Reconstruction as an Opportunity to Promote Local Self-sustainable Development of Shrinking Territories in Seismic Inner Areas in Central Italy

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Abstract. The natural disasters that hit the Italian Apennines with increasing frequency, earthquakes, landslides and floods, cause enormous damage to people and things, modifying economies and social contexts, already affected by the scarcity and antiquity of infrastructures and the abandonment of some territories, located in particular in the inner areas of the country. In these territories there is a significant social, historical, economic, environmental and landscape capital of Italy that everyone knows and loves. The need emerges to increase infrastructural resilience, carrying out significant extraordinary maintenance interventions, promoting the technological development of monitoring activities and infrastructures, prevention activities, civil protection and public rescue. Resilience, however, is a broader concept than the physical ability to overcome disasters, as the ongoing pandemic crisis has shown. This includes, for example, the ability of the urban system to respond to unforeseen seismic events or health problems; the solidity of the network of public spaces and services to support communities and their ability to effectively deal with sudden crises. In the event of catastrophic events, it is precisely the peripheral urban contexts of the Inner Areas that are most exposed to "Risks of isolation", as shown by the seismic events of 2016, where the secondary infrastructural network was heavily affected, limiting mobility of residents in an unsustainable way and sentencing them to further forms of isolation. The work explores the experimental methodologies capable of planning substantial changes to the structure of cities and minor urban areas (both with reference to damaged buildings and to the infrastructural network) that reconstruction can allow, making it a unique opportunity to renew and re-organize the territory.

Keywords: Inner areas · Shrinking cities · Urban planning

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1 Seismic Inner Areas in Central Italy: First Elements of Analysis

A severe earthquake struck Central Italy in 2016, affecting four regions, 10 provinces and 139[1] Municipalities, up to a total of approximately 8,000 km^2, reaching 6.5 Mw magnitude with the shock recorded on October 30th, which caused the destruction of highly valuable historic centers. The earthquake of 2016 reached a far greater intensity than the previous earthquake that occurred in L'Aquila in 2009, which was regarded as the "fifth most severe disaster in the modern history of Italy", not in terms of the number of victims, but because of the intensity of the earthquake (with the highest peak reaching a 6.3 Mw magnitude) in the affected area.

The Marche Region was the most severely affected region out of the four regions within the area struck by the earthquake, with extensive damage in 86 out of a total of 139 municipalities (3,978 km^2 of affected regional surface). The toll was very high: with more than 104,000 damaged buildings, 54,000 evacuated buildings and 32,000 displaced people, of whom 28,500 benefited from Autonomous Accommodation contributions (CAS), temporarily accommodating over 8,000 people in Emergency Housing Facilities (SAE) and hosted in accommodation facilities along the Adriatic coast[2].

The majority of population inhabiting areas affected by las seismic events, in spite of the substantial difficulties experienced till now, didn't migrate from their land of origin. The choice of settling temporary shelter modules, SAE – Emergency Housing Solutions – (activity that showed itself as uneconomical and rather complex in this mountainous areas), can find its origin from the very same will not to disperse the local community, composed in the majority of the cases by a predominant + 65 population [14], and to try to contrast in some way the abandonment of the territory as a consequence of the seismic event.

Other than the damage of the built environment and the identarian heritage sites, the earthquake worsened the criticalities already present in this complex environment, regarding minimum standards for dwelling, accessibility and basic services.

Already before 2016 earthquake, with the definition of the SNAI – Inner Areas National Strategy, Italian state put particular attention at the Apennine area (Occupying a vast part of the peninsula), an area that during last decades witnessed a marginalization process and a consequent population shrinkage, resulting in a largely inadequate use and management of the territory.

"Inner Areas" cover a vast part of the Italian territory hosting a population of more than 13.540 million. Around one quarter of Italy's population lives in these areas, divided among more than four thousand municipalities, which cover sixty per cent of the entire national territory [2].

[1] On January 1st, 2017 the Municipality of Valfornace was established from the merger of the municipalities of Fiordimonte and Pievebovigliana. The number of municipalities located within the seismic area fell to 139, compared to 140 municipalities set out by decrees Dl 186/2016 and 8/2017.

[2] Variable data surveyed on a monthly basis, source: Osservatorio Sisma (Earthquake Observatory), Marche Region. https://sisma2016.gov.it/.

SNAI emphasised that those marginal areas constitute 53% of Italian municipalities, 23% of the population and 60% of the territory of the nation[3].

This territory possesses a "territorial capital" of exceptional value and diversity, but which is largely unused as a consequence of the long-term demographic decline that began in the 1950s when Italy started its industrial take-off. The Strategy adopted by Italy – now in its experimental phase – has the overall objective of promoting local development by activating unused territorial capital through carefully selected development projects. Improving the quality and quantity of the key welfare services (education, health, transport) in the inner areas is a central pillar of that strategy.

After SNAI evaluation process, 72 pilot areas where selected, identified by a low level of population density, (2001–2011 Census data) and by a population shrinkage of −4,4% compared to the Italian average of +4,3%. The shrinkage tendency was confirmed by the data of the period 2011–2017, with a further reduction of −3,2% in just 6 years, compared to a +1,9% increase in the national average. This tendency makes even more urgent to increase the dedication and the action to achieve a fast actuation and application of the planned strategies.

In this complex framework, where environmental fragility adds to economic criticalities, becomes central to reflect on the reconstruction planning, projecting in the disaster response the research for new construction and territorial forms, new structural and functional relationships, more sustainable and resilient, to activate substantial development strategies, able to restore better environment and more solid communities to the Central Apennine fragile environment.

2 Infrastructure and Mobility: Evaluation of Accessibility in the Inner Areas of 2016

SNAI approached the transportation topic for the inner areas under 3 big families of needing highlighted in the Guidelines for Inner areas Mobility, namely: "Planning and programming", "Improvement and requalification of infrastructural network" and "Development of transport services (internal and external accessibility)". From the analysis of the documents produced by SNAI (now included in the CIPE report for the year 2018) and now approved, it is clear that in spite of the limited resources, the territories privileged the rethinking of governance for the public transport system, and somehow profited of the increased contractual power when facing the transport providers, given by the support of national level professionals, and by the power a minister has in comparison to a local authority. Among the 138 municipalities affected by the earthquake, 84 fall under one of the 3 categories of Inner area defined by SNAI, also defined by the proximity to an essential service provider.

In total there are 4 project area defined by SNAI (Fig. 1): 2 in Marche (Ascoli Piceno with 15 municipalities and 25.000 inhabitants and Nuovo Maceratese, with 19 municipalities and 18.000 inhabitants), 1 in Umbria (Val Nerina, with 14 municipalities

[3] Data source: SNAI annual report, presented to Cipe (Department for the planning and coordination of economic policy of the Italian Government) by the Minister for Territorial Cohesion and the South, December 2016.

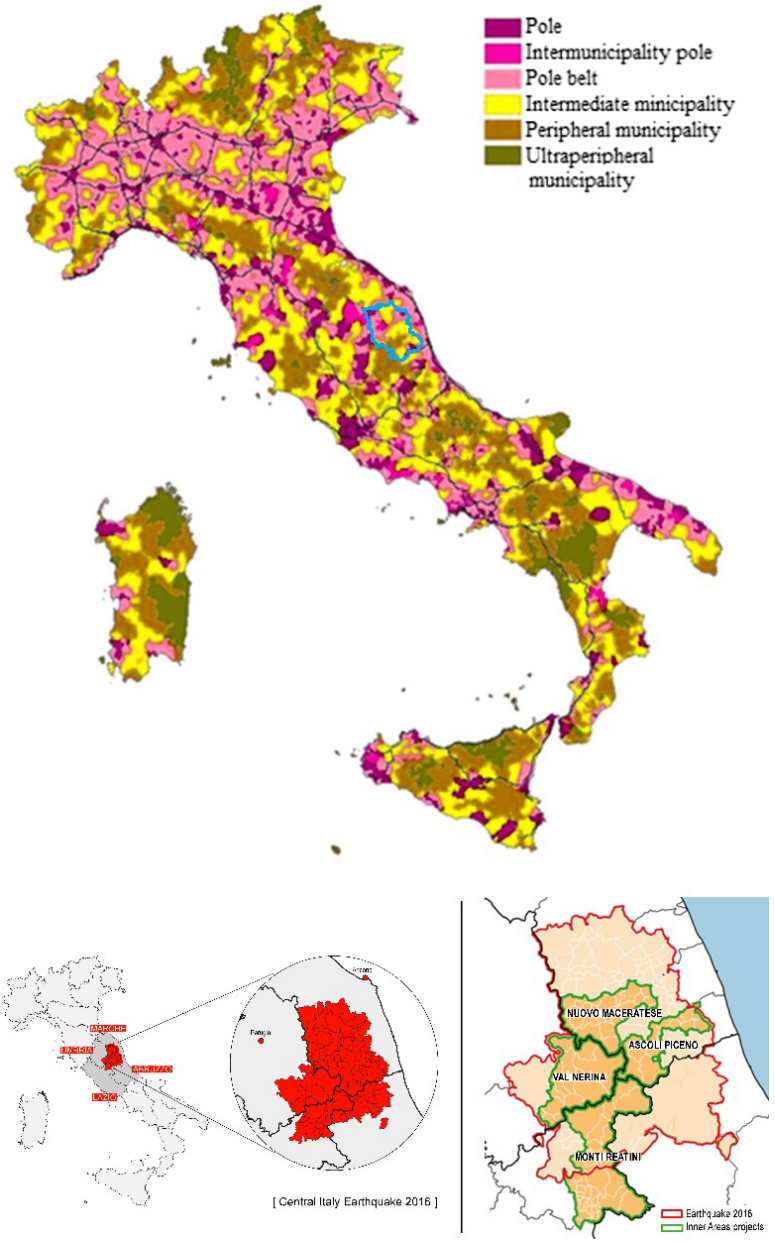

Fig. 1. Central Italy territory affected by earthquake, regions: Abruzzo, Lazio, Marche, Umbria. The inner areas in Italy. UVAL-UVER processing of data from the Ministry of Health, Ministry of Education and FS. The blue area indicates the study area of this work: the inner areas of the Marche region affected by the 2016 earthquake.

and 19.000 inhabitants, and one in Lazio (Monti Reatini, 31 municipalities and 34.000 inhabitants) giving a partial coverage of the examined area.

The topic of connectivity and accessibility to the territory, especially the inner ones hit by the seismic events is a core precondition to local development. SNAI says: "for the peripherality not to transform in marginality it is necessary to improve accessibility to basic services for inner areas, first of all education and health. This can be obtained through 2 modes of action: a) strengthen and rethink the service offering; b) improve mobility, reducing the transport time to access the service hub". It is then clear that accessibility is fundamental, ad basic condition fir the success of all the development intervention.

Till now, the majority of areas that defined the Strategy (around 50) invested resources coming from the rationalization of the system on actions primarily targeting sustainability for the transport network, highlighting a radical shift from traditional service management. This lead not anymore to a generic increase of the services, but rather an increase in efficiency, often using in a more rational way existing resources, and increasing the efficiency. This leads to rather interesting projects, that demand a new governance and more flexible regulations to become widespread examples.

3 Pilot Area Alto Maceratese: A Possible Case Study

For the Marche region, a first pilot case resulted in the definition of the Alto Maceratese Area (17 municipalities, headed by Unione Montana Marca di Camerino), that is related to investments with EAFRD (European Agricultural Fund for Rural Development) and the Italian Stability Law funding, to strengthen local public transportation, with the creation of 3 modal hub and 17 pit-stop micro station to recharge electric vehicle. Hubs are seen as access gates to inner area and to the Monti Sibillini National Park, exchange infrastructure for public infrastructure, for the rental and recharge of electric vehicle, bike-sharing hub and public transport stop, connecting road infrastructure for natural and cultural explorations.

In 2019, with the regional project "*Nuovi Sentieri di Sviluppo per l'Appennino Marchigiano dopo il sisma del 2016*" the 2nd trajectory "*Borghi in rete. Connettività e mobilità sostenibile nelle aree dell'Appennino Marchigiano*"[4] promoted the extension of this strategy to the whole earthquake affected area, imagining an exchange hub network system, connected with natural and cultural heritage exploration paths, connecting national parks, and Rete Natura 2000 areas.

The area explored by the project is characterized by limited connectivity, in terms of digital infrastructure, of road network and of public transport service.

These problems are amplified in in the inner areas, where the combination of "poor digital connectivity + poor physical accessibility" represents one of the greatest limits to development and life quality. From the point of view of physical accessibility, the main criticalities are represented by an imbalance between the offer of services related to local public transport and the potential demand from the territories to be served.

This can be traced back to three main structural characteristics of the territory:

[4] https://www.consiglio.marche.it/informazione_e_comunicazione/pubblicazioni/quaderni/pdf/289.pdf.

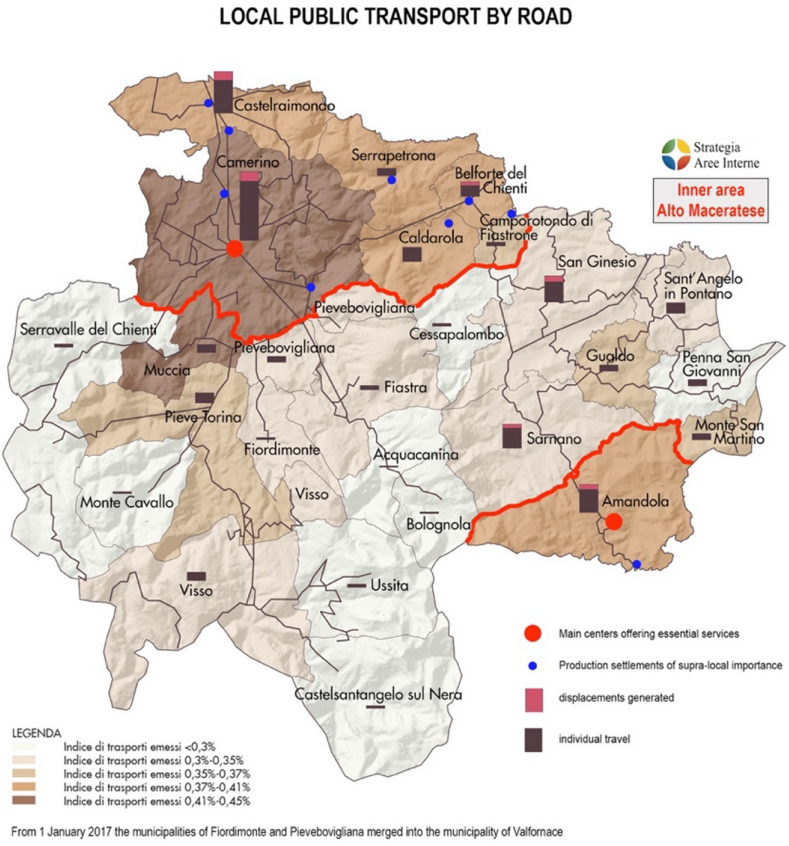

Fig. 2. Alto Macerata Inner Area transport analysis, year 2018.

- the diffusion and fragmentation of the settlement system, consisting of small villages, hamlets and historic centers, with low population density, which necessarily entails, on the one hand, an increase in travel times due to the reduction of travel speed and an increase in the management costs of local public transport services, thus making it uneconomic;
- the morphology of the area, which make it difficult to activate a service suited to the needs of residents and visitors to the area; increased difficulty following seismic events for which, to date, various infrastructures cannot be used, or are only partially, due to damage or due to risk situations induced by landslide slopes or other critical conditions;
- a limited hierarchy of the infrastructural system, due in particular to the lack of supra-local connection infrastructures, able to quickly connect the small internal centers with the surrounding area, both through adequate transversal north-south connections, and through east-west, or coast-inland, connections.

4 Post-earthquake Criticalities in the Marche's Infrastructural Framework: First Assessments and Opportunities

The 2016 earthquake highlighted not only the shortcomings of the existing infrastructural network, but above all its weakness: landslides of roadsides and detachments of road surfaces have worsened the capability to act during the emergency and made it more difficult (in some cases prevented) the operation of rescuers.

Moreover, the presence of collapsed or unsafe buildings at the fringe of some of the access roads to the main cities and villages, compromised even more the accessibility, especially where the road affected was the only way of access. The most recent primary road infrastructure, based on the "Quadrilatero Umbria-Marche" (SS. 76 Vallesina and SS.77 Val di Chienti), Fig. 2, has not suffered substantial damage, with the only exception of the SS.4 Salaria, interrupted due to landslides [7]. Many municipal and provincial roads have suffered a worsening of accessibility, also caused by very little maintenance in recent years due to the scarce financial resources of the managing institutions (Fig. 3). Also due to these criticalities, the Provinces of Marche have returned the management responsibility of the former state-road network to the Regional authorities, which in turn has established a partnership with Anas for the maintenance of the aforementioned road network. This transfer of powers has caused a fragmentation of potential projects (divided between Anas, Provinces and Municipalities, with the Region only responsible as the owner for the ex-Anas viability), with the result that in the "Piano Operativo del Fondo Sviluppo e Coesione Infrastrutture 2014–2020", approved with Resolution CIPE 25/2016, in the Marche's territory no road project has been funded.

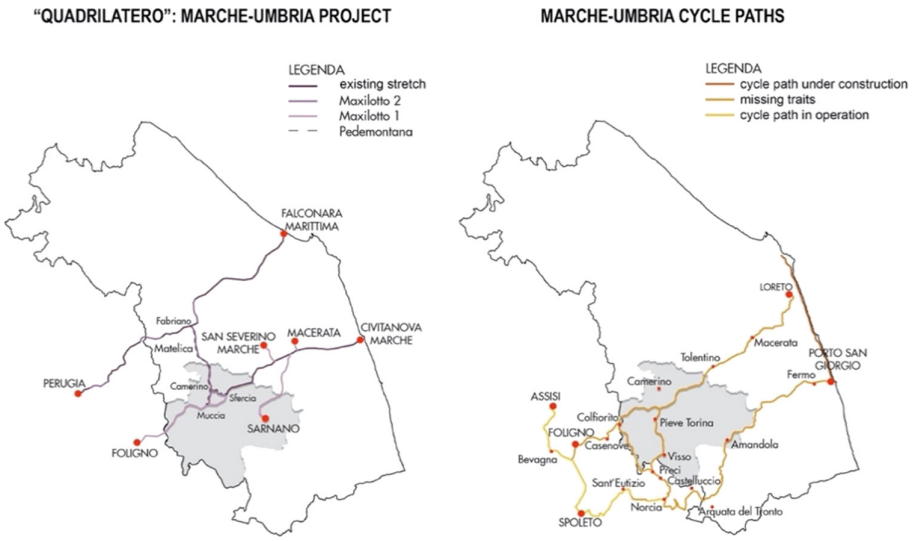

Fig. 3. Marche Region Inner area Alto Maceratese. Primary infrastructure network

Despite the infrastructural network of the Marche crater has shown all its vulnerability, on the other hand it has shown undoubted positive aspects, especially regarding

hillside and mountain tourism: the deficiency of the road network is balanced by the substantial environmental integrity of the landscape, with very few exceptions.

Up to now, the mountain has also been protected regarding the settlement of ski resorts and the maintenance of unobstructed views of the cultivated hills and promontories, which in themselves represent a natural resource to be preserved and enhanced.

For these reasons, the need for intervention on the infrastructural network of the Marche territory mitigating local and territorial vulnerability, cannot ignore the protection of the delicate balance between infrastructures and landscape composed by various landscape matrices [17, 18], in line with the development of local economic activities (especially artisanal and agricultural), and of services related to tourism, which do not require new large and fast infrastructures, but rather a complete and safe network with constant maintenance.

4.1 Development Goals for the Secondary Road Network

It is evident that the reconstruction cannot ignore the reorganization of the infrastructural system and the sustainable development of the territory, through a renewed accessibility to the cities at the foothills and "Inner Areas", which allows to live in an effective condition of resilience to cope with future seismic events.

The reconstruction offers the opportunity to make substantial changes to the layout of villages and minor urban areas affected by the earthquake (regarding both the damaged buildings and the infrastructural network), giving a unique and unrepeatable opportunity for innovation and organic rearrangement of the territory [12, 13]. Pursuing this goal means first and foremost ensuring that:

1. The Minimum Urban Structures (SUM) provided for by the O.C. 39 (ordinance governing the Reconstruction Implementation Plans), should have access infrastructures from with a low degree of vulnerability, achieved by a suitable road and building project (junctions, roundabouts, setbacks and localised voids, etc.);
2. Road layouts (regional, provincial and municipal) are made safe from landslides, through containment works, tunnels, reduction of tortuosity and what is necessary to ensure full accessibility even in emergency conditions.

A complex but lasting intervention, which must not consist on new roads, but on the substantial improvement of the existing network and its accessibility, with the goal to make all the cities of the crater that are going to be rebuilt easily accessible, in any weather condition and in any circumstance [8]. An intervention with strong of environmental sustainability qualities, which will require:

– the access to a subsidized and multi-year financial source;
– a singular implementing authority throughout the crater, or at least for each territorial area, through a design and consequent implementation in strict contact with local authorities, with the urban planning decision of each territory;

the improvement of the transversal valley network (e.g. Val d'Aso, Val Tenna, etc.) connecting the area of the crater to the coastal road system, with regional and/or state funding (Fig. 4).

Fig. 4. Marche Region, Visso (MC), Damage to infrastructure caused by the 2016 Central Italy earthquake.

4.2 Development Goals for the Primary Road Network

The road infrastructure of the crater area, in spite of the resiliency shown in 2016, require a development project (since long scheduled by ANAS, the Italian Society for highways) such as the foothill network Fabriano-Muccia (already designed) and Sforzacosta-Sarnano, that even if already part of the Quadrilatero network after 1997 seismic event still demand for a rapid completion.

The road network has to be completed, improving the existing system to facilitate the development of the area exploiting tourism and the rich productive landscape [1].

Finally, it is important to consider the problematic north-south regional connection, rethinking the primary road infrastructure, starting from the missing of the third highway lane in the region, source of limitations especially in emergency situations.

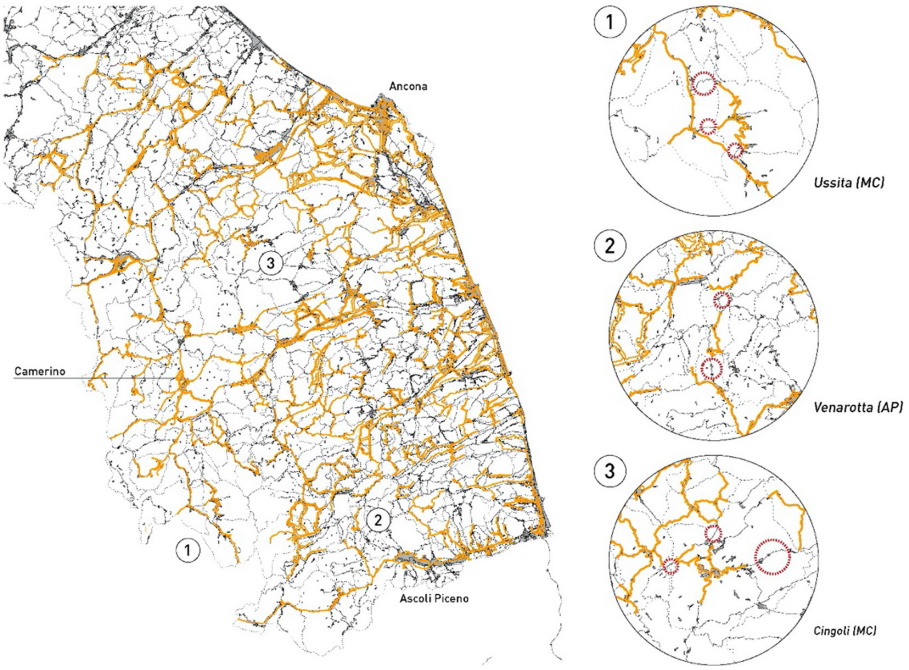

Fig. 5. Regional Mosaic for Emergency Limit Condition (CLE). In orange connective and accessibility infra-structure included in CLE; in red the gaps between CLE regarding neighbouring municipalities.

5 Resilience Infrastructures and Lifelines for a Territorial Safety Project

The seismic events of Central Italy 2016–17 highlighted the vulnerability of the local infrastructural system, so that the sequence of natural events affects the functionality of road infrastructures of local interest and connecting the Adriatic coast to the Tyrrhenian one, often not providing an alternative route. The vulnerability of the territory is linked to the particular morphology of a mountainous area, which is composed by roads through witch is not easy to reach small villages and inhabited centers scattered throughout the territory [3, 4]. The main disruptions of the road infrastructures concern the opening of cracks in the road surface, subsidence and horizontal deformations. These effects are associated with the instability phenomena that involved landslide slopes and support structures. The damage caused to the road infrastructure by the Central Italy sequence is documented in detail in GEER [9, 10], Durante [6] and Lanzo [11].

In the Marche region (the one hit the hardest by the 2016 events) the "safety project" consists almost exclusively of the Emergency Limit Condition (CLE), a tool that by definition represents the "Condition of the urban system under which, following the occurrence of a seismic event, even in conjunction with the occurrence of physical and functional damages, resulting in the interruption of almost all the urban activities including the housing, the urban area still allows, as a whole, the operation of most of the

strategic emergency activities, their accessibility and connection with the urban network" [16]. Even if the CLE evaluation is configured as a tool for verifying the instruments of the emergency management system on a municipal scale (strategic buildings, safe areas, accessibility infrastructures), small-medium municipalities erroneously attribute to this the role of a "project", neglecting the constituent components of a project: definition of actions/interventions and their implementation [15].

The analysis and application action of this tool is limited within the municipal boundary, limiting the seismic vulnerability assessments to individual centers and neglecting the territorial criticalities that may emerge following a calamitous event (Fig. 5). This paradigm, limited to the municipal administrative borders, gives rise to a fragmentation in the territorial safety project, in which the connection with the infrastructural systems on a regional scale is not always guaranteed. The peripheral urban systems are exposed to the "risk of isolation" in the event of a calamitous event, a condition found in 2016 following the earthquake, in which the secondary road infrastructures went into crisis, with many inconveniences for those living in the areas.

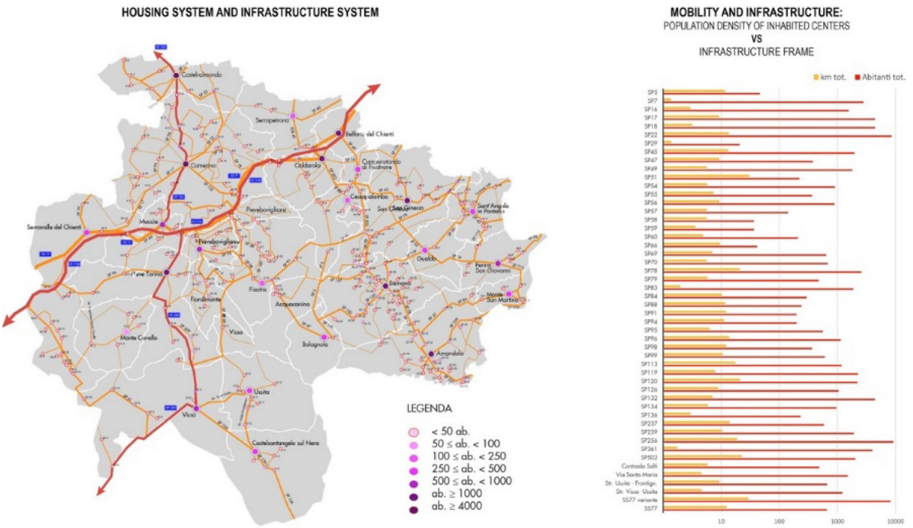

Fig. 6. Marche region Inner area Alto Maceratese, secondary road network and population distribution related to road segments. Analysis of population risk exposure. Secondary road length related to population resident in proximity to each road sector.

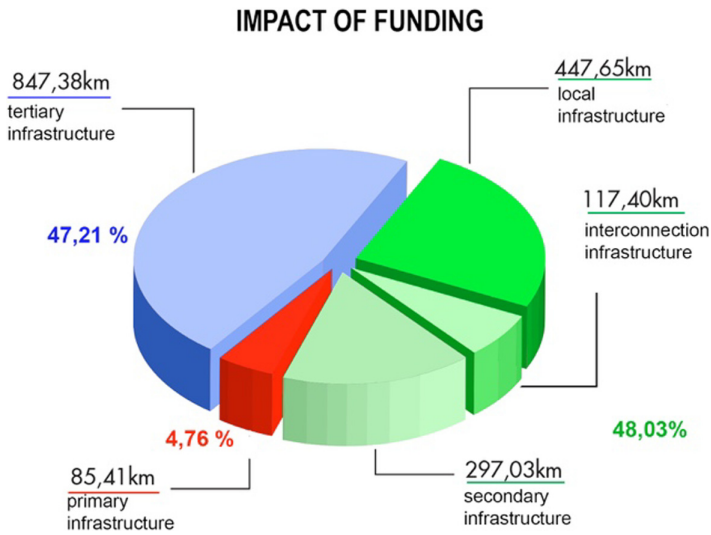

Fig. 7. Marche region Inner area Alto Maceratese. Funds distribution for post-earthquake infrastructure reconstruction.

6 Conclusions and Working Trajectories

The integration between prevention tools, territorial development/revitalization strategies and ordinary planning for territorial management can no longer be postponed, there is a need to rethink new urban-territorial balances in the fragile territories of the seismic crater of Central Italy, with the goal of preserving the Italian historical environmental heritage.

The theme of scenario-assessment/management of post-disaster put on evidence the weakness points of prevention. Overcoming the sterile debate on "where it was as it was", it is possible to outline cross-disciplinary principles and common elements, to define the foundation of the reconstruction actions:

- Operating in areas hit by recent earthquakes means combining the "re-construction" plan with a "re-housing" project based on innovative tools and strategies in which prevention, urban quality and safety take on a complementary role for the regeneration of territories in crisis.
- Accepting the risk and seismogenetics of the territory as a permanent factor to deal with is a prerequisite to undertake the technical-cultural leap at the base of the process of reconstruction in Central Italy.
- Highlight the gap, in temporal and economic terms, between the goals and desires of the citizens, and their possible fulfilment [5] and define concrete operational responses.
- Develop a systemic risk prevention project, integrated into reconstruction plans and activate general planning for permanent preparedness of the fragile territories of the Central Apennines.

It is clear that the topic of safety should be addressed together with a multi-risk approach, focusing on places and communities, analysing the various components that can affect the level of safety (Figs. 6–7). It is necessary to overcome the approach linked to homogeneous and undifferentiated policies on the national territory, in favour of targeted policies, defining specific action for each specific risk situation embedded in the site, taking into consideration the living conditions and customs of the communities that live in the area.

It's relevant to enphasize the "unterestimated conflict planning-prevention" and to underline that it can be reduced by providing for future planning, the use of criteria arising from the study ex ante scenarios related to the past events.

As with all policies for inner areas, it should be noted that the entire system of interventions in transport that can be activated with SNAI would greatly benefit from greater attention in national sector policies. Today these policies are unbalanced on the centrality assigned to large urban areas and on efficiency regulations that are "blind" to the territorial diversity of our country. Without reasonable criteria of flexibility, the planning and reorganization efforts that the territories are putting in place risk to penalise transport services in inland areas.

The reactivation of the areas of the earthquake depends on a process of restitution and generation of value in territories that have been compromised by a sequence of events and crises that have conditioned the capacity to generate value. Nonetheless these territories can recover this capacity with combined systemic actions, capable of fostering the recovery and eco-sustainable regeneration, based on the qualities present in the different geographical areas. The idea that moves the PNRR program is that the overall positive result and use in Italy of the Recovery Plan related funding is only possible if it is first of all able to restore vitality and industriousness to those local communities that have been hit by the effects of a crisis that is now more than ten years old, removing the shortcomings in terms of infrastructures and determining real benefits for those who want to live and invest in these places, through the promotion of services and infrastructures capable of overcoming diseconomies and difficulties that have occurred in the recent years, which have reduced the population and the intensity regarding economic activity and social relations.

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