first group, mid-dimensional urban areas have a smaller importance, somewhat limited to the local level.

The third group comprises mountain towns and cities, as defined by the Deliberation of the Regional Government (DRG) no. 49/16 of October 21st, 2005. Following Sardinian Regional Law no. 12/2005, this DRG lists as mountain cities (a) those municipalities whose land area has an altitude of at least 400 meters above the sea level for at least a half of its surface, and (b) those municipalities whose land area has an altitude of at least 400 meters above the sea level for at least a 30 percent of its surface, provided that the difference between minimum and maximum height is at least equal to 600 meters. Since seven (Iglesias, Lanusei, Maracalagonis, Pula, Sinnai, Tempio Pausania, Villacidro) out of the 120 municipalities classed as mountain cities by the DRG had already been categorized according to the ROP-ERDF either as greater urban areas or as mid-dimensional urban areas, only 113 municipalities were here considered as included in this third group.

The 231 remaining municipalities were classed on the basis of the value of the population density (as of 2001) of the LWS they belonged to.⁴ In order to calculate this value, the shapefile containing municipal boundaries was used together with a two-field matrix linking each municipality with the LWS it belonged to.⁵ The *dissolve* procedure (Chrisman, 2002), also known as “spatial aggregation” (Biallo, 2002), was then used to aggregate all the polygons (in this case, those representing Sardinian municipalities) that shared the same value of a given attribute (here, the LWS code). By doing so, lines dividing two contiguous polygons having the same LWS code were dropped and a new shapefile, representing the 45 Sardinian LWS, was obtained. Land area and resident population of each LWS were derived from municipal land areas and municipal resident populations by means of the *summarize* function⁶ in order to calculate, for each LWS, its population density. This made it possible to categorize the remaining 231 municipalities according to the value of this attribute.

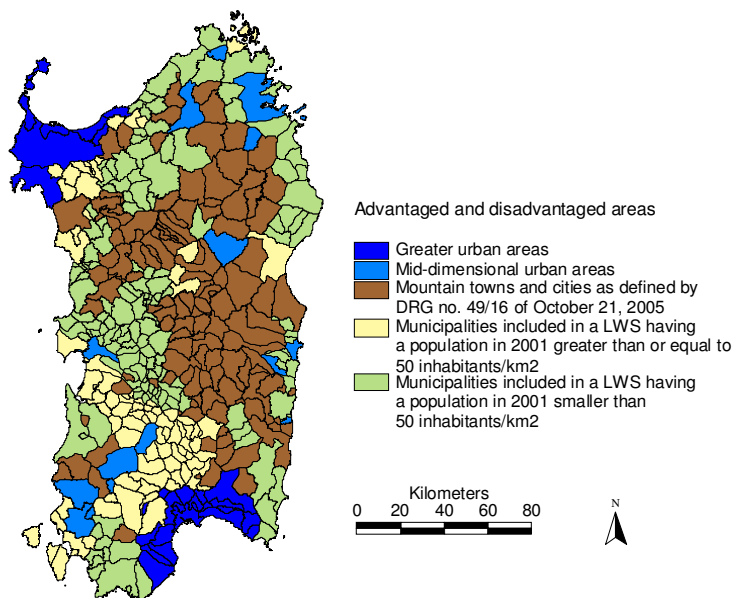


Figure 2. Sardinian municipalities: advantaged and disadvantaged areas.

It is worth noting, though, that an exception was made for the Oristano LWS. In fact, this LWS (whose population density is greater than 50 inhabitants per km²), according to the ROP-ERDF is characterized by a significant level of disparity between its constituent cities, so that two groups can be identified. On the one hand lie the main city (Oristano) and its hinterland, consisting of four cities; on the other hand, 20 disadvantaged, small-size towns and villages having an extremely low population density. These 20 municipalities were thus categorized as belonging to the fifth group (“municipalities included in a Local Work System (LWS) having a population density in 2001 smaller than 50 inhabitants per km²”), in spite of the actual population density of their LWS, to take into account their disadvantaged condition.

The choropleth map in Figure 2 shows the output of this classification process.

2.3. Sardinian Regional Landscape Plan: Coastal Landscape Units

The Sardinian RLP is the first statutory landscape plan with regional dimensions produced in Italy under the National Code of Cultural Heritage and Landscape, which required that each regional executive committee should approve a regional landscape plan. Furthermore, a regional law approved in

⁴ A spreadsheet listing Italian LWS's is available on the Internet at the Italian Institute of Statistics' (ISTAT) website: http://dwcis.istat.it/cis/docs/sistemi/tav_12_sll.xls [last-access date: March 3rd, 2010].

⁵ The table can be downloaded from http://www.sardegnaistatistiche.it/documenti/12_166_20080314111709.xls [last-access date: March 3rd, 2010].

⁶ Given a table where a field (in which multiple occurrences of a certain value are allowed) has been selected as the key field, the *summarize* function returns an output summary table consisting of as many rows as the unique values of the selected field in the original table are. Various statistical fields can be added to the summary table (Environmental Systems Research Institute, 1999; Hutchinson, 2004).

2004 required that the Sardinian RLP for coastal areas be approved within one year since the approval of the regional law itself, so in 2006 the RLP was approved by the regional executive. The Regional Administration of Sardinian initially focused on coastal areas only, in order to protect a part of the island considered both economically strategic and environmentally fragile (Zoppi and Lai, 2010). For this reason, 27 “Coastal Landscape Units” (CLUs, Figure 3 left) were identified “on the basis of detailed spatial analyses, and of heritage, built environment and environmental characteristics” (Planning Implementation Code of the RLP, next referred to as PIC, article 14). General rules and restrictions contained in the PIC are in force in those municipalities whose territory either is completely within the CLUs or partially overlaps the CLUs. To the contrary, for the remaining municipalities located in the inner part of the island, whose territory does not overlap any of the CLUs, only specific articles of the PIC, dealing with the preservation of specific landscape features or assets, precisely identified in maps and lists contained in the plan, are in force. Whether or not a municipality overlaps a CLU is thus of the outmost importance.

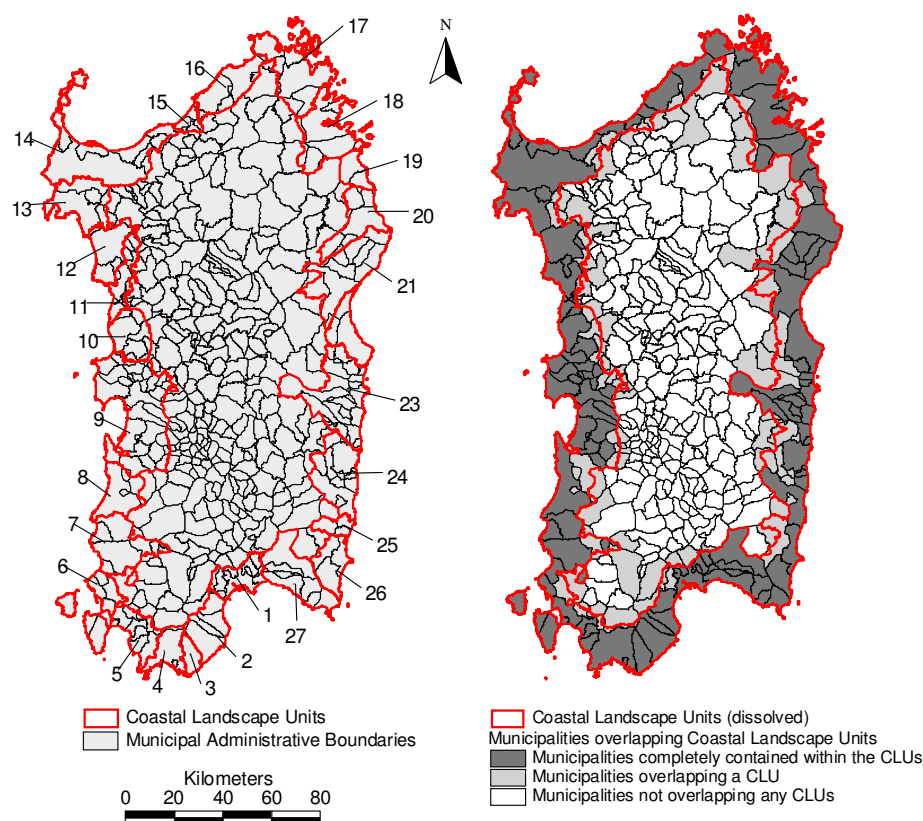


Figure 3. Spatial distribution of the 27 Coastal Landscape Units (left) and a classification of municipalities according to their spatial relationship (inclusion or intersection) with the CLUs (right).

To begin with, a *dissolve* procedure was performed on a shapefile containing the 27 CLUs, so as to obtain a polygonal layer containing only one polygon; this preliminary step was necessary to avoid having more than one record per municipality as a result of the spatial intersection procedure, because boundaries of the CLUs do not coincide with municipal boundaries. A spatial intersection was next performed, by using the MAB as the input layer and the one-record polygonal theme representing the area covered by the CLUs as the overlay layer; this made it possible to fill in the values of a text field (“in_CLUs”) used to categorize municipalities into three types: (i) completely included in the CLUs; (ii) partially included in the CLUs; (iii) not overlapping any CLUs. By means of the same spatial intersection, the area of the intersection (“COASTAM”), as well as the percentage of the municipal land area included in the CLUs (“PERC_in_CLUs”), was calculated. Finally, data from the four-field resulting table (the fourth field being the census code, “ISTAT”) were imported into the MAB table by

means of a join. Figure 3 (right) shows the results of this analysis: 102 municipalities are completely contained within the CLUs, 65 overlap them, and the remaining 210 are not part of any CLUs, so general rules and restrictions of the PPR are currently in force in 167 out of the 377 Sardinian municipalities.

2.4. Sardinian Regional Landscape Plan: the “coastal strip”

The so-called “coastal strip” (CS) is defined in article 19 of the PIC as a “strategic resource, vital for the achievement of sustainable development in Sardinia, that requires integrated planning and management.” From the geographic point of view, its boundary is precisely identified in a series of 1:25,000 maps which are part of the RLP and, as Figure 4 (right) shows, the CS is completely included in the CLUs.

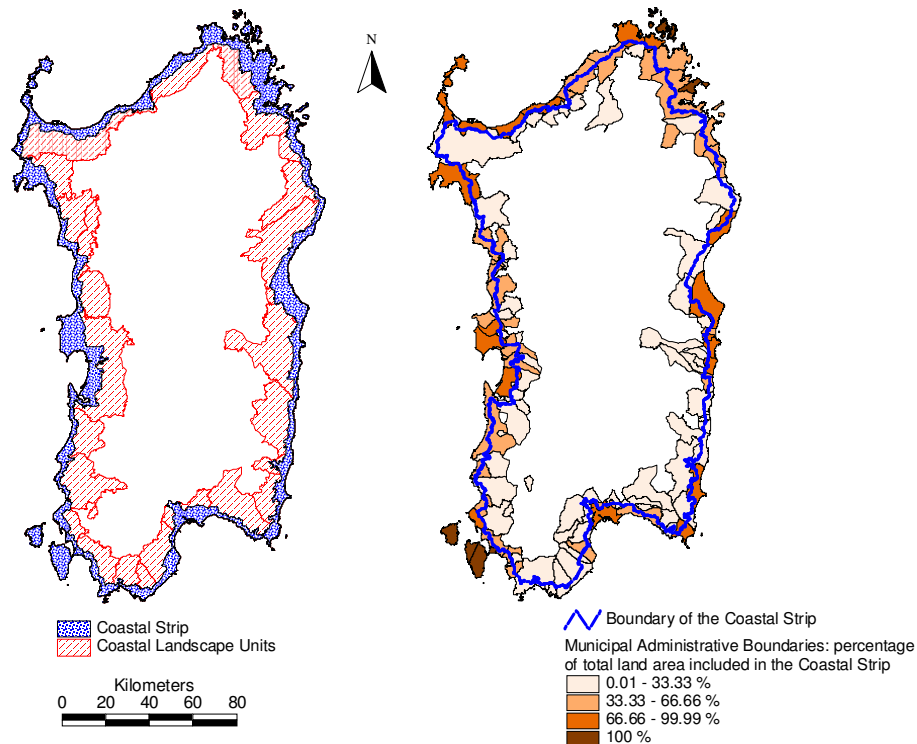


Figure 4. The Coastal Strip (left) and a classification of municipalities according to the percentage of their land area included in the CS (right).

Under article 20 of the PIC, as a general rule, new development of land and transformation of current land uses are not allowed in the CS; in particular, construction of new major roads, of new industrial or commercial developments, of new camping sites and of facilities associated with golf courses is forbidden within the CS. Some exceptions to the general rule are allowed, provided that municipalities and developers abide by regulations and procedures given by the PIC. Due to these particular restrictions in force in the CS, it was believed that the amount of municipal land area included in the CS could be a relevant impact factor on the ability of cities and towns to spend funds allocated for public services and infrastructure.

Since a linear shapefile containing only one record, the inner boundary of the CS, was available, it was necessary that a polygonal layer (with only one record, that is the CS itself) be obtained. The same procedure as in section 2.4 was next performed, in order to fill in the values of a text field (“in_CS”) used to categorize municipalities into two types: (i) those that overlap the CS; (ii) those that do not overlap the CS, and to calculate, for each municipality, both the amount (field “COASTRIP”) and the percentage of municipal land area included in the CS (field “PERC_in_CS”). Out of the 377 Sardinian municipalities, 272 do not overlap the CS. The 105 municipalities whose territory overlaps the CS are shown in Figure 4 (right); out of these 105, only six are completely contained in the CS.

2.5. Urbanized land within the “coastal strip”

The amount of urbanized land within the CS was calculated by means of a series of spatial analysis procedures on the basis of two different sources of data.

The first source was the RLP’s spatial database; in particular, a set of themes concerning the description of urban built environment was used. According to article 63 of the PIC, urban built environment consists of: historic town and city centers, areas urbanized up to the 1950s, areas urbanized in more recent times (that is, from 1950s onwards), programmed developments in urban areas, and scattered urban developments. For each type, the PIC gives a precise definition, plus a set of prescriptions and directions for planning activities. Only the first three types were here taken into account; the fourth was not included because areas for future development were not spatially identified by the RLP (in fact, they have to be allocated by municipal zoning schemes, which in turns must be compliant with the RLP’s rules and directions), while the fifth was here not considered because, from a geographical perspective, polygons in this theme do not represent plots of land; rather, this layer consists of small, scattered polygons, each representing a detached building in the countryside. In addition, developments for tourism purposes were also included in our analysis. Article 88 of the PIC defines them as consisting of “mostly private houses and camping sites, mainly scattered along the coastline and built from the 1960s onwards to accommodate tourists” especially in summers. The above four themes, which are mutually exclusive (e.g., a certain plot of land cannot be classed both as “area urbanized up to the 1950s” and as “development for tourism purposes”), were merged together and a single theme was obtained.

The second source of data was the regional land-use map,⁷ in which current land uses are identified by means of a five-tier hierarchical alphanumeric code, in compliance with the European project “Corine Land Cover.”⁸ Only those records whose land-use code began with the letter “1”, “artificial surfaces” were selected by performing a simple attribute query.

Data from the two sources were subsequently merged by means of a “union” procedure.⁹ A single plot of land was therefore treated as “urbanized area” when it was classed as “built environment” according to the RLP, or as “artificial surface” according to the regional land-use map, or both. This was necessary because of the different aims and spatial resolutions of the two data sources here used: for example, a pond in an urban park could be included within the built environment by the RLP while being regarded as a sub-type of water bodies (class 5) by the regional land-use map. Moreover, class 1 of the land-use map also included urbanized lands other than residential areas and areas for tourism developments (e.g. industrial areas, urban parks, cemeteries, airports). In doing so, we tried to obtain, for the whole island, a spatial representation of urbanized land as comprehensive and thorough as possible. The single theme resulting from the previous “union” procedure was next clipped by using the CS as the clipping layer. As a result, a second theme, representing the spatial distribution of urbanized land within the coastal strip (ULCS) was obtained. Figure 5 shows the final outcome of this procedure.

⁷ Completed in 2008, the so-called “New Land Use Map of the Region of Sardinia” is, in fact, a spatial data base that covers the whole island and has a scale of 1:25,000. Minimum mapping unit (Longley *et al.*, 2001 p.151) of the map equals 0.5 hectares in urban areas and 0.75 hectares in the countryside (<http://www.sardegnaterritorio.it/j/ v/ 241?s= 107719&v= 2&c=1950&t=1> [last-access date: March 3rd, 2009]).

⁸ This means that the first letter corresponds to a general land use, which is described in greater detail by means of a second letter, and further by means of a third letter, and so on. General class 1 corresponds to “artificial surfaces,” class 2 to “agricultural areas,” class 3 to “forest and semi-natural areas,” class 4 to “wetlands” and class 5 to “water bodies.”

⁹ This procedure is also called “*spatial OR*” because, given two input layers, the output layer comprises features included in any of the input layers.

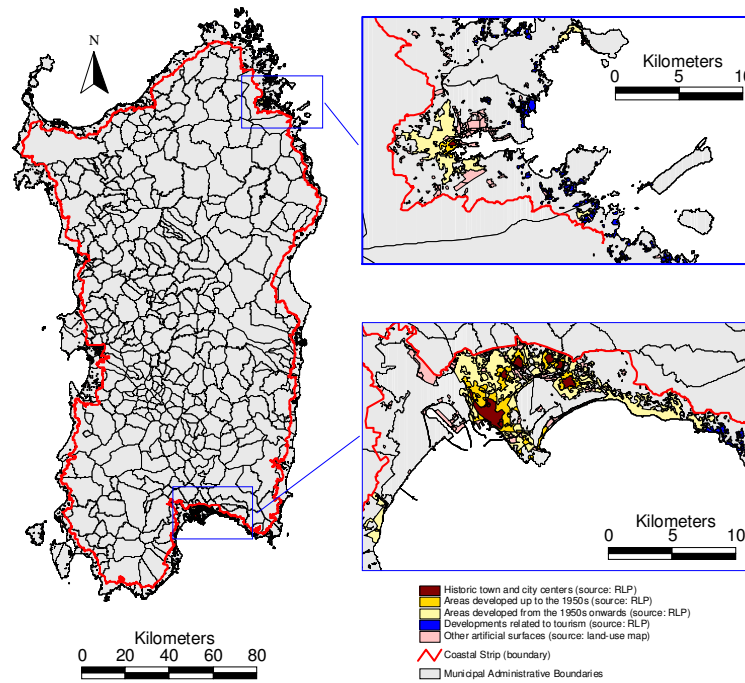


Figure 5. Spatial distribution of urbanized land within the CS, classed according to the type and source (left); details (right).

Finally, a spatial intersection was performed by using the ULCS as the input layer and the MAB as the overlay layer. This allowed us to calculate, for each municipality, the amount of urbanized land included in the coastal strip (field “COASTURB”, Figure 6) and the ratio urbanized land included within the coastal strip by municipal land area included within the coastal strip (field “PERC_UL_in_CS”).

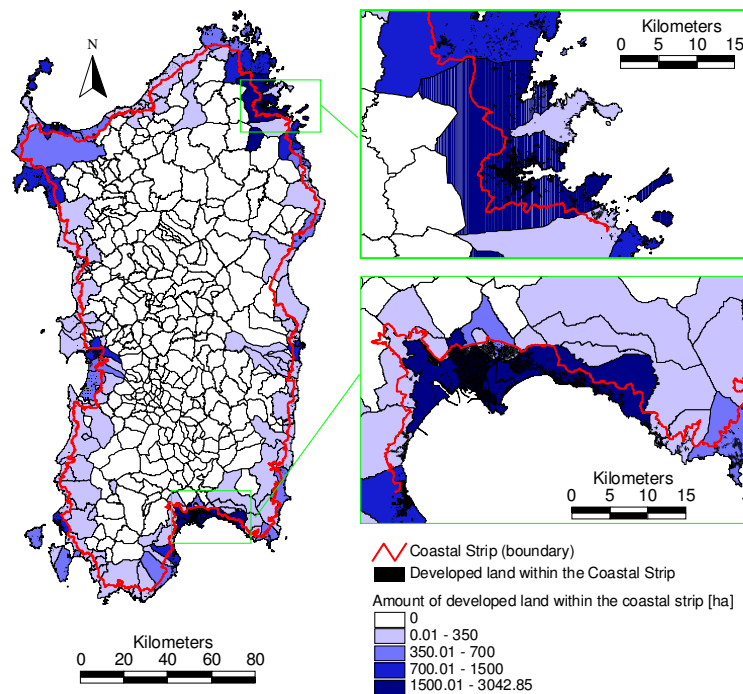


Figure 6. A classification of municipalities according to the amount of urbanized land included in the coastal strip; details (right).

2.6. Financial data

Implementation of projects co-financed through the European cohesion policy in Italy was monitored, at the national level, by means of a web database called MONIT. Data included in the database were related to technical, administrative and financial management of projects, and could be queried in many different ways. Financial data in the database were last updated June 30th, 2009, which was also the final date for eligibility of expenditure of funds from the programming period 2000/2006, as a result of the extension granted because of the economic crisis.

From the national database we selected only those records for which both of the following conditions were true: (i) projects were carried out in Sardinia, and (ii) funds were granted for public services and infrastructure (as opposed both to supply of goods and services and to incentives to private investors), irrespective of whether the projects had been funded through the European Regional Development Fund (ERDF), the European Social Fund (ESF), the European Agricultural Guidance and Guarantee Fund (EAGGF), or the Financial Instrument for Fisheries Guidance (FIFG). By means of this query, 4288 record meeting both conditions were selected.

Out of these 4288 projects, 34 were deleted because they were not related to a single municipality; in fact, 10 had been carried out at the regional level and affected therefore the whole Sardinian territory, and 24 had been carried out at the provincial level. As a result, 4254 projects could be directly connected to a municipality.

Next, 158 records were deleted because the field “Expenditure” equaled zero; in other words, by June 30th 2009, final date for the eligibility of expenditure, no funds had been spent on these 158 projects. The number of projects that could be used for the purpose of this research was therefore equal to 4096. A total of Euros 2,459,504,928.52 had been spent, on these projects, by June 30th 2009.

By means of the *summarize* function, and by choosing as the key field the one containing the codes that uniquely identify each municipality, a summary table consisting of 377 records was obtained. This means that all of the 377 Sardinian municipalities, through the European cohesion policy, had received and spent funds for public services and infrastructure. For each municipality, the following fields were added and their values were calculated:

- “INVEST”: expenditure for public services and infrastructure by June 30th, 2009 [Euros];
- “INVEST_PC”: expenditure per capita for public services and infrastructure by June 30th, 2009 [Euros];
- “INV_ERDF”: expenditure through the ERDF for public services and infrastructure by June 30th, 2009 [Euros];
- “PERC_ERDF”: ratio expenditure through the ERDF for public services and infrastructure by June 30th, 2009 by total expenditure for public services and infrastructure by June 30th, 2009 [Euros];
- “INV_EAGGF”: expenditure through the EAGGF for public services and infrastructure by June 30th, 2009 [Euros];
- “PERC_EAGGF”: ratio expenditure through the EAGGF for public services and infrastructure by June 30th, 2009 by total expenditure for public services and infrastructure by June 30th, 2009 [Euros];
- “INV_FIFG”: expenditure through the FIFG for public services and infrastructure by June 30th, 2009 [Euros];
- “PERC_FIFG”: ratio expenditure through the FIFG for public services and infrastructure by June 30th, 2009 by total expenditure for public services and infrastructure by June 30th, 2009 [Euros].

As it could be expected, no projects for public services and infrastructure were funded through the ESF. The choropleth map in Figure 7 shows a classification of municipalities based on total expenditure for public services and infrastructure (as of June 30th, 2009) through the European cohesion policy. A rough idea of the distribution of investment according to funding sources (ERDF, EAGGF, FIFG) is given in the detailed maps on the right-hand side.

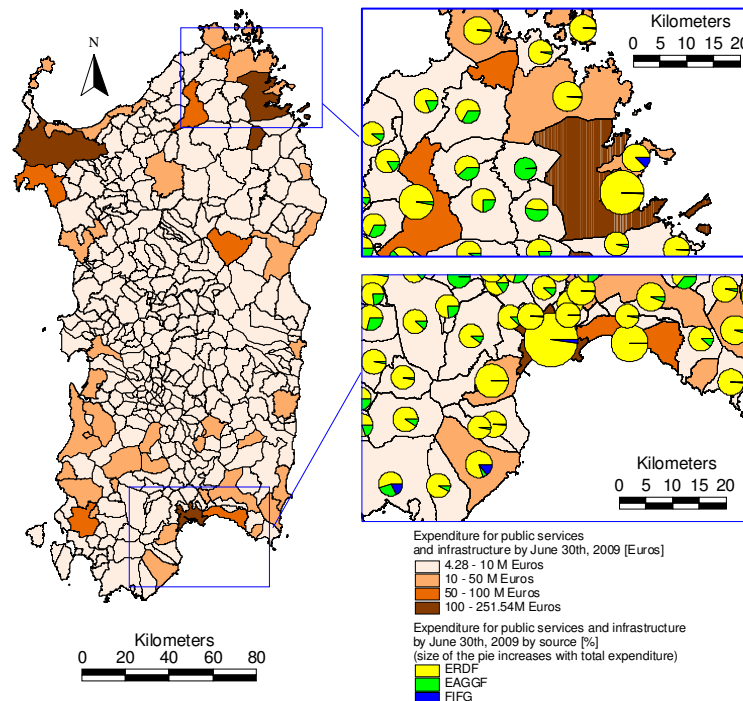


Figure 7. A classification of municipalities based on total investment for public services and infrastructure by June 30th, 2009 (left); level of expenditure and source (right).

Building upon the results of the GIS-based analysis presented in this section, the following section will examine the impact of some of the attributes here identified and quantified on municipal investments for public services and infrastructure.

3. PUBLIC INVESTMENT FOR SERVICES AND INFRASTRUCTURE IN THE COASTAL CITIES IN THE CONTEXT OF THE 2000-2006 ROP

The process of adjustment of the Masterplans (MPS) of the cities of the coastal strip to the RLP is quite complicated. The MPS have to conform themselves to the descriptive, prescriptive and propositive contents of the RLP, to the general planning rules and directives established by the RLP for the coastal zones, and to the strategic policies for the “conservation and protection, maintenance, improvement or restoration of the landscape values identified in the landscape units.” (Planning implementation code of the RLP (PIC), article 7, paragraph 1). The relationships between landscape values, characteristics of the zones and categories of strategic actions are described in the Annex 1 of the PIC. A significant and problematic issue concerning the change of the MPS in order to follow the RLP is referred: i) to the areas which belong to the “Coastal strip” according to the PIC; these zones roughly correspond to the “Tourist coastal zones” (labeled as “F” zones) of the MPS; ii) to the residential areas, identified as “C” zones in the actual MPS immediately adjacent to the consolidated urban fabric of the city; these zones may or may not correspond to the “Programmed expansions” of the PIC. This question is extremely important, in the context of the adaptation process of the urban planning rules of cities and provinces to the RLP, whose territory is inside the boundary of the coastal strip as defined by the PIC.

The question of the adaptation process of the actual MPS to the RLP is of paramount importance for the effectiveness of the new planning policies of the Sardinian regional administration, and for the definition of a general model for the strategic assessment of city planning based on the analysis of perceived needs and expectations of the local communities, through sustainable-development-oriented governance processes (Cau and Zoppi, 2008).

The PIC states the planning rules for the tourist coastal zones without detailed plans in force. These are the following:

- i. the quality of the existing tourist supply (houses, hotels, camping sites) of urban centers, villages, rural and scattered settlements, and old mining villages, must be fostered (PIC, article 90, paragraph 1, letter a);
- ii. tourist projects for the existing settlements and their public areas must be defined and implemented, possibly through a step-by-step approach, in order to promote the improvement of the quality of the tourist supply and to favor a longer tourist season (article 90, paragraph 1, letter b, §1);
- iii. tourist projects must aim to increase the supply of rooms in hotels rather than build vacation houses (article 89, paragraph 1, letters a and b);
- iv. new projects should increase the tourist supply through the restoration of existing residential buildings and the realization of rooms and suites available for tourists, rather than through construction of new buildings; transformation of houses into hotels can be stimulated by giving extra building permits in areas located outside the coastal strip (article 90, paragraph 1, letter b, §2);
- v. settlements in the coastal strip should be relocated outside it; these should take place possibly in sites adjacent to existing residential settlements in order to minimize impacts on the landscape; relocation of residential settlements can be stimulated by giving extra building permits in areas located outside the coastal strip, allowing for up to 100 percent residential volume increment (article 90, paragraph 1, letter b, §3).

It is evident that the adjustment of the MPS to the RLP implies significant losses of residential volume and tourist houses in the coastal strip, and, as a consequence, a decline in projected investment for public services and infrastructure.

Let us consider, for example, the case of Sinnai, an important coastal city of Southern Sardinia, close to the regional capital, Cagliari. Let us take two sections of the tourist coastal zone adjacent to each other, identified as F2- and F4-type areas by the MPS, both in the territory of the administrative area of Solanas. The MPS allows to build houses up to 3,000 m³ on a 29,000-m² area (F2) for a nominal population of 50 residents, and hotels, residences, bungalows and camping sites, up to 16,000 m³ on a 125,000-m² area (F4) for a nominal population of 270 residents. With the exception of a 3 percent of the F4-type area, where, optimistically, a 485-m³ very small new hotel could be built – which, incidentally, could be allowed only if it were demonstrated that it is a functional improvement of an existing building – all the whole building capacity of the MPS would be lost, were it adjusted to the RLP. This loss amounts to about 20,000 m³ and it brings about a dramatic decrease of projected investment for public services and infrastructure.¹⁰

Coastal cities are of paramount importance for the policy of the ongoing 2007-2013 ROP-ERDF, since among these are the large- and medium-sized urban areas, on which about a half of the total investment of the program is concentrated. The concentration principle is connected to the question of territorial cohesion.

Territorial cohesion is recognized as an important informative principle of the EU 2007-2013 cohesion policy, based on the Structural Funds. Regulation no. 1080/2006/EC, concerning the European ERDF, states that “in the case of action involving sustainable urban development as referred to in Article 37(4)(a) of Regulation (EC) no. 1083/2006, the ERDF may, where appropriate, support the development of participative, integrated and sustainable strategies to tackle the high concentration of economic, environmental and social problems affecting urban areas. These strategies shall promote sustainable urban development through activities such as: strengthening economic growth, the rehabilitation of the physical environment, brownfield redevelopment, the preservation and development of natural and cultural heritage, the promotion of entrepreneurship, local employment and community development, and the provision of services to the population taking account of changing demographic structures.” (art. 8) Moreover, the questions of territorial cohesion are stressed in art. 10, which establishes that the ERDF can finance investments for the urban, economic and social development of “areas facing geographical and natural handicaps as referred to in point (f) of Article 52 of Regulation (EC) no. 1083/2006,” which, in the Sardinian case, are identified with mountain areas, and zones with low (less than 50 inhabitants per km²) and very low (less than 8) demographic density.

¹⁰ The detail of the calculations is omitted here. It is based on the information provided in the Main Report of the MPS of Sinnai. The MPS was established by two Deliberations of the City Council (no. 87/October 30, 2000, 41/July 17, 2001 and no. 63/October 30, 2002), and published on the Bulletin of the Autonomous Region of Sardinia no. 40/November 26, 2002.

The 2007-2013 ROP-ERDF respects the rules of the ERDF on the investments for territorial cohesion since it promotes their regional geographic concentration. These investments are evenly shared between large- and medium-sized urban areas, and disadvantaged zones, as defined above.

So, a large share of the 2007-2013 ROP-ERDF is concentrated in coastal cities, and, at the same time, coastal cities are heavily influenced in their future development by the limits superimposed by the RLP. In this section we try to analyze the impact of the RLP rules on investment for public services and infrastructure coming from the 2000-2006 ROP in coastal cities. This investment is a large share of the total public investment which occurred in the 2000-2009 period.¹¹ We show that the greater the share of the city area included in the coastal strip, the lower the investment. In other words, we find that the RLP rules have a depressing impact on the expenditure for public services and infrastructure.

This section is organized as follows. In the first paragraph, the MLM methodology is presented in the context of the case study discussed in this essay. Secondly, the results concerning the analysis of the impact of the RLP rules on the investment for Sardinian Region's coastal cities coming from the 2000-2006 ROP Sardinian Region are discussed; there results stem from the application of the MLM methodology.

3.1. Methodology

The MLM's describe how people choose among a discrete set of mutually exclusive alternatives. McFadden's work (1978, 1980) on generalized extreme value formulation, which generalized the work of Williams (1977), provides a rigorous foundation for consumer choice modeling derived from economic theory. Although the original formulation of the random utility maximization as a behavioral model followed the economists' theory of consumer behavior, it also included features of the taste template that were heterogeneous across individuals and unknown to the analyst, as well as unobserved aspects of experience and of information on the attributes of alternatives, interpreted as random factors (McFadden, 1978, 1980, 2000). This led to the paradigm for generating discrete-choice models commonly reported in textbooks (Ben-Akiva and Lerman, 1985; Ortúzar and Willumsen, 2001; Train, 2009), that the random part of the individual utility reflects the modellers' lack of complete information about all the elements considered by the individual making a choice and the observed deviations of individual behavior from perfect rationality (Tversky, 1972).

The key assumption of the MLM is that errors are mutually independent. This independence means that the unobserved portion of utility for one alternative is unrelated to the unobserved portion of utility for another alternative. It is a fairly restrictive assumption, and the development of other models has arisen largely for the purpose of avoiding this assumption and allowing for correlated errors. It is important to realize that the independence assumption is not as restrictive as it might at first seem, and in fact can be interpreted as a natural outcome of a well-specified model.¹²

The MLM methodology is generally used to study phenomena characterized by nominal observations, that is, observations represented by categories of outcomes defined by means of names. These names do not represent any order.

The assumption of the MLM models is that these phenomena are correlated to other phenomena, represented by numerical and nominal variables, through a logistic probability function. This function makes it possible to characterize these correlations.

The MLM approach is used in different and mostly-heterogeneous scientific fields, since it is extremely effective, theoretically and empirically, in order to analyze several issues concerning the interpretation of human behavior.¹³

MLM methods are widely used to study subjective choices between multiple alternatives. This is true, for example, when referring to choices between different destinations for recreational activities. Bockstael *et al.* (1987) use the MLM approach to characterize the choice between seawater and freshwater beaches, while Bockstael *et al.* (1991), when describing the approach proposed by McFadden (1974, 1978), put in evidence that his methodology requires particular attention if the choice implies nested steps, such as "if...then...else..." which follow each other: choice of a recreational activity

¹¹ By June 30, 2009, the expenditure of the 2000-2006 ROP had to be entirely realized and the official statements of account had to be made available to the European Commission.

¹² This introductory discussion largely draws on Cherchi (2009).

¹³ For the applications of the MLM approach in several fields see Bhat (2007).

(e.g.: fishing), choice of the activity type (e.g.: underwater fishing), choice of the most suitable, choice of the type of fish, etc.

Consistent with this framework is McFadden's theoretical and practical research, which was awarded the Nobel prize in 2000 (McFadden won the prize with Heckman). McFadden studies the issue of discrete choice under different points of view. Among these are the demand for urban transport services (1974a), the choice between different transport modes (McFadden and Train, 1978), the demand for local phone services (McFadden *et al.*, 1987), the decision-making processes of the public administration (1976).

Other important applications of the MLM approach are referred to the analysis of wage mobility in Europe (Pavlopoulos *et al.*, 2010), and to the assessment of the incidence of specific external factors on the ineffectiveness of particular clinical treatments (Ambrogi *et al.*, 2009).

In this essay, an MLM model is used to analyze the relation between a discrete variable, the investment for public services and infrastructure in Sardinian coastal cities through the 2000-2006 ROP, and other variables that are likely to be correlated to the investment variable. The MLM model is based on Greene's (1993, pp. 666-672), and Nerlove and Press's (1973) approaches.

The model considers a set of events $J, J=\{0, 1, \dots, N\}$, with probability of event $Y_i = j$ given by:

$$\text{Prob}(Y_i = j) = \frac{e^{\beta_j' x_i}}{1 + \sum_{k=1}^J e^{\beta_k' x_i}} \quad (1),$$

$$\text{Prob}(Y_i = 0) = \frac{1}{1 + \sum_{k=1}^J e^{\beta_k' x_i}} \quad (2)^{14},$$

where $j \in \{1, \dots, N\}$, β_j is a vector of coefficients referred to the event j , and x_i is a vector of characteristics of the territorial context i , where the event j occurs, $i \in \{1, \dots, M\}$. Coefficients β_j 's are estimated by solving the maximization problem of the following log-likelihood function, $\ln L$:

$$\ln L = \sum_{i=1}^M \sum_{j=0}^J d_{ij} \ln \text{Prob}(Y_i = j) \quad (3)$$

(where $d_{ij}=1$ if in the context i the event j occurs, and $d_{ij}=0$ otherwise), in the coefficients β_j 's. These coefficients will appear in (3) through the expressions (1) and (2) of $\text{Prob}(Y_i = \cdot)$.

The derivatives of (3) with respect to the coefficients β_j 's have the following form:

$$\frac{\partial \ln L}{\partial \beta_j} = \sum_{i=1}^M [d_{ij} - \text{Prob}(Y_i = j)] x_i \quad (4)$$

The values of the vectors of coefficients β_j 's which maximize (3) are the solution of the system which comes from equalizing to zero the derivatives expressed by (4).

The values of the vectors of coefficients β_j 's make it possible to calculate the marginal effects of a change of the vector of characteristics x_i on the probability that the event j occurs in the context i , $\frac{\partial \text{Prob}(Y_i=j)}{\partial x_i}$, as follows:

$$\frac{\partial \text{Prob}(Y_i=j)}{\partial x_i} = [\text{Prob}(Y_i = j)] \{ \beta_j - \sum_{k=1}^J [\text{Prob}(Y_i = k)] \beta_k \}. \quad (5)$$

The estimate of the model makes it possible to calculate the marginal effects of (5), e.g. with reference to the average values of the x_i 's, and the probabilities of the events j 's. Moreover, the model makes it possible to estimate the standard errors of the estimates of the β_j 's and of the marginal effects of (5).

¹⁴ If we define $\beta_j^* = \beta_j + q$ for any nonzero vector q , the identical set of probabilities result, as the terms involving q involving q all drop out. A convenient normalization that solves the problem is to assume that vector $\beta_0 = 0$. The probability for $Y = 0$ is therefore given by (2) (Greene, *cit.*, p. 666).

3.2. The analysis of the 2000-2006 ROP investment for coastal cities

The analysis of the investment for public services and infrastructure in Sardinian coastal cities is based on the model described in paragraph 3.1. Characteristics x_i and their measures are defined, and the results of the model application are reported with reference to: i. the estimates of coefficients β_j 's, ii. the marginal effects from (5), and iii. the probabilities of the events contained in the set J.

The territorial contexts, indicated by letter i in paragraph 3.1., $i \in \{1, \dots, M\}$, are the 167 Sardinian coastal cities whose policies were funded through the 2000-2006 ROP-ERDF. These are approximately a half of the Sardinian cities.

Characteristics x_i , their measures and descriptive statistics are reported in Table 1.

The discrete variable which describes the investment, indicated by Y_i in paragraph 3.1. and labeled INVEST in Table 1, takes three values (0, low investment level; 1, medium; 2, high) identified by the three intervals of the 33rd and 67th percentiles.

The choice of the explanatory variables which characterize the 167 Sardinian coastal cities is justified as follows. The residential density (DENS) puts in evidence, at least to a certain extent, the relation between residential layout and a city's territory: it is evident that, everything else being the same, the greater the residential density, the greater the consumption of the urban territory, and the lower the availability of areas for future urban residential expansions. Moreover, a more consumed urban territory implies a greater attention to the protection of natural resources and to urban renewal policies.

A typological taxonomy of the Sardinian cities (URBS) is based on the urban development concept and the policies for the disadvantaged zones of the 2007-2013 ROP-ERDF, which are referred to the geographic concentration of the investments. This variable puts in evidence, with reference to the policies implemented between 2000 and 2006 if, and by how much, investment for deprived zones (disadvantaged zones¹⁵ and cities included in a Local work system (LWS) with a residential density in 2001 lower than 50 residents/km²) is different from investment for large and medium-sized urban areas, and in cities included in a LWS with a residential density in 2001 greater than or equal to 50 residents/km². This variable controls if, and by how much, the investment policy for territorial cohesion, based on the principle of geographic concentration, has been properly implemented.

The variable concerning the amount of a city's territory included in coastal landscape units (COASTAM) indicates to what extent the city's territory is subject to the general rules of the RLP, which are valid only for the areas belonging to coastal landscape units. It is likely that the more a city's territory is subject to the RLP's rules, the lower the investment. Moreover, two explanatory variables are used for a better understanding of the role played by the RLP: i. a variable that controls for the amount of a city's territory included in the coastal strip (COASTRIP), which is the part of the territory belonging to the coastal boundary where the most restrictive rules concerning future developments hold; ii. a variable referred to the amount of a city's territory included in the coastal strip which is already urbanized (COASTURB). It is likely that: i. the more a city's territory is included in the coastal strip, the lower the investment; ii. the more the coastal-zone urbanized area, the less restrictive the RLP rules, the higher the investment.

The procedure described in the previous paragraph is used to estimate the coefficients β_j 's and marginal effects $\frac{\partial \text{Prob}(Y_i=j)}{\partial x_i}$ on the probability of the events j's at the mean values of the x_i 's.

The estimates of the marginal effects on the probabilities of the events j's at the mean values of the x_i 's and the cumulative probabilities at the mean values of the x_i 's are reported in Table 2.

In the following paragraphs, the results concerning the effects of the explanatory variables on the three events which describe the investment level (low, medium and high) are discussed.

3.2.1. Residential density

The marginal effect of the residential density is negative and significant¹⁶ on the probability of event "0", while it is positive and non-significant for the events "1" and "2". This indicates that this variable is certainly more influential on the lowest investment levels, while it seems rather uncorrelated to the probability that higher levels do occur.

¹⁵ Defined by point (f) of Article 52 of Regulation (EC) no. 1083/2006, cited in the introductory paragraph of session 3.

¹⁶ If not otherwise specified, we define "significant" a value of a marginal effect which is significant at a 5 percent hypothesis test.

Variable	Definition	Mean	St.dev.
<i>INVEST</i>	Discrete variable – 2000-2006 ROP Investment for public services and infrastructure in the Sardinian coastal cities <ul style="list-style-type: none"> • 0 if it is less than the 33rd percentile; • 1 if it is between the 33rd and the 67th percentiles; • 2 if it is greater than the 67th percentile. The 33 rd and 67 th percentiles are the following: 1,861,229.0280 Euros; 6,043,620.3642 Euros	1.0000	0.81403
<i>DENS</i>	City residential density (residents per km ²)	116.8930	307.7800
<i>URBS</i>	Dummy - Investment does occur in large and medium-sized urban areas, and in cities included in a LWS with a residential density in 2001 greater than or equal to 50 residents/km ²	0.3772	0.4861
<i>COASTAM</i>	Amount of a city's territory included in coastal landscape units (km ²)	59.9702	72.7321
<i>COASTRIP</i>	Amount of a city's territory included in the coastal strip (km ²)	20.4041	33.6783
<i>COASTURB</i>	Amount of a city's territory included in the coastal strip which is already urbanized (km ²)	1.8435	4.2332

Table 1. Definition of variables and descriptive statistics

Variable	Marginal effect	z-statistic	Hypothesis test: marginal effect=0
Marginal effect on probability of $Y_i=0$ (low investment level), $\partial \text{Prob}(Y_i=0)/\partial x_i$, $\text{Prob}(Y_i=0) = 0.138$ ¹⁷			
<i>DENS</i>	-7.0173E-04	-2.445	0.0145
<i>URBS</i>	-4.4806E-02	-1.281	0.2002
<i>COASTAM</i>	-4.4686E-03	-3.055	0.0023
<i>COASTRIP</i>	3.1231E-03	1.848	0.0646
<i>COASTURB</i>	-4.6657E-02	-1.754	0.0794
Marginal effect on probability of $Y_i=1$ (medium investment level), $\partial \text{Prob}(Y_i=1)/\partial x_i$, $\text{Prob}(Y_i=1) = 0.463$			
<i>DENS</i>	-7.0173E-04	0.641	0.5218
<i>URBS</i>	-4.4806E-02	-1.210	0.2261
<i>COASTAM</i>	-4.4686E-03	-0.137	0.8914
<i>COASTRIP</i>	3.1231E-03	0.256	0.7978
<i>COASTURB</i>	-4.6657E-02	-0.734	0.4632
Marginal effect on probability of $Y_i=2$ (high investment level), $\partial \text{Prob}(Y_i=2)/\partial x_i$, $\text{Prob}(Y_i=2) = 0.399$			
<i>DENS</i>	2.7063E-04	0.320	0.7490
<i>URBS</i>	1.8594E-01	1.132	0.2576
<i>COASTAM</i>	4.8310E-03	1.959	0.0501
<i>COASTRIP</i>	-4.2828E-03	-0.908	0.3637
<i>COASTURB</i>	1.0149E-01	1.593	0.1112

Table 2. Marginal effects on the probabilities of the three events which define investment for public services and infrastructure

¹⁷ At the mean vector.

3.2.2. Investment does occur in large and medium-sized urban areas, and in cities included in a LWS with a residential density in 2001 greater than or equal to 50 residents/km²

The dummy variable URBS is always weakly significant (at more-than-20% hypothesis tests). Its influence is positive on the probability of event “2”, and negative otherwise. Apart from the significance level, there is a clear positive correlation between the highest levels of investment and the size of the urban area of the city, that is, the greater its urban size, the higher the probability that a high level of investment does occur. This is conversely confirmed at low and medium levels of investment.

3.2.3. City land included in coastal landscape units

The results are almost the same as in the case of URBS. The difference is in the significance levels: at the low and high investment levels the estimated marginal effect is significant, while at the medium level it is not. This finding indicates that, everything else being equal, investment is more attracted by the coastal cities whose amount of coastal land is greater.

3.2.4. City land included in the coastal strip

The marginal effect of this variable is only significant (at a 7% hypothesis test) on the probability that a low investment level does occur. The sign indicates that the higher the amount of the city land included in the coastal strip, the higher the probability that a low investment level does occur, which is consistent with the idea that the restrictions established by the PIC of the RLP on the coastal strip have a depressing impact on the investment for services and infrastructure.

3.2.5. Urbanized city land included in the coastal strip

The results are the same as in the case of COASTAM. This indicates that, everything else being equal, investment is more attracted by the coastal cities whose amount of urbanized coastal land is greater. So, since new urban developments in the coastal strip are forbidden by the PIC of the RLP, this finding implies a future irreversible decline of investment for public services and infrastructure for the coastal cities. This decline should be comparatively stronger for the (virtuous) cities which in the past tried to limit urban development in the coastal strip than for the cities which exploited more permissive rules of the good old days to boost coastal urbanization.

4. DISCUSSION AND CONCLUSIONS

The results put in evidence that, in general, the investment level for public services and infrastructure in Sardinian coastal cities concerning the 2000-2006 ROP is influenced by the rules of the PIC of the RLP. The results show that the hypothesized depressing influence of the comprehensive RLP's regional planning approach on investment for public services and infrastructure is punctually confirmed by the analysis implemented through the MLM.

Among Sardinian coastal cities, in fact, the most attractive are the “most coastal” ones, since the probability of higher levels of investment increases as the amount of a city's coastal land included in coastal landscape units increases, and the probability of lower levels of investment increases as the amount of coastal land decreases. Moreover, the “most coastal” cities are more densely populated and have a comparatively larger urban size; therefore, they attract higher levels of investment according to the results concerning the variables DENS and URBS.

On the other hand, coastal cities are less attractive for investment in public services and infrastructure provided that they have larger land portions and smaller urbanized areas in the coastal strip. Furthermore, since the PIC of the RLP prevents future urbanization in areas included within the coastal strip, it is likely that future investment will flee coastal cities and rush to other (inner) locations, with less restrictive rules coming from the PIC of the RLP.

The latter observation is reinforced by the results of a recent study of the authors (Lai and Zoppi, 2009), which shows that Sardinian non-coastal cities spent more easily and efficiently than coastal cities during the implementation of the 2000-2006 ROP. This is likely to be connected to the fact that since November 2004, when the Regional Law no. 8 was approved, Sardinian coastal cities have had to make their planning policies consistent with very strict planning rules, especially for areas included in the coastal strip (Zoppi, 2008).

Moreover, the depressing impact of the restrictive rules of the PIC of the RLP on investment in public services and infrastructure could be possibly connected to other negative impacts. Coastal cities could suffer from the decline of building expansion rights, since they could not rely any longer on the financial resources for public services and infrastructure that would come from the impact fees paid by the developers. Another problem for the budget of the city would come from the decrease in payments of the communal tax for real estate which includes land property, since the value of land would dramatically drop without development rights. Since in many of the actual tourist coastal zones it would not be possible to build anymore, a crisis of the local construction industry would probably occur. This industry is the most important in terms of income and employment for the local economy, which is characterized by a high unemployment rate. Its crisis would worsen an already difficult economic and social situation (Regione Autonoma della Sardegna, 2006a).

This paper has employed an MLM approach to analyze investment for public services and infrastructure in Sardinian coastal cities with respect to the 2000-2006 ROP. In doing so, it demonstrates how a spatial analysis approach based on a GIS can be utilized to figure out the geography of territorial phenomena, thereby improving upon the objectivity and accuracy of the implemented MLM. Moreover, the application of this method allows for an integration of the results of the GIS and MLM approaches, which can be used by city planners in the development of policy-making processes concerning city residential areas. In this respect, the paper makes an important methodological contribution.

By applying the method developed in this paper, planners can improve significantly their understanding of territorial phenomena, and the effectiveness of policy making and implementation.

The technical and administrative procedures implemented by the Italian Regions to develop their ROP's, especially by the Regions of the Objective 1 of the 2000-2006 Cohesion Policy of the European Union, are quite similar to each other, since they are based on the same regulations of the European Union. For this reason, the results obtained by the GIS-based MLM could be an important reference point to compare investment for public services and infrastructure across Italian Objective 1 Regions. In other words, an important feature of the methodology developed in this paper is that it is easily exportable, and, as a consequence, it allows for comparisons of different spatial configuration and policies.

The optimal choice of the attributes to be included in the MLM includes as many variables as necessary to describe the investment for public services and infrastructure satisfactorily. Of course, this choice is heavily influenced by available information. The analysis here implemented is based on a set of variables representing the best choice given the information available, rather than the optimal choice. These variables should be considered as a subset of the optimal variable choice. Nevertheless, they give us an interesting picture of the phenomenon.

Regarding this point, it must be stated that there are a number of variables that should have been included in the MLM and were not included since no information is available. One is the household income, which could be very important in determining the income effect on the investment. Moreover, data on capacity of the system of public infrastructure and services would be very helpful.

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