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# ANALYSIS OF URBAN AREAS WITH LOW ROAD SAFETY PERFORMANCES

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***Key words:*** *urban road safety, road accidents, GIS modelling*

***Abstract:*** *The impact of traffic safety is rarely included in urban planning, though the social cost of road accident is overall evaluated being very high. The recently road safety research concludes that road safety has to represents an additional criterion in selection of the best urban planning alternative. Therefore a prediction of intrinsic road safety is necessary for each urban road network configuration. An initial phase in achieving this goal consists in identifying typologies of low safety features of urban road network and relationships between functionalities of urban areas and traffic safety. The paper presents a GIS model developed to analyze the urban areas with low safety performances and to obtain the datasets necessary in definition and calibration of safety performances functions.*

## INTRODUCTION

Due to social and economic consequences of road accidents, the analysis of road safety performances and especially the identifying of appropriate measures to road safety enhancement represent subjects of many studies (Mallschutzke et al., 2005; Gaudry & Gefrin, 2007; Elvik, 2009; Gaudry & Lapparent, 2010). This paper presents the model developed to analyze relationships between road accidents and features of urban zones in Bucharest, a large city characterized by drastic changes of urban configuration and people mobility needs in the last two decades.

Urban area, where road traffic risk arises, represents a spatial complex system. Four classes of input data in the system are outlining risk situation:

1. *Objects* – including mobile entities (vehicles, cyclists, pedestrians, etc.) or elements of the technical and road urban infrastructures;
2. *Actors* – including different groups or organizations which could influence the system: urban authorities, urban networks management company, associations, population;
3. *Spatial structure* - describing the topology and configuration of elements and phenomena related to traffic risk;
4. *Temporal structure* - describing time position of system entities, phases of activity/inactivity, intensity of daily/seasonal journey, etc.

Interactions between classes generate traffic flows characterized by uncertainty on traffic risk. This paper presents the analysis of elements included in the first and third classes, namely:

- ♦topology and configuration of urban road network;
- ♦pattern of urban area function of land use and urban functionalities.

Based on available road accident statistical data in Bucharest during 2008 - 2012, we have developed the GIS model (Fig. 1) to analyse the particularities of urban road network features and urban areas with low safety performances.

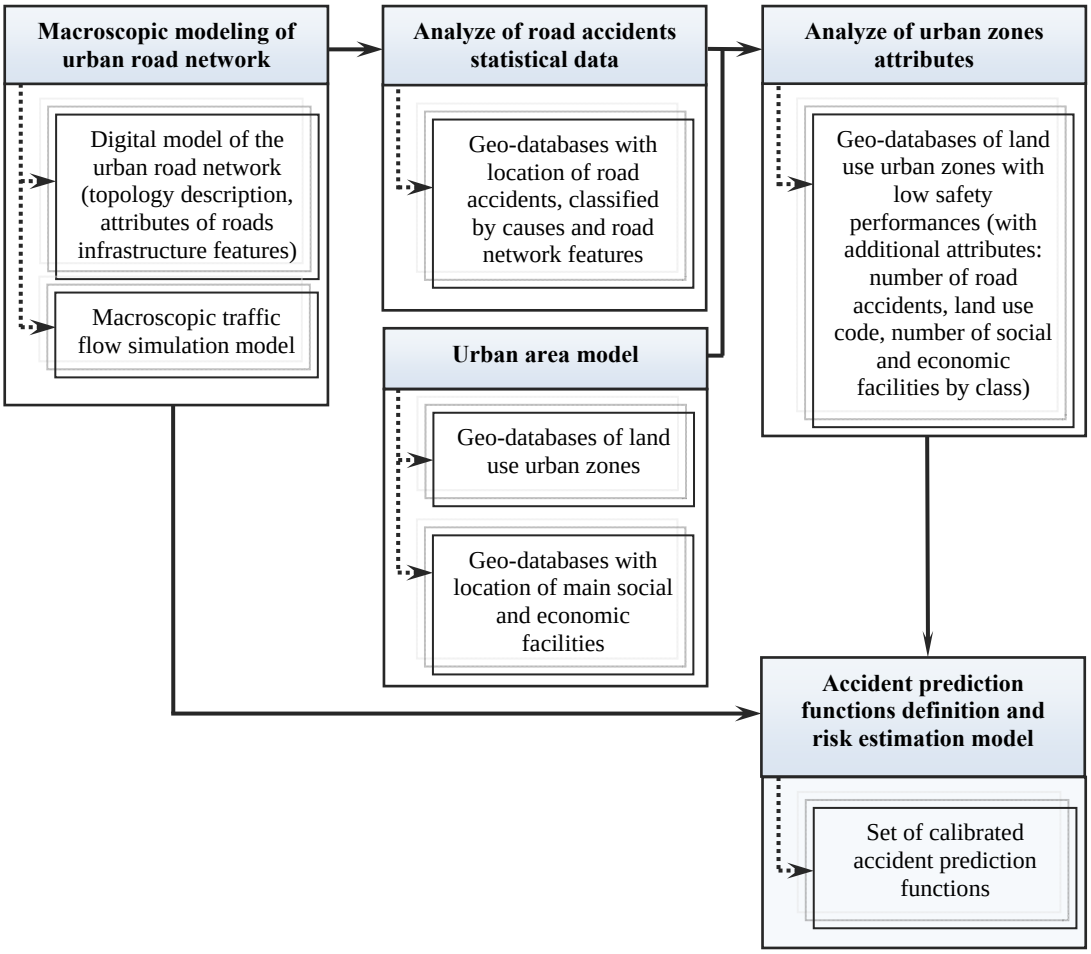


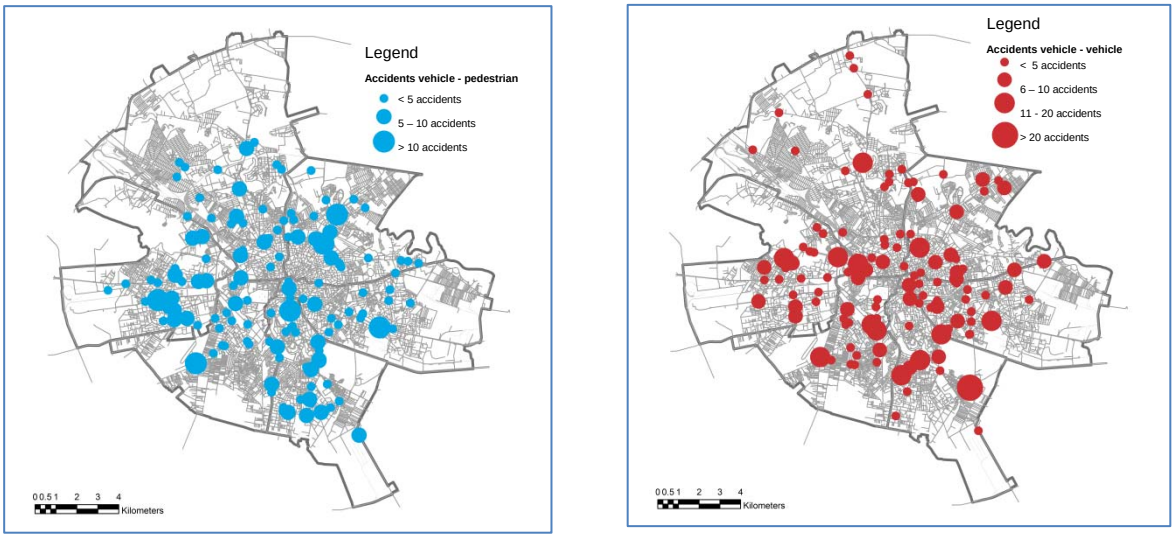

**Fig. 1. Structure of the model for estimate of the traffic safety performances**

Sets of urban zones where road accidents were recorded are selected and series of attributes of urban functionality/land use are obtained and used to quantify the sensitivity of safety performances. In order to provide decision makers with a tool which include traffic risk as additional criteria in selection of the best urban planning alternative, our research aims to identify the relations between functionalities of urban areas and traffic safety.

## ANALYSIS OF URBAN ZONES WITH LOW SAFETY PERFORMANCES

The input data of the GIS model includes the geo-databases about socio-economical city structure and urban road network features, necessary to composite examination of available statistics on road accidents:

- geo-database with location of road accidents recorded in Bucharest during 2008 - 2012, with attributes about accident causes (Fig. 2);
- geo-database with traffic analyse zones (TAZ);
- geo-database with urban zoning function of land use;
- geo-database with location of the main socio-economic facilities, generating significat vehicle/pedestrian flow (administrative institution, commercial centres, schools, hospitals etc.).




a) accidents with involved pedestrians

b) accidents only with vehicles

**Fig. 2 Spatial distribution of road accidents recorded in Bucharest during 2008 - 2012**

Using these geo-databases, GIS procedures (Fig. 3) are applied to identify the typologies and features of urban zones with low safety performances. The analysis is realised separately for road accidents with involved pedestrians and for road accidents only with vehicles. Figure 4 presents examples of obtained results, with accident location relative to population density and relative to selection of schools. Significant concentration of road accidents is located in urban zones with high density of population and buildings, on major but also on minor roads. Because a significant number of accidents are recorded in proximity of metro station, we decided to investigate also the relation between surface urban traffic flow and pedestrian flow attracted/generated by subway transit system, which influence the traffic risk situation.

The large amount of analysis results are processed to obtain specific attributes of Bucharest urban zones. They will be useful in:

1. identifying of the appropriate dependent variables used in accident estimate; in this phase of analysis we have selected the next variable: population, population density, population density in zones with high concentration of buildings, urban road network length, area occupied by road infrastructure, traffic flow, densities of socio-economic facilities (schools, commercial centers, administrative institutions, hospitals); statistical tests will be applied to verify the spatial correlation of these variable (Mitchell, 2005) and their influence on accident number (Cameron & Trivedi, 1998);
2. identifying and calibrating the appropriate model of accident number estimation; the ratio between average and variance of dependent variables selected in the previous step will indicate the preliminary equations proposed to accident estimation (Hauer et al. 2002; Lord & Mannering, 2010; Pulugurtha et al. 2013);

the results of the GIS model will be used to calibrate the parameters included in accident estimation function;

3. assesment of traffic risk for diferent scenarios of urban planning.

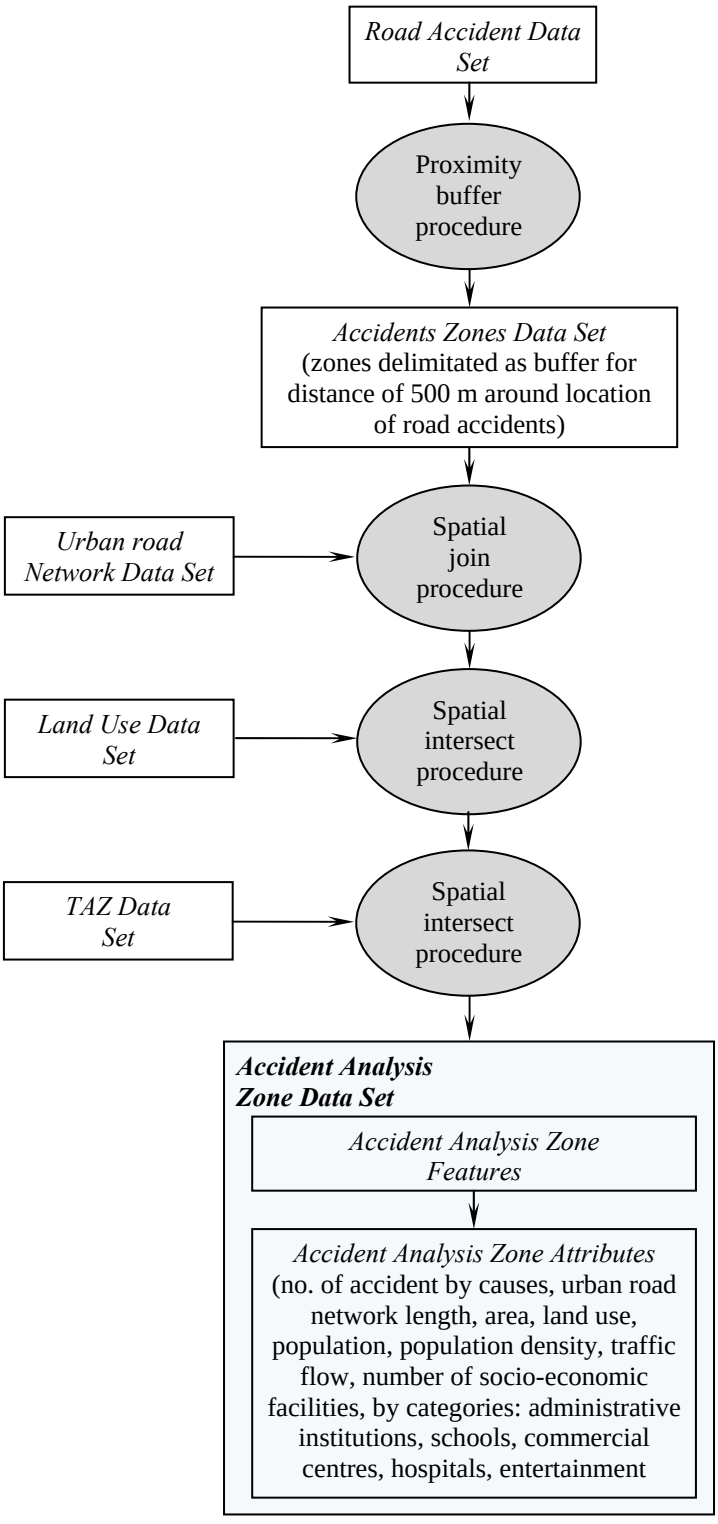
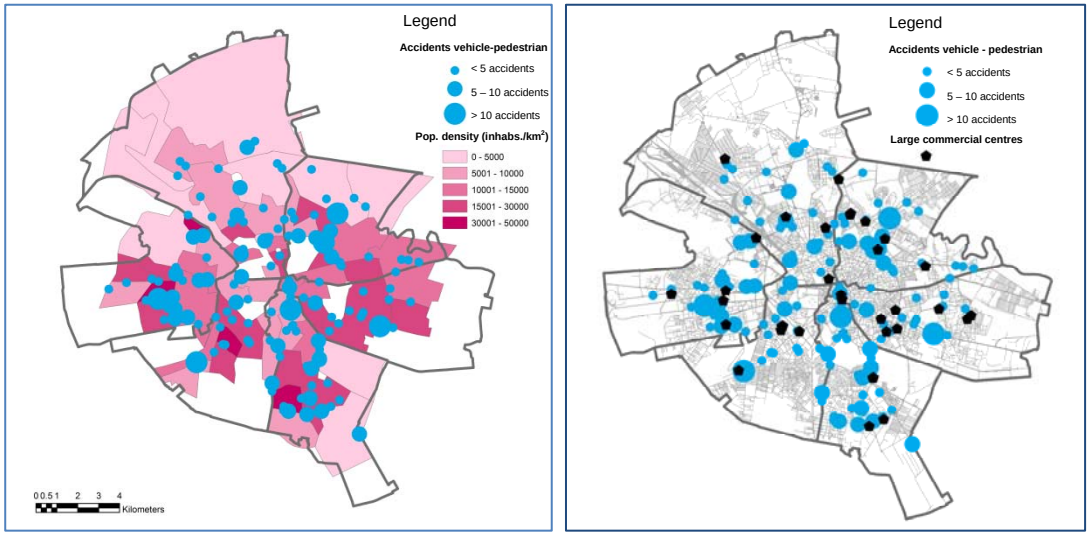



**Fig. 3. Flow diagram of analysis data set preparation process**




a) population density around accident location

b) selection of commercial centres located in areas with recorded accidents

**Fig. 4. Example of features obtained for urban zones with low safety performances (selection for accidents with involved pedestrians)**

## CONCLUSION

The last two decades in Bucharest City are marked by fast and drastic socio-economic life changes and consequently by traffic pattern modification, with direct effect on road safety performances. The solutions applied to satisfy people mobility needs depend on size, shape and outline of urban agglomeration and are potential responsible on traffic risk dimension.

In this frame, models are necessary to estimate road safety performances for different urban planning alternatives and to allow identifying the most appropriate measure to reduce traffic risk. An important step in development of these models is the analysis of the relationships between road accidents and urban land use. The structure of the GIS model built to perform this analysis, presented in this paper, was applied to obtain the data sets with attributes describing the features of urban zones with low safety performances. These data sets will be useful in further research to identify the dependent variables and to define and calibrate of accident prediction function.

## ACKNOWLEDGEMENT

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# АНАЛИЗ НА ГРАДСКИ РЕГИОНИ, ПРИ КОИТО СЕ НАБЛЮДАВАТ НИСКИ НИВА НА ПЪТНА БЕЗОПАСНОСТ

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***Ключови думи:*** *градска безопасност, пътно-транспортни произшествия, GIS моделиране.*

***Резюме:*** *Много често пътната безопасност не се взема предвид при градското планиране, тъй като социалните разходи, в резултат на пътно-транспортни инциденти са доста високи. Последните проведени изследвания в областта на пътната безопасност сочат, че е необходимо въвеждането на допълнителни критерии, в зависимост от които да се осъществява градското планиране. Ето защо при изграждането на всяка една пътна мрежа е необходимо да се отчете и пътната безопасност. В тази връзка, от изключителна важност е идентифициране на причините за ниски нива на пътната безопасност в съответния регион и определяне на функционалните връзки между градските райони и пътния трафик. Настоящият доклад има за цел да представи усъвършенстван GIS модел, с помощта на който да се изследват градски райони с ниска пътна безопасност и да се събере необходимата база от данни за дефиниране на функциите, описващи взаимодействието между пътна мрежа и пътна безопасност.*