TeMA

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This special issue collects a selection of peer-review papers presented at the 8th International Conference INPUT 2014 titled "Smart City: planning for energy, transportation and sustainability of urban systems", held on 4-6 June in Naples, Italy. The issue includes recent developments on the theme of relationship between innovation and city management and planning.

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TeMA. Journal of Land Use, Mobility and Environment offers researches, applications and contributions with a unified approach to planning and mobility and publishes original inter-disciplinary papers on the interaction of transport, land use and environment. Domains include engineering, planning, modeling, behavior, economics, geography, regional science, sociology, architecture and design, network science, and complex systems.

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This special issue of TeMA collects the papers presented at the 8th International Conference INPUT 2014 which will take place in Naples from 4th to 6th June. The Conference focuses on one of the central topics within the urban studies debate and combines, in a new perspective, researches concerning the relationship between innovation and management of city changing.

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EIGHTH INTERNATIONAL CONFERENCE INPUT 2014

SMART CITY. PLANNING FOR ENERGY, TRANSPORTATION AND SUSTAINABILITY OF THE URBAN SYSTEM

This special issue of TeMA collects the papers presented at the Eighth International Conference INPUT, 2014, titled "Smart City. Planning for energy, transportation and sustainability of the urban system" that takes place in Naples from 4 to 6 of June 2014.

INPUT (Innovation in Urban Planning and Territorial) consists of an informal group/network of academic researchers Italians and foreigners working in several areas related to urban and territorial planning. Starting from the first conference, held in Venice in 1999, INPUT has represented an opportunity to reflect on the use of Information and Communication Technologies (ICTs) as key planning support tools. The theme of the eighth conference focuses on one of the most topical debate of urban studies that combines , in a new perspective, researches concerning the relationship between innovation (technological, methodological, of process etc..) and the management of the changes of the city. The Smart City is also currently the most investigated subject by TeMA that with this number is intended to provide a broad overview of the research activities currently in place in Italy and a number of European countries. Naples, with its tradition of studies in this particular research field, represents the best place to review progress on what is being done and try to identify some structural elements of a planning approach.

Furthermore the conference has represented the ideal space of mind comparison and ideas exchanging about a number of topics like: planning support systems, models to geo-design, qualitative cognitive models and formal ontologies, smart mobility and urban transport, Visualization and spatial perception in urban planning innovative processes for urban regeneration, smart city and smart citizen, the Smart Energy Master project, urban entropy and evaluation in urban planning, etc..

The conference INPUT Naples 2014 were sent 84 papers, through a computerized procedure using the website www.input2014.it . The papers were subjected to a series of monitoring and control operations. The first fundamental phase saw the submission of the papers to reviewers. To enable a blind procedure the papers have been checked in advance, in order to eliminate any reference to the authors. The review was carried out on a form set up by the local scientific committee. The review forms received were sent to the authors who have adapted the papers, in a more or less extensive way, on the base of the received comments. At this point (third stage), the new version of the paper was subjected to control for to standardize the content to the layout required for the publication within TeMA. In parallel, the Local Scientific Committee, along with the Editorial Board of the magazine, has provided to the technical operation on the site TeMA (insertion of data for the indexing and insertion of pdf version of the papers). In the light of the time's shortness and of the high number of contributions the Local Scientific Committee decided to publish the papers by applying some simplifies compared with the normal procedures used by TeMA. Specifically:

- Each paper was equipped with cover, TeMA Editorial Advisory Board, INPUT Scientific Committee, introductory page of INPUT 2014 and summary;
- Summary and sorting of the papers are in alphabetical order, based on the surname of the first author;
- Each paper is indexed with own DOI codex which can be found in the electronic version on TeMA website (www.tema.unina.it). The codex is not present on the pdf version of the papers.

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SPECIAL ISSUE

Eighth International Conference INPUT
Smart City - Planning for Energy, Transportation and Sustainability of the Urban System

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NETWORK SCREENING FOR SMARTER ROAD SITES

A REGIONAL CASE

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ABSTRACT

Road safety has been a main societal and policy issue in many European countries since the early years of last decade. After the 2000-2010 Road Safety Programme launched by the European Commission, in 2011 the Commission adopted the new 2020 programme, even more demanding than the previous.

As the societal consequences of road casualties are increasingly perceived as a core dimension of smart mobility, road safety system is now facing new challenges. Current mobility shifts to softer and greener transportation means raise new safety concerns for an increasingly larger share of vulnerable road users. The need to integrate road safety requirements with other residential, mobility, and environmental policies calls for a more detailed understanding of the phenomenon at different spatial levels and with different observation lenses.

The pilot study described in this paper is a contribution to this end.

It aims at identifying the accident prone sites of the regional road network to help prioritizing safety interventions, by the regional administration having road planning responsibilities.

The study develops a screening approach to select hazardous road locations, outside urban premises, from the Piedmont provincial and state roads. The most recent data for the 2010-2012 years were considered, drawn from the ISTAT road accident database, managed by the CMRSS.

The procedure consists of the following steps: identification of the elementary road sections to be screened, through a GIS analysis; definition of the screening groups (road sections have been subdivided in 4 length classes); definition of the selection criteria, with two severity thresholds based on the crash density; classification of the elementary road sections by severity thresholds.

KEYWORDS

Road Safety, Road network screening, Regional monitoring centre, Crash data

1 INTRODUCTION

Since the launching of the 2000 Road Safety Programme by the European Commission, road safety has become a main societal and policy issue in most European countries. By 2010, the final year of that programme, several policy initiatives at national and regional levels were carried out and road deaths considerably reduced, although the target of halving road deaths was not achieved.

In 2011, the Commission adopted the 2020 programme which aims, as the earlier one, to cut by half road deaths in Europe by the end of the decade. It also sets out a mix of initiatives, focusing on improving vehicle safety, the safety of infrastructure and road users' behavior.

In Italy, improvements in road safety between 2001 and 2010 have been significant: road deaths reduced by 43%, and a decrease in the number of accidents was recorded for the first time.

The European initiatives had a main role in stimulating research on the various aspects involved in road safety, concerning road users, vehicles and infrastructures (see the DG move website[1]). They raised questions of data availability and comparability across countries and helped to establish a European road safety observatory[2], stimulating similar initiatives at national and regional levels.

In Italy, for example, an inter-institutional agreement was signed which involved representatives of the Transport, Health and Defense Ministries, as well as of the National Statistical Office (ISTAT) and local government Associations (ANCI and UPI)[3]. It made it possible for sub national governmental bodies to directly engage in road safety monitoring activities, seeing to the data gathering and quality control operations, as well as to the analysis of the collected evidence.

Road safety research is now facing new challenges. As the societal consequences of road casualties are increasingly perceived as a core dimension of smart mobility, it is realized that approaches currently used to probe into road casualties need refinement both on the methodological and practical grounds (see Hakkert and Braimaster 2002; Maibach *et al.* 2008; OECD/International Transport Forum 2008, Antoniou and Yannis 2012).

This is even more apparent at local level, where primary responsibilities to take actions for road safety usually lie. Many indicators conventionally used in studying road accidents, in fact, need to be detailed or better specified according to situated contexts in order to support stakeholders in identifying effective countermeasures.

The study discussed in this paper is a contribution in this direction. Its motivations stem from the activities carried out by the Piedmont Road Safety Monitoring Center (RSMS) (see Boero et al. 2010, Occelli, 2013), which has a main commitment to provide road safety evidence and research support to regional stakeholders.

More specifically, the study aims at identifying the accident prone sites of the regional road network to help prioritizing safety interventions, by the regional administration having road planning responsibilities. In the following, section 2 describes the pilot approach to road screening which has been investigated in the study region. Section 3 presents the main results of its application and comments on the findings. Finally, section 4 makes some general recommendations for next research steps.

1 http://ec.europa.eu/transport/road_safety/index_en.htm.
2 http://www.erso.eu.
3 http:// www.sicurezzastradalepiemonte.it/it/documentazione/normativa/italia/Protocollo%20intesa%202011.pdf.

2 AN APPROACH TO ROAD SCREENING AT REGIONAL LEVEL

2.1 BACKGROUND

Improving road crash data gathering and reporting have been at the core of the RSMS activities since its establishment. As a result, the regional road crash database has progressively got better over time, and the quality of casualty and location data considerably improved as well. Reliable information about the location of a crash event is a fundamental requirement in any approach meant to identify road sites where countermeasures have to be realized.

This is the main goal of network screening which aims at selecting from a large number of road sites (including intersections and sections), a relatively small subgroup which merit deeper investigation from an engineer and/or economic point of view (Hawer *et al.* 2002; Cheng and Washington 2008).

Network screening is the first stage in the development of appropriate and cost-effective treatments to reduce the frequency or severity of accidents. As shown in Fig. 1, the overall process for site improvement consists of three stages (Hawer *et al.* 2002): a) examination of the road network in order to obtain a list of sites ranked in order of priority, which will be subsequently subjected to Detailed Engineering/Economic Studies (DES); b) generation of "prospectively cost-effective" projects, based on DESs and c) evaluation of the road screening methods and DESs.

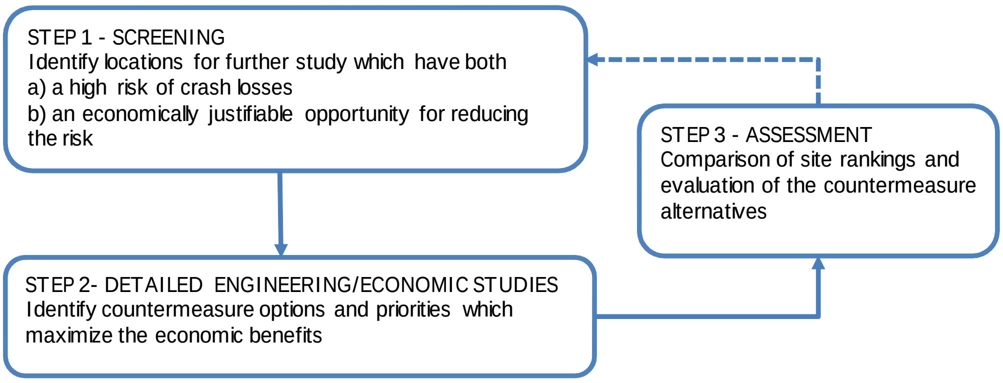

Fig. 1 Main stages in approaches to road site improvement

The present study develops a screening approach to select hazardous road locations, outside urban premises, from the Piedmont provincial and state roads, which are under the jurisdiction of regional and national authorities. Municipal roads and highways are therefore excluded from the analysis.

The information basis is drawn from the ISTAT road accident database for Piedmont, managed by the CMRSS. It stores the elementary crash data collected by the police since 1978, through a data gathering protocol which records information concerning people injured, vehicles involved, and rescue team, type of crash, accident likely causes, and crash location.

The latter, in particular, is specified according to several descriptors such as road type, municipality code, road site (intersection or section), premise (in urban or rural area), address, and more recently geo-code coordinates. The most recent data for the 2010-2012 years were considered; they account for about 20% of the crashes which occurred in the region in that period and were responsible for more than 40% of the deaths.

2.2 THE PROCEDURE

The approach is motivated by institutional responsibility in managing road infrastructure. It extends an earlier investigation of hazardous roads (see CMRSS 2013), although it has still to be considered as a work in progress in the development of road screening approaches at regional level.

The implemented procedure exploits the existing material and namely the crash information basis, mentioned above, and a descriptive profile of road sections obtained by means of a GIS analysis of the regional road network. Other information often used in road screening techniques such as the road functional level, accident exposure level or risk was not available. The procedure consists of the following steps:

- A. *Identification of the elementary road sections to be screened*. These are identified through a GIS analysis as the extra-urban road sections delimited by municipal boundaries. By considering the road name, municipality code, and specification of premise, road crashes in the 2010-2012 are assigned to the identified road sections (see CMRSS 2011). Besides its ID (formed by joining the road and municipal code), an elementary road section has three type of descriptors: i) spatial indicators such as length and population density of the municipality in which the tract is situated; ii) accident variables, such as the total number of crashes, and casualties, the number of accidents and casualties by road users, type of collision and site; iii) accident indicators such as crash density, defined as the ratio between number of crashes and section length.
- *B. Definition of the screening groups*. Road sections have been ordered by increasing length and the resulting ranking subdivided in 4 length classes, according to a twofold criterion of having meaningful length classes and a balanced distribution of the number of road sections in each group. The elementary road sections are then classified according to these length classes.
- *C. Definition of the selection criteria: severity thresholds on the crash density*. Within each screening group the Crash Density Mean (CDM) is computed. Because of the high variability in the end to end of road sections, two severity thresholds are distinguished taking into account the value of the Standard Deviation (SD) of the crash density in each group. T2, the higher threshold value is calculated as CDM+SD, and, T1, the lower one, as CDM+SD/2.
- *D. Classification of the elementary road sections by severity thresholds*. For each reference groups, the elementary road sections are then classified according to a threefold value, S0, S1 and S2, depending if their crash density value is less then T1, between T1 and T2 or higher than T2, respectively.

Table 1 below outlines the road safety descriptive profile for the 4 screening groups, obtained from the A-C steps of the adopted procedure. Not unexpectedly, longer road sections (screening group 4) account for the largest share of crashes (44%) and for nearly half of those occurring in the most densely populated areas.

Screening groups. Length classes (km)	N. road sections	N. Crashes	N. Deaths	N. Injured	% Crash by population density		
					less than 150 in/skm	from 150 to 500 inh/skm	greater than 500 inh/skm
1) shorter than 1,5	435	934	57	1425	10%	14%	19%
2) from 1,5 to 2,5	452	1310	68	2016	18%	21%	12%
3) from 2,5 to 4,1	452	1706	121	2660	28%	22%	20%
4) longer than 4,1	452	3120	184	4967	43%	43%	49%
Total	1791	7070	430	11068	100%	100%	100%

Tab. 1 Descriptive account of the Piedmont road sections by screening groups

Crash density and severity thresholds, however, have maximum values in the screening group concentrating the shortest road sections, see Fig.2. Longer or moderately long road sections (screening groups 3 and 4) have relatively lower values of crash density and severity thresholds.

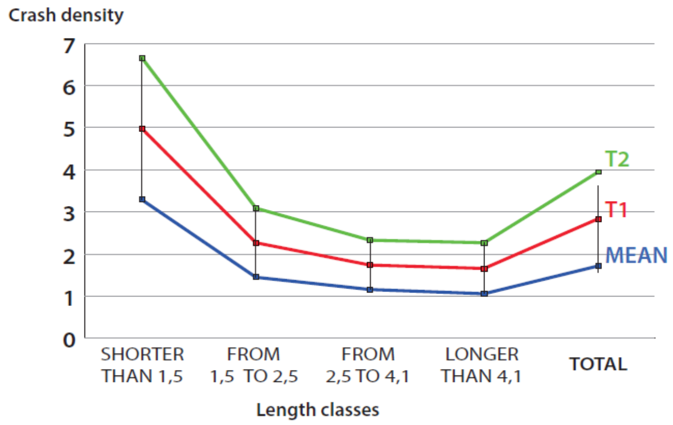

Fig. 2 Mean crash density and severity thresholds by screening groups (length classes) and for the overall network

3 RESULTS OF THE SCREENING PROCEDURE

3.1 AN OVERVIEW

The results of the above procedure can be appreciated from a twofold perspective. First, from an analytic point of view they allow us to outline a multi faceted profile of the hazardous situations of the regional road network. Second, on the operational ground they make it possible to draw a list of road sections filtered by severity thresholds which can inform more detailed analysis.

The analytic focus, in particular, shows that, overall, 34% of the Piedmont road sections are S1 hazardous, and concentrate 13% of crashes. Only 10 out of 100 road sections are S2 unsafe but these account for 36% of accidents. As shown in Fig. 3, the largest share of the most dangerous (S2) road sections belong to the group with longer road sections.

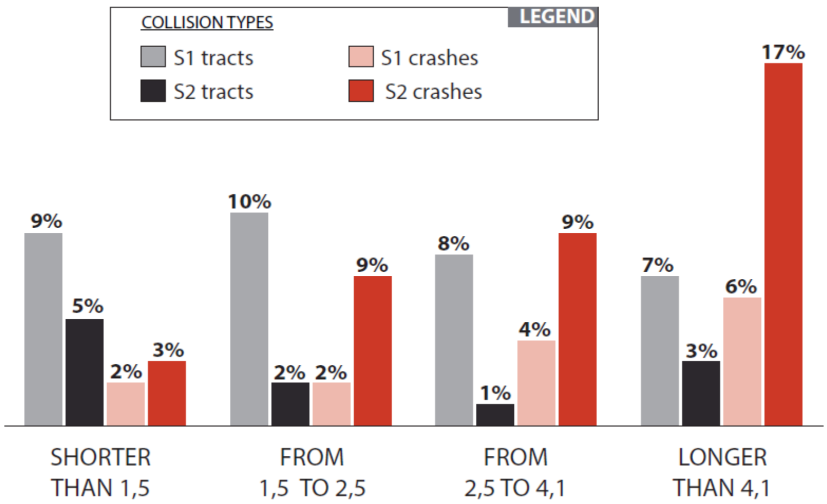

Fig. 3 Share of S1 and S2 dangerous road sections by road length classes

A comparison of the crash distribution by type of collision for the unsafe road sections (S2) and the safe ones (S0), Fig.4, reveals that head-on collisions tend to concentrate on medium length road sections. Front-side collisions and sliding accidents occur to a larger extent on longer road sections.

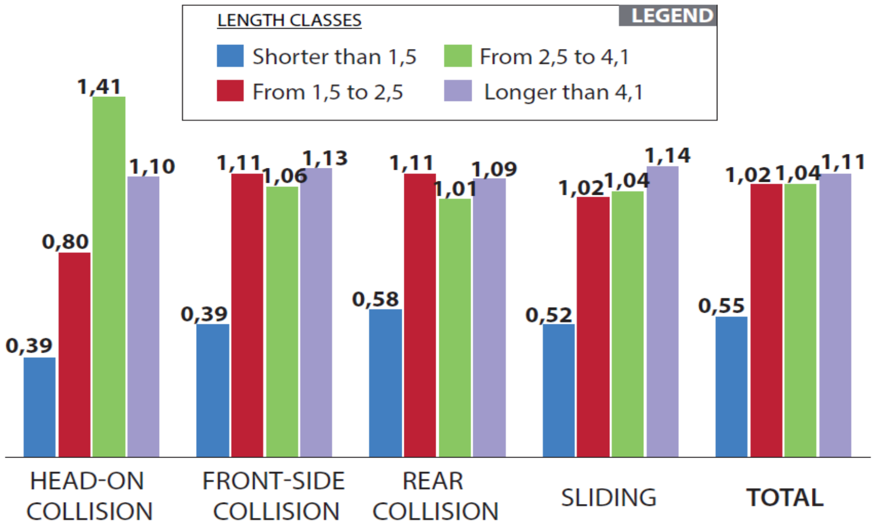

Fig. 4 S2 crash concentration index by type of collision and road length classes

Crashes involving vulnerable road users (pedestrians, cyclists and motorcyclists) account for 18% of the accidents occurring on S2 road sections, Tab.2. The percentage is rather homogeneous across the reference groups, although slightly higher for the shorter road sections.

Motorcyclists account for the largest share of crashes involving vulnerable road users (70%). This is even larger within the screening group including longer road sections.

	Number of crashes				% crashes		
Reference goups. Length classes (km)	All road sections (a)	On S2 road sections (b)	Vulnerable road users on S2 road sections (c)	Motorcyclists on S2 road sections (d)	S2 (b/a)	S2 vulnerable road users (c/b)	S2 Motorcyclists (d/c)
shorter than 1,5	934	231	47	30	25%	20,3%	63,8%
from 1,5 to 2,5	1310	516	90	58	39%	17,4%	64,4%
from 2,5 to 4,1	1706	632	122	86	37%	19,3%	70,5%
longer than 4,1	3120	1193	208	154	38%	17,4%	74,0%
Total	7070	2572	467	328	36%	18,2%	70,2%

Tab.2 Shares of crashes for vulnerable road users (pedestrians, cyclists and motorcyclists) and for motorcyclists by screening groups

An overview of the location of the unsafe road sections is offered in the map of Fig.5, where the population density by municipality is also shown. The map reveals a concentration of the most dangerous road sections (S2) in high density municipalities and particularly in the metropolitan area. One out of 4 of the accidents occurring on the most unsafe road sections are in high density areas.

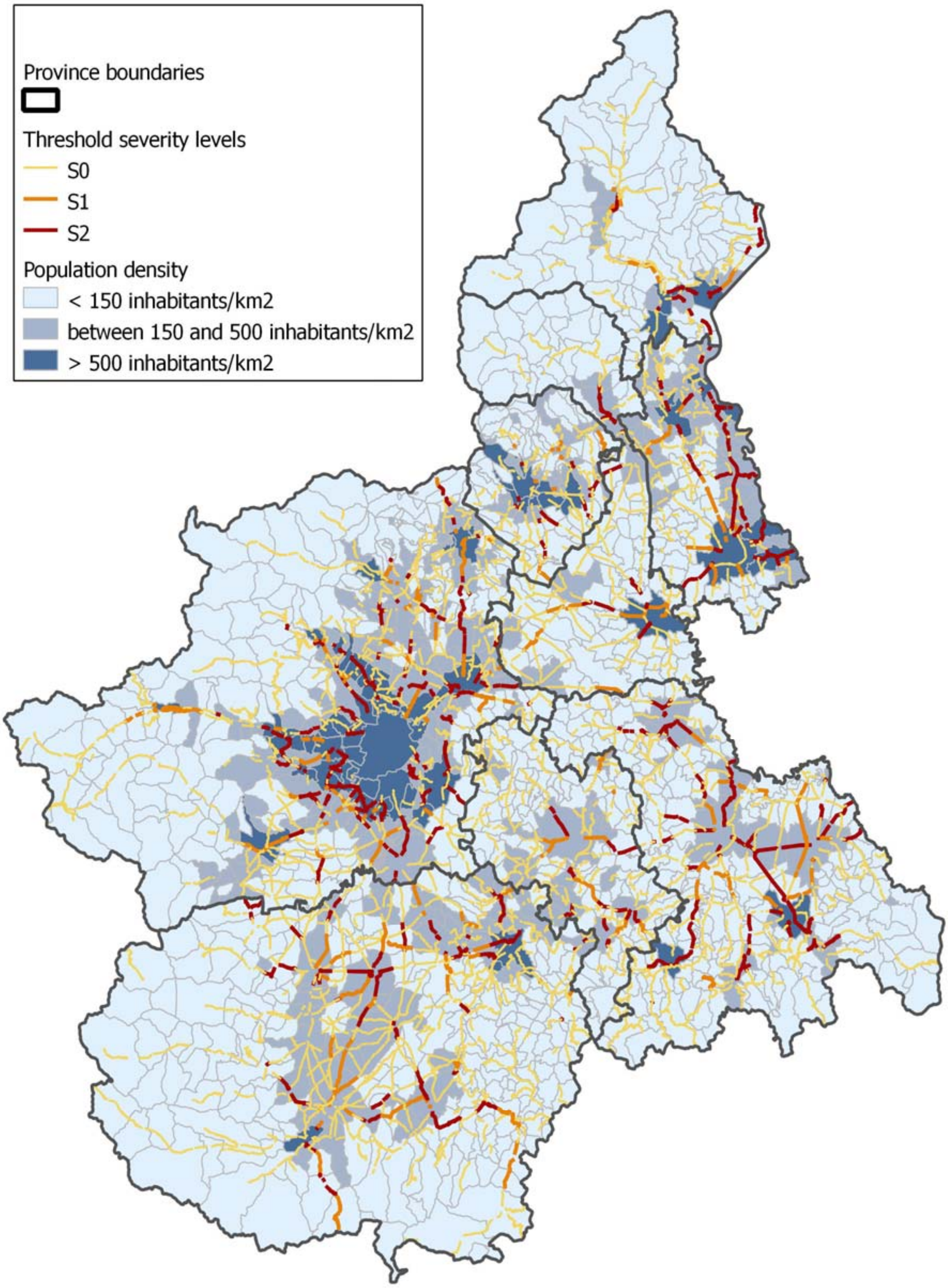

Fig. 5. Unsafe road sections by severity thresholds on the Piedmont road network (2010-2012)

3.2 A FOCUS ON THE MOST UNSAFE ROAD

The first 10 most hazardous road sections ranked by number of accidents is presented in Tab.3.

Road ID	Municipality code	reference group	population density (inh/km^2)	crash density (N. crashes/km)	N.Crashes	N. Deaths	N. Injured
006SP010	006003	4	439,6	7,2	109	2	193
006SP035bis	006114	4	500,1	10,2	54	1	85
001SP143	001171	4	1011,1	7,4	43	1	66
004SP020	004215	4	188,9	4,4	43	3	67
103SS034	103072	4	808,8	6,7	38	0	64
003SP011	003149	4	519,3	5,3	38	1	54
001SP002	001063	2	639,7	20,0	37	0	50
004SP662	004215	4	188,9	4,3	35	1	73
001SP006	001194	4	452,7	7,2	33	2	61
004SP007	004029	3	487,5	8,4	32	3	55

Tab. 3 The 10 most unsafe road sections (S2) by number of crashes

In order to appreciate the potential of the tested procedure in the following a diagnostic profile for the road on the top of the ranking is summarized in Tab.4.

SP 10 - ALESSANDRIA	Total	S0	S1	S2
N. crashes	177	9	0	168
Injured	288	12	0	276
Dead	5	0	0	5
Length (km)	39,1	8,1	0	29,8
N. road sections	7	2	0	4
Crash density (crashes/km)	3,63	1,16	0	4,87
Collision Types:				
Head crash	6	1	0	5
Head-side crash	37	1	0	36
Collision	65	5	0	60
Sliding	32	1	0	31
Crashes at intersection	35%	33%	0	35%

Tab. 4 Descriptive profile of SP 10 road in Alessandria province (2010-2012)

An examination of the types of crash collision can be appreciated by comparing their distribution on the whole SP10 road and on the S2 sections, Fig. 6.

Four collision types are considered: head crash, head-side crash, collision and sliding. Distribution of crashes is made by comparing the SP10 as a whole with the totality of the provincial roads of the region, and then the more dangerous sections of SP10 (S2) with the totality of dangerous stretches of the entire region. The distribution of whole SP10 reflects the distribution of the sections belonging to thresholds S2; a comparison with the region shows a greater concentration of collisions in SP10 road.

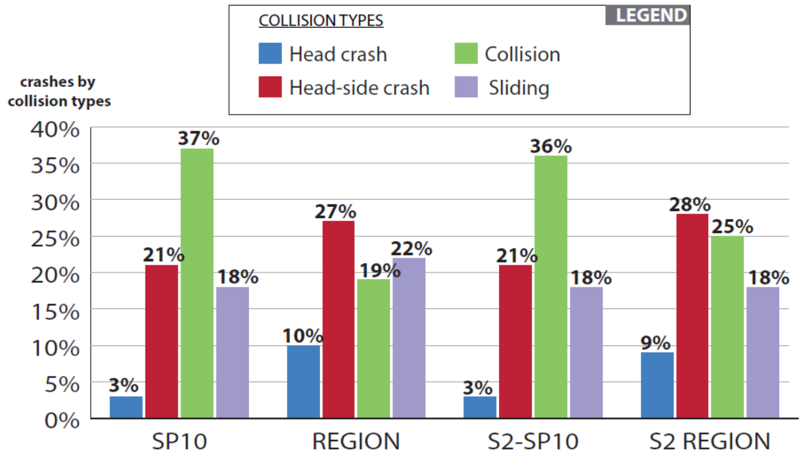

Fig. 6. Crash distribution by collision types on SP10 road and its sections

Fig. 7 shows the four municipalities which are crossed by the S2 road sections. It allows us to visualize that the most dangerous sections belongs to Alessandria. This tract is the longest and has the highest value of the density crash.

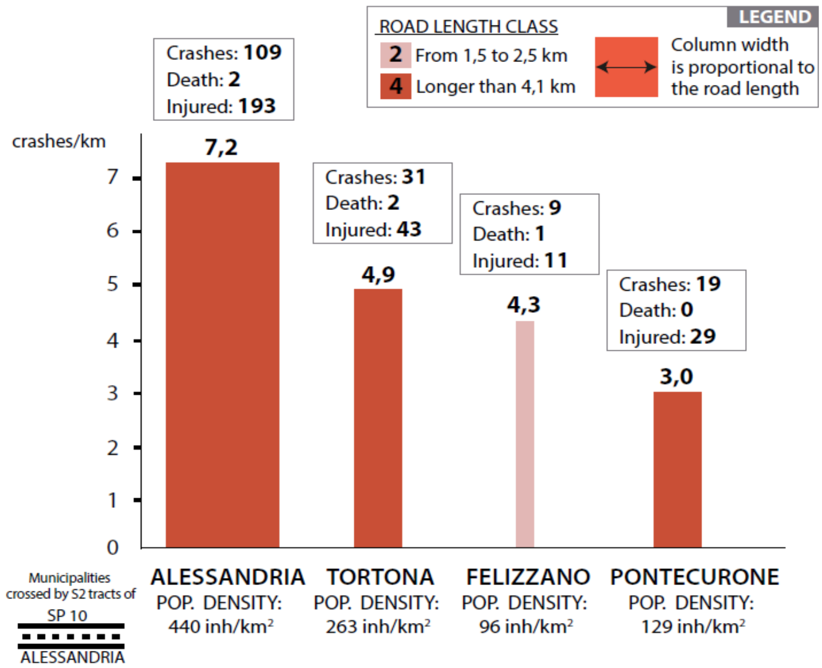

Fig. 7. Municipalities crossed by S2 tracts belonging to SP10 road

This kind of statistical overview can be complemented by a GIS visualization of the crashes provided by the TWIST GIS application. An example is shown in Fig. 8 which visualizes the road sections of SP10 connecting the municipality of Alessandria with that of Tortona.

Fig. 7. Crashes on SP10 between the municipality of Alessandria and Tortona. The red dots represent the crashes on extra-urban provincial roads. Only crashes which have been geo-referenced are shown

4 CONCLUDING REMARKS

Nowadays, the need to integrate the demands of road safety with the other territorial policies, with mobility and environmental issues requires a deeper understanding of the phenomenon at different spatial levels and with different points of view.

The transition to softer mobility styles and greener means of transport raises new concerns about the safety of an increasing proportion of vulnerable road users (pedestrians, cyclists, motorbike and moped riders).

In the current framework of increasingly limited economic resources, it becomes essential to implement effective screening procedures to identify dangerous roads, in order to select a list of sites ranked in priority order to conduct a more detailed engineering and economic investigation.

The pilot study described in this paper is a contribution to that goal.

Of course, additional research is required to establish the basis for a systemic approach oriented to road safety and for the development of effective network screening techniques.

According to the adopted selection procedure about 200 unsafe road sections have been detected, far too many to allow us to carry out a deeper investigation. It will be therefore necessary to sharp the approach and identify more selective filtering criterion.

This calls for a refinement of the network screening technique, to avoid mis-allocation of resources due to the randomness of accident counts. It further requires building a firmer background of the network profiles in the region against which to appreciate the results of the network screening procedures by the different stakeholders.

In this regard other information should be used to support the analysis: in addition to the population density, used here, it is possible to analyze the types of accidents, the morphology of the areas crossed, the vehicular traffic flows (when available), the social costs of accidents, and other variables.

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IMAGES SOURCES

Fig. 1: ISTAT and Regione Piemonte.

Figg. 2, 3, 4, 5, 6, 7, 8: processing CMRSS on ISTAT data.

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