

## **ISSUES AND SOLUTIONS USING OPEN STREET MAP: THE CASE OF SECONDARY ROADS IN SICILY<sup>1</sup>**

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### **1. The strategic role of road transport in Sicily**

To date, the equipment and functionalities of the sustainable mobility services available in the Inner Areas are not such as to represent an alternative to the use of the car. This not only in relation to traditional rail transport services, but also to innovative services related to sharing mobility, micro-mobility, infomobility, flexible public transport services.

The entire offer of services tends to be concentrated in large urban areas and this makes transport in Inner Areas unsustainable also in terms of cost, because there is no alternative to using the car, as well as in terms of environmental and social sustainability. This is confirmed by the railway network endowment index, equal to 59.89 (Italy = 100; Southern Italy = 87.91), which recorded a worsening, both in absolute terms (in 2001 the index was equal to 64), and in relation only to the regions of the South, as a consequence of the disposals in 2002 and of the new railway investments in the southern peninsula.

Hence the strategic role of road transport in the short-medium term of road transport in the development strategies of inland areas. This determines the absence of a valid alternative to the road transport system, which can have limited access to the financing of community resources and, above all, as regards the secondary roads, with the consequent need to carry out extraordinary maintenance interventions on this Program. and redevelopment of the existing road network which can guarantee - in the first place - the safety of users of the road infrastructure.

The development objectives of the Sicilian Road System have as reference elements the Integrated Plan of Infrastructures and Mobility of the Sicilian Region, the APQ "Road transport" and the strategy promoted by the European Union with the 2011 White Paper "Roadmap towards a single European transport area - for a

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competitive and sustainable transport policy”, aimed at combining the increase in mobility with the improvement of road safety and the reduction of emissions.

Not only is it essential to redevelop, by increasing the regional road network, both belonging to the primary level, of connection of the main nodes, and to the secondary level, of penetration and access to territories, but it is also fundamental to adopt a management growth path, on the part of road owners, which aims to overcome the logic of emergency management of road maintenance and which constitutes solid knowledge bases for the implementation, in network logic, of scheduled maintenance techniques. These knowledge bases, relating not only to the consistency but mainly to the condition of the state of the Sicilian road network, are in fact the starting point for the optimization of maintenance interventions to be implemented over time so that, by hierarchizing the intervention priorities and in the compliance with investment constraints, the best result can be guaranteed in terms of investment effectiveness and the state of the road network. Maintenance must therefore represent both the improvement and management of existing networks, and through the constitution of specific investment plans for the lesser way, a necessary road objective, an objective that must not be neglected, both for positive needs. in terms of employment and in terms of development of the functions of the establishments (tourism, hospitality, environmental, protection, etc.) and of response to demographic changes and territorial challenges acquired over time. For this type of enhancement of road infrastructures, from the point of view of functionality and safety, coordinated with respect for environmental resources and the socio-economic development of the territorial area of insertion, it is essential to identify an ordering of roads based on both the use and they are associated in the territory and on their role within the road network framework to which they belong to.

The New Italian Highway Code (Legislative decree 30 April 1992, n. 285) with article 13, paragraph 6 establishes the Cadastre of roads or road cadastre. In particular, the article in question reads:

The road owners are obliged to establish and keep up to date the cartography, the cadastre of the roads and their appurtenances according to the procedures established with a specific decree that the Minister of Infrastructure and Transport issues after consultation with the Higher Council for Public Works and the National Council. of searches. The land registry must also include permanent installations and services connected to the needs of road traffic.

The rule that establishes the characteristics of the Road Cadastre arrived in 2001: "Procedures for establishing and updating the Road Cadastre pursuant to art. 13, paragraph 6, of Legislative Decree 30 April 1992, n. 285, and subsequent amendments - D.M. LL. PP. 1 June 2001 (Ministero dei Lavori Pubblici)" and is

based on the European standard GDF - Geographic Data File - Roads and Railways section.

The provision and implementation of the Road Cadastre for the competent authorities is not only a legislative obligation but represents an important opportunity to have a precise knowledge of the infrastructure that is in custody in order to be able, thus, to prepare an efficient planning of each activity of conservation and maintenance having knowledge not only of the kilometric dimensions, but of every other element that insists on the path of its competence.

The moment of recognition of the state of affairs, aimed at identifying the technical characteristics of the road, must be preceded for the purposes of classification by an overall potential assessment of the network, which leads to the definition based on the role, and type of traffic served, the relationship functional hierarchy between the individual roads (objective function).

For this reason, it is inadequate to act with limited initiatives, but it is necessary, instead, to articulate a set of actions that, in addition to addressing specific problems, help to raise the overall level of mobility governance.

Raising the quality of road design is one of these actions because, in addition to increasing the average standard of interventions, it increases the ability of the public client to express a culture of action capable of harmonizing the evolution of techniques and technologies with the need for sustainable development of the territory and the communities that inhabit it.

For this purpose, the D.M. 5/11/2001 "Functional and geometric standards for road design", indicates the fundamental factors which, characterizing the road networks from a functional point of view, make it possible to place the network under study in a specific class. They are:

Type of movement served (transit, distribution, penetration, access); the movement is also to be understood in the opposite sense, that is, of progressive collection at the various levels:

- Extent of displacement (average distance travelled and vehicular flow);
- Function assumed in the territorial context crossed (national, interregional, provincial, local link);
- Traffic components and related categories (light vehicles, heavy vehicles, motorcycles, pedestrians, etc.).

Strengthening the administrative and support capacity of local authorities in the planning, management, implementation and reporting of interventions based on available extra-regional resources, is a discriminating element with respect to the success of the entire regional programming, given the financial resources allocated to Sicilian local authorities.

The Sicilian Region, with DGR n. 426/2018, established the Special Office for regional planning to give a concrete response to the needs of municipalities,

metropolitan cities and free municipal consortia, often lacking in internal technical skills, allowing them to make use of the technical skills and know-how of regional administration. With the DD n. 1/2019 of the Manager of the Office in question, the model agreement scheme between the Special Design Office and local authorities was approved; with DA n.16 / 2019, the Regional Councillor for Infrastructure and Mobility finally defined its functioning.

## **2. The information sources of the national road network: subjects, rules and classifications**

Data on road infrastructures (motorways, roads of national interest, regional and provincial roads and municipal roads) are characterized by a fragmentation of competences entrusted, by the legislation currently under review, to various national and territorial bodies based on the classification of the roads. Specifically, the main subjects that collect and manage information on road infrastructures are:

- Anas, which is responsible for directly managed motorways, motorway junctions and part of the state roads;
- Aiscat, which manages the motorways not managed by Anas and the tunnels;
- Regions and Provinces that have jurisdiction on state roads not managed by Anas and on regional and provincial roads;
- Municipalities that manage municipal roads.

The Ministry of Infrastructure and Transport collects from these Subjects the information that is published annually in the "National infrastructure and transport account – 2019" (Minister Infrastructure and Transport, 2019) with a regional detail for motorways, roads of national interest, regional and provincial roads, and in the case of municipal roads through a survey conducted in the provincial capitals.

The legislation on the division and legal attribution of many of the main Italian roads between state roads (now called "of national interest", together with the motorways), regional, provincial and municipal roads is under review<sup>2</sup>. This is the consequence of the legal / administrative structure, established by Legislative Decree 31 March 1998, n. 112, which involved the national road network. The aforementioned Legislative Decree of "Conferral of functions and administrative tasks of the State to the Regions and Local Authorities, in implementation of chapter I of the law of 15 March 1997, n. 59", has in fact fixed the transfer of roads

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<sup>2</sup> Proposal for the revision of the national road network Government Act 91 – 92. In the National Infrastructure and Transport Account - Years 2019-2020 is underlined that "the division and legal attribution of many of the main Italian roads between the former state roads (now called "of national interest", together with the Motorways), Regional, Provincial and Municipal".

and motorways, formerly belonging to the state property, to the state property of the Regions or, with regional laws, to the property of the local authorities. In the context of this assignment, the related administrative functions not expressly attributed to the State are also transferred to the Regions and Local Authorities.

The passage to the Regions of roads not included in the national motorway and road network "" took place in the total absence of a basic governance model ". In fact, the "devolution" of the road network was not accompanied by clear strategic choices and adequate financial resources, which could put local authorities in a position to manage the new functions adequately, thus inducing a differentiation of management models as the boundaries vary territorial. The consequences of these criticalities have also led to the inhomogeneity of the information processes including those relating to the monitoring of the extension of the road network with a sub-provincial level of territorial detail. These criticalities therefore triggered a process of rethinking the attribution of a part of the road network to local authorities.

The classification of the road network published by MIT in the «National infrastructure and transport account» represents a macro summary of the more precise classification governed by art. 2, paragraph 2, of Legislative Decree 295/1992 (Highway Code), which sees the roads classified, with regard to their constructive, technical and functional characteristics, in the following types:

- a) Highways;
- b) Main extra-urban roads;
- c) Secondary suburban roads;
- d) Urban sliding roads;
- e) Urban neighbourhood streets;
- f) Local roads;
- g) F-bis - Cycle and pedestrian routes.

This classification detail is not present in any type of territorial and geographical information system except for Open Street Map (OSM), which therefore represents the only tool that potentially, with the necessary corrections, can provide information on the national road network with a sub-provincial level of detail, filling that information / knowledge gap of a fundamental and strategic area for the planning of new territorial development policies.

### **3. Methods and tools to offer a reliable measure of the road endowment of a geographical area**

The need to upgrade the regional road network both at primary level (through the connection of main nodes) and at secondary level (through penetration and

access to territories) can be achieved by increasing safety and sustainability. This is a key step for road owners to begin a management growth path aiming to overcome the logic of emergency management for road maintenance and building a solid knowledge base for implementing, scheduled maintenance techniques according to a network logic. The use of GIS (Geographic Information Systems) tools and open-source databases of roads, such as *Open Street Map* (OSM), can help to adequately understand the type and correct length of roads to be implemented in a territory (ISTAT, 2019). The carriageway length in meters per direction of travel of the road (in the Open Street Map) definitely provides a first coherent series of information relating to the various territories. This information is not available in national official statistics and, though territorially detailed road maps and archives exist, the harmonized and systematic national official road cadastre is far from being complete despite having been created in April 1992 by legislative decree 285 and amended in June 2001. The integration of OSM data (Open Street Map, 2022) with the information layers of the inhabited localities in the ISTAT territorial bases (ISTAT, 2016) further allows to obtain correct information relating to the identification of the road sections on a territory, especially for the secondary road network in Sicily.

Such identification allows improving road infrastructures in terms of functionality, safety and environmental resources, takes into account the socio-economic development of the local area of insertion and is a key element in identifying an ordering road based on both their use in the territory and their role within the road network they belong to.

Planning road maintenance activities in the network without identifying the real kilometre length would be like restoring a building without knowing its size.

Therefore, monitoring requires identifying the actual road heritage, especially for municipal roads, i.e., the extension in km of the roads within the municipal boundaries.

There are different information and regulatory areas that must be jointly taken into account to understand how to identify the streets according to different classification systems: Open Street Map has its own classification system that obviously does not coincide with that of the Italian Highway Code (which is a national system, not international). OSM provides an extremely detailed classification and does not define the roads according to their use or the area they are in, or even according to the legal attribution for the management of the road network. Here's an example In Sicily: road passing through an inhabited centre is considered as a state road (SS), therefore it is subject to state management, but only if the municipality has less than 10,000 residents, otherwise road management will be at municipal level, as it is considered a urban road. Conversely, it may happen that a road of particular importance (e.g., a beltway), while passing through an

inhabited area of a large Sicilian city, is exclusively under state jurisdiction. Since the allocation of funds for management and maintenance of the road network is often linked to the managing body, using two different classification systems for road identification could lead to inaccurate results for determining the amount of km of roads by type, falling within the municipal area.

In any case, the Open Street Map makes it possible to trace a correct classification of the streets, with the necessary *interventions*, filling that information / knowledge gap of an area, which is fundamental and strategic for the planning of new territorial development policies.

OSM today has more than four million users worldwide, is supported by Open Street Map Foundation, and contributes to providing data, individual members, commercial companies, associations, governmental and non-governmental entities. The open-source geodatabase collects vector data of areas and territories, point layers of places, land use layers, point and polygonal data of infrastructures, and road graphs.

The classification includes five groups of road categories: *main roads*, *minor roads*, *motorway connections (stopovers / ramps)*, *very small roads*, *routes not suitable for cars* (Open Street Map, 2021). Within each group we find different road categories and each category corresponds to a precise identification code within the geodatabase. The roads, or parts of the road, are identified according to transects, polyline segments, and all together define the road graph.

In Sicily, as of April 29, 2022, 330,038 transects have been identified, of which 27,780 are unclassified and 42 unknowns.

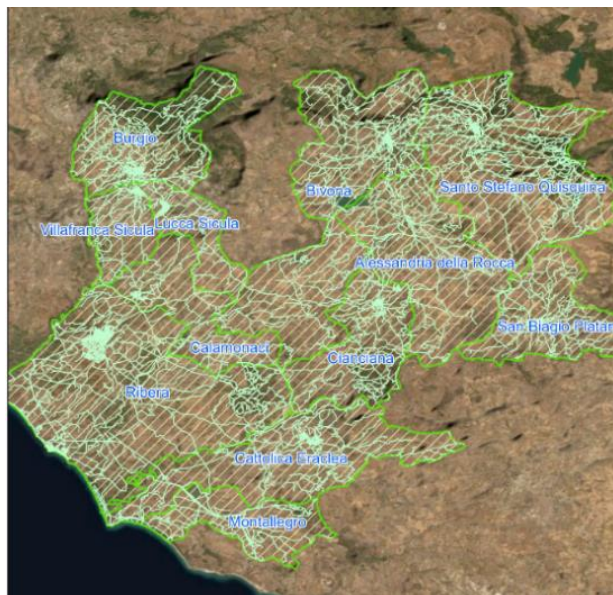
Some correspondence was also found between the road classifications of OSM and the Highway Code, in such a way as to obtain a relationship between the road type in OSM and the management according to the legal attribution indicated in the Legislative Decree of 31 March 1998, n. 112. Only roads that have not been classified under OSM (code 5121) remain to be classified.

#### **4. An application of OSM to the case of the Sicani Internal Area**

The check of the correct classification of the roads and the correct attribution of these to the related municipalities concerned an inland area of Sicily in the Province of Agrigento. Exactly twelve municipalities: Alessandria della Rocca (2,500 inhabitants), Bivona (3,226 inhabitants), Burgio (2,504 inhabitants), Calamonaci (1,173 inhabitants), Cattolica Eraclea (3,307 inhabitants), Cianciana (3,099 inhabitants), Lucca Sicula (1,729 inhabitants), Montallegro (2,369 inhabitants), Ribera (17,871 inhabitants), San Biagio Platani (2,878 inhabitants), Santo Stefano Quisquina (4,138 inhabitants), Villafanca Sicula (1,342

inhabitants) with a population recorded as of 1 January 2022 (figure 4.1), for a total of 46,136 resident inhabitants, an area of 636.56 sq km, 5,964 road transects of which 542 are unclassified and a total of 2,252 km of roads (figure 1).

**Figure 1 - Sicani Internal Area and road grid.**

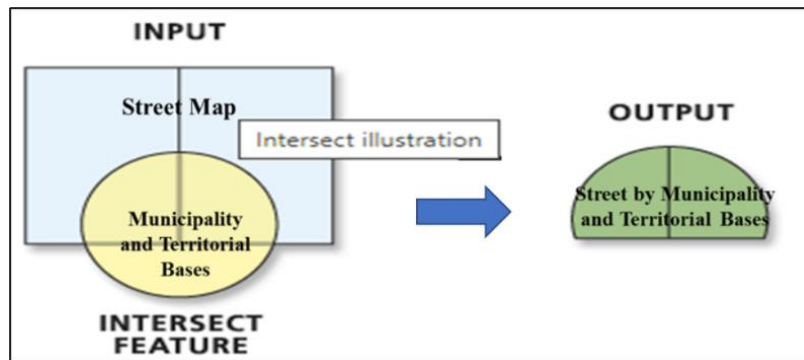


The semi-automatic procedure (figures 2 and 3) provided: **a)** the classification of transects that were not classified into OSM; **b)** the verification of the continuity of the classification of the transects, i.e., for example if a road is composed of three transects, the first and the last of which are classified as *track\_grade1*, the central transect can only be classified in the same way, i.e., continuity is respected road classification; **c)** the elimination of duplication of transects, especially for the most important roads which may have two parallel transects for the two directions of the road when the carriageway is single; **d)** the overlap (*intersect* operation in ArcGIS PRO) (ESRI, 2022) of the information layers of the ISTAT Territorial Bases of ISTAT (ISTAT, 2011) with the areas of the *inhabited centre*, *inhabited nucleus*, *production locations and scattered houses*, and the road graph completely classified in OSM (figure 4.2). This procedure aimed to verify whether the roads already classified with a certain category respect the areas of the territory on which they pass and that is, for example, if a road that in an area outside the inhabited area is classified as a *secondary road*, its part, entering the built-up area must be classified as *residential* and must have a different code than its part outside the urban area; **e)** the exact calculation of the length, with an *intersect* operation

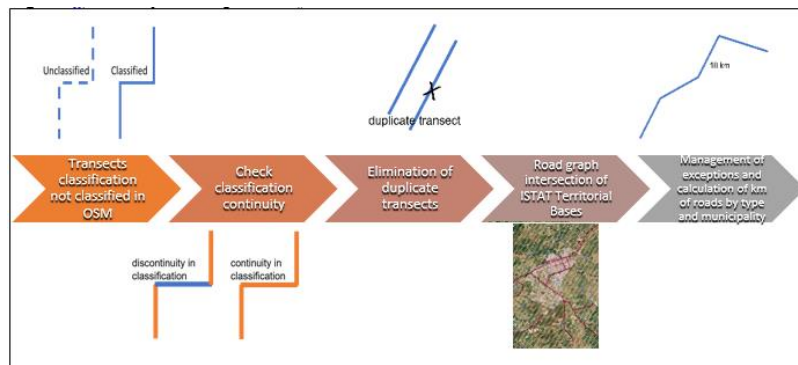


(*intersect* in ArcGIS PRO) with the municipal layers, of the roads by category and municipality. At the end of the process, all the lengths of the roads for each municipality belonging to the Sicani Internal Area were obtained, classifying one hundred percent of the transects (table 1).

**Figure 2 – Intersect (Analysis).**



**Figure 3 - Classification process**



**5. Some concluding remarks**

There are many reasons why it is important to know the exact dimensions of the road infrastructure in a specific area. This knowledge allows for more efficient planning of public and private transportation, helps identify any shortages or overcrowding in the road system, enabling improvements to be made, allows for the evaluation of the impact of new development on the existing road network, and can be used to study road safety and identify potentially hazardous areas. Additionally, knowing the exact road infrastructure of an area is important for

evaluating the environmental impact of road traffic, such as atmospheric or noise pollution.

**Table 1 - Km of roads by type and municipality**

Road Type (km)	Alessandria della Rocca	Bivona	Burgio	Calamonaci	Cattolica Eraclea	Cianciana	Lucca Sicula	Montalelegro	Ribera	San Biagio Platani	Santo Stefano Quisquina	Villafranca Sicula	Total
Cycleway											2,12		2,12
Footway		0,06	1,00		2,05	0,09	0,15		1,58	0,00	5,07		10,00
Living_Street								0,14	0,45				0,59
Path	5,20	18,02	14,01	2,28	4,33	8,61	0,09	1,84	6,81	2,48	29,94	0,22	93,82
Pedestrian		0,29	0,01				0,10		0,35		0,27		1,02
Primary	12,28	7,42			2,16	10,75		6,67	12,33		9,77		61,37
Residential	5,61	19,51	18,23	7,60	24,02	19,16	15,68	11,71	91,49	25,02	22,32	10,11	270,44
Secondary	8,47	5,98	8,38	7,21	2,04	13,76	0,61		38,66	21,56	23,32	11,63	141,62
Secondary_Link						0,27		1,00					1,26
Service	7,59	32,87	23,80	8,03	21,34	14,15	4,05	6,22	40,84	12,09	33,53	11,50	216,02
Steps		0,12	0,34		0,14	0,06	0,03	0,12	0,19	0,12	0,05		1,17
Tertiary	7,12	27,69	2,32	24,55	37,66	13,82	15,43	43,27	65,77	9,16	11,00	15,71	273,49
Tertiary_Link	0,20	0,13						0,09	0,46			0,06	0,94
Track		0,20	14,93		0,77		4,31	0,04	2,06		1,98	0,62	24,91
Track_Grade1	4,28	29,13	0,76	1,74	2,85	3,21	2,03	0,51	9,04	0,13	16,03		69,71
Track_Grade2	58,86	79,34	85,85	16,37	50,33	36,11	13,37	16,10	117,90	34,67	111,74	10,55	631,19
Track_Grade3	39,57	44,15	12,53	10,42	26,55	26,23	2,52	9,30	42,44	26,00	55,76	1,33	296,80
Track_Grade4	20,84	33,50	5,34	3,02	13,89	14,31	2,22	5,35	21,22	14,37	19,19	0,08	153,33
Track_Grade5	0,85	2,12		1,33	0,64					1,03	0,54		6,51
Total	170,87	300,53	187,50	82,55	188,77	160,52	60,57	101,35	452,59	146,62	342,61	61,81	2.256

In Italy, there are several sources of information that can be used to determine the exact dimensions of the road infrastructure in a specific area, which, however, describe different pictures of the road infrastructure. These sources include online maps such as Open Street Map, which provide up-to-date information on the Italian road network and can be used to accurately determine the dimensions of the road infrastructure in a specific area.

Open Street Map has its own classification system that does not align with that of the Italian Highway Code, which is a national system rather than international. While the Italian Highway Code categorizes roads based on their use, location, and management, Open Street Map provides a more detailed classification. Nevertheless, Open Street Map enables a thorough classification of streets and can help fill gaps in knowledge about an area, which is crucial for the planning of new territorial development policies.

The use of Open Street Map requires standardization and reconciliation between its road classification and the Highway Code, which requires careful attention to detail. In particular, the semi-automatic procedure for classifying transects becomes more time-consuming when there is a high number of unclassified transects, as manual checks of doubtful classifications must be performed. Verifying duplicates of transects on major streets is also challenging, as it requires examining each street individually. Another issue is accurately attributing road kilometers to managerial competence, which can be difficult due to the numerous exceptions in the Sicilian territory and the need to address each case individually. Overall, it is important to pay close attention to these issues to ensure accurate classification of roads.

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### SUMMARY

An adequate road infrastructure system represents an essential and necessary condition to increase the productivity and competitiveness of a territory and to guarantee its development, especially with reference to the innermost areas. Continuous and huge financial investments are needed, the programming of which should be based on a clear knowledge and measurement of the road endowment up to the municipal level, which is not currently available. Open street map can represent a robust and reliable source of road equipment in a specific area on which public policies for the enhancement or safety of the road system intend to intervene. The OpenStreetMap (OSM) project since July 2004 has collected a huge amount of spatial data on a voluntary basis making it not perfectly standardized. Through an application to an Internal Area included in the National Strategy for Internal Areas (SNAI), the area of “Terre dei Sicani”, we have determined the road distances present in each single municipality of the Area and for each road category, proceeding to an appropriate standardization. Through the use of particular GIS methodologies, the application proposes the resolution of some redundancies and criticalities present in OSM, which in some cases attribute additional road sections to the correct categories, assigning each single stretch of road to each municipality of the Area on the basis of its administrative limits.

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