Flood risk management: the role of geo-information in the insurance industry

by Franco Guzzetti and Alice Pasquinelli

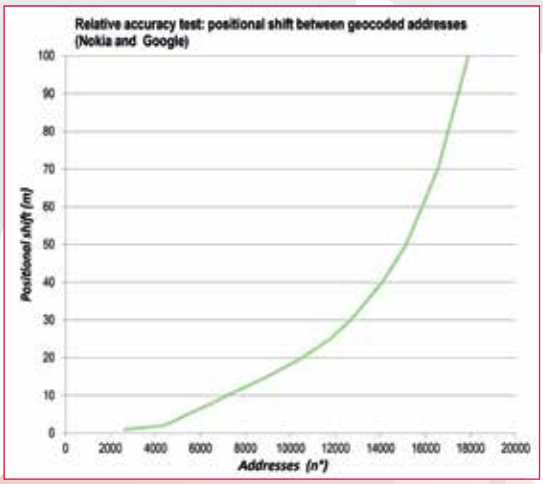
The use of Geographic Information Systems for management purposes is going beyond the traditional field of territorial government and new applications are developed supporting other sectors dealing with territorial issues: insurance industry is one of the sectors where spatial data are acquiring importance, introducing an innovative way for the definition of flood risk insurance premiums.

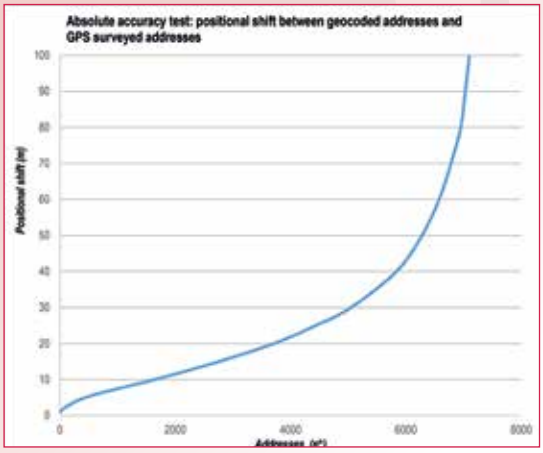
During year 2014 the ABC department of Politecnico di Milano, with the technical support of R3 GIS company, undertook a research project with a major insurance company: the scope was the development of a management system aimed to support the underwriting process of flood insurance policies in the consumer market. The topic of flood risk is strictly related with territorial and geographic features, such as the presence of a river, the interference of human activities, constructions and modification on natural environment, the protection and mitigation measures adopted in order to reduce assets exposure (FEMA, 2007): it is clear how, due to the objective of the project, GIS technologies and spatial information came to the aid (Thompson, 2013).
This partnership is due to the changes in progress on the national panorama that might force insurance sector to provide access to this kind of coverage not only in case of high value properties (like corporations or big factories) but also to house owners. The economic burden of losses related to natural disasters can no longer be borne exclusively by the State, especially in case of predictable and manageable events: for this reason since late 2013 Italian Government started a debate with the insurance industry hypothesizing the adoption of a risk transfer and sharing policy at national level, providing financial support to mitigate their impact on the society (Institution of Civil Engineers, 1995).
In this context, the need of insurance companies is to define a method that allow a quick estimates of the risk assumed in case of standard consumer policies and to deepen all relevant aspects in case of high value, tailor made policies: the value of the insured portfolio and its exposure have to be constantly monitored in order to be aware of the actual possibility to meet claims in case of event, as required by European law (European Directive 2009/138/CE "Solvency II"). Considering these needs, an informative system were structured in order to allow insurers to evaluate potential losses related to flood risks assumption, on the one hand, and to support commercial and price strategies in order to balance refund costs and guarantee financial solvency, on the other hand.
The main output of the project was the creation of a technological infrastructure supporting agents during the underwriting process step by step, up to the definition of the insurance premium: the latter is defined considering building exposure (its location within or outside flood prone areas) and all features that make a building more or less vulnerable in case of flood. Building vulnerability (its propensity to undergo dam-

ages) is a crucial factor in the determination of the insurance premium and its computation requires several input parameters (FEMA, 2007). As primary parameters concern the geographic positions of buildings, the whole management system were based on a thematic GIS.

The "Risk GIS"

In case of a new flood policy the building evaluation process, to be carried out at the early stage of the underwriting phase, consist of a first desktop assessment of building exposure, based on the confrontation between building position and flood prone areas; thereafter, if the policy value is relevant, the agent will proceed with an on-site survey collecting detailed information on building features that determine its vulnerability. Building are the objects covered by the insurance policy that occupy specific places in the territory: what determines the exposure of a building to hydraulic hazards is its location which might be inside or outside a flood prone areas. In order to detect this kind of information the geographic knowledge involved concerns, at least, two factors: buildings position and flood areas extent in case of overflow with different occurrence probability (return period). Theoretically, both these types of information are known: every building is referenced on the territory by an address; specific public authorities are in charge for the identification and mapping of flood areas in each watershed. Practically, the combination of the aforementioned information in a geographic information system is far from being easy and automatic: addresses may change in time, and those stored in archive, like the one in use in an insurance company, might be unstructured and out of date; Italian Basin Authorities, in charge of hydrogeological hazard mapping, do not follow common rules neither for the definition of flood areas nor for data structuring (hazard classification, coordinates system, …). Therefore the realization of a "risk GIS" required hard data cleaning and harmonization in order to allow interoperability among datasets. On the one hand addresses contained in the insurance company archives, related to insured properties, were structured and georeferenced through a geocoding tool. The choice of the geocoder used derives from a comparative assessment of position accuracy provided by three different geocoders (Nokia, Google and Mapquest).





Img. 1 and 2 - Results from the relative and absolute accuracy tests on geocoded addresses.

Quality tests, as described in (Guzzetti et al, 2014) concerned:

- relative accuracy, determining which tool located the most of addresses up to the level of detail of house number;
- absolute accuracy, confronting geocoded addresses and surveyed addresses in use in public administration.

Even if results deriving from the abovementioned test are satisfactory, geocoded addresses are not considered certain until they're verified on field. As a consequence buildings positions are considered as a temporary data: on-site GPS survey will be conducted whenever the company will consider it worthwhile, like in case of tailor made policies related to high-value properties.
On the other hand geographic data concerning flood areas were collected, cleaned and reorganized. Due to their deliberative and financial autonomy, each Basin Authority produce its hazard map independently and there are no common procedures or methodologies about how to model hydraulic risk: nevertheless, in order to accomplish the duties related to the "Flood Directive" 2007/60/CE, the Ministry of the Environment released national rules (MATTM, 2013) leading off a standardization process of all the risk zone classification identified by the Basin Authorities. In order to produce a nation-wide hydraulic hazard map the research group proceeded with a first quick normalization of existing maps following rules and specification delivered by the Ministry: several aspects made this a time-consuming process,

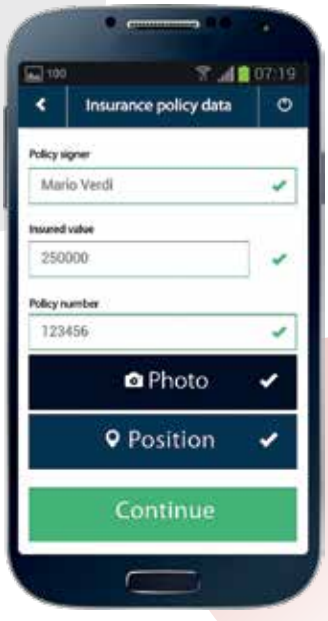
such as differences in hazard zones modeling and classification, coordinate systems, overlaps of different classification in cross-boundary areas, data availability and accessibility. Nevertheless it was possible to create a unified classification, in three hazard level, of all Italian flood areas, which may be substituted with new official data whose release is expected by June 2015.
The combination of these two spatial datasets allow a quick evaluation of hazard exposure of insured assets overlapping buildings positions, generated by geocoding, and flood areas, with different hazard level: this superimposition is realized through a web-GIS tool accessible by insurance agents, providing a first feedback about properties at risk. When the feedback is positive agents may consider, depending on the value of the properties involved, whether to apply a standard fare related to the hazard level detected or to proceed with an on-site survey in order to acquire more detailed information about building position and features that might increase or reduce losses in case of flood.
The pricing policy adopted by the insurance company follows a rewarding mechanism that make prices decrease when the hazard level is low or whenever flood-proofing measures, reducing buildings vulnerability, exist. On the contrary, policy premium for properties falling within frequently flooded areas with no mitigation measures adopted will increase. For this reason data collection on several parameters determining buildings vulnerability have to be submitted to the system in order to correctly define the

Img. 3 - Flood areas and geocoded addresses in Vicenza city.

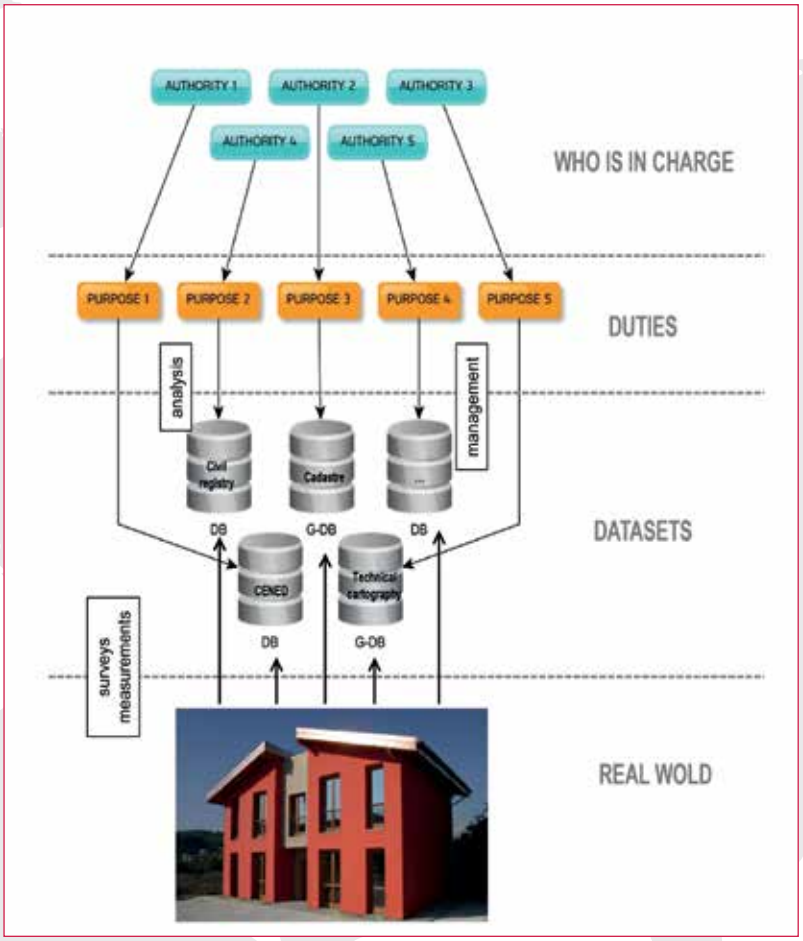
policy price: such parameters concern, for instance, the accesses and openings elevation compared to the height reached by the water, the presence of underground floors, the position of values inside the building, the adoption of flood proofing measures.
As a supporting tool for data collection, a mobile application integrated with the system were developed: this smartphone application lead insurance agents during the on-site survey, requiring them to insert information concerning the abovementioned parameters. Some of these information are acquired automatically, like the building position and height, thanks to the GPS antenna installed in each smartphone; others have to be inserted by the operator, like the number of floors included in the properties. Data gathered through the application are then uploaded to the system and used in the computation of the insurance premium.
After the research and testing phase, the new web-GIS management system is being progressively acquired by the ICT sector of the insurance company. The resort to GIS technology involved a cultural shift toward a geographic-based approach in a sector, like the insurance industry, that traditionally based its business on historic data and statistical analysis.

The potential for territorial risk reduction

The definition of a pricing policy that reward positive behavior in buildings protection contribute to trigger owners commitment in the adoption of protection measures, reduc-



Img. 4 - Mobile interface for data collection during on-site survey (smartphone version).



Img. 5 - One object, many data, different datasets: informative fragmentation concerning buildings.

ing the amount of damages that properties might be subjected to and, at the same time, allowing the company to apply fair and competitive price for insurance coverage. Moreover, the perspective of further damage reduction incentivize the insurance company itself to finance prevention services or the purchase of protection devices, whose price is decisively lower compared to refund costs in the aftermath. Even if not with structural interventions for risk reduction (like the construction of levees or overflow channels) the combined effect of many punctual protection measures will contribute in the general reduction of the effects and impacts of flood events. The experience accrued within this project opens up to some consideration concerning the general matter of territorial management and government. Traditionally, after catastrophic events, economic aid for recovery in disaster areas came from the central government: up to the present public resources have been mainly addressed to damage refunds, focusing on emergency intervention. Preventative measures hardly get public funding, even if investments on risk reduction and mitigation strategies might reduce the amount of damages and so restoration costs in the aftermath. It is not possible now to know whether the Italian State will introduce compulsory flood insurance for buildings, but it is important to enable citizens to act for their safety through the knowledge of the territory they live in. For this reason, the increase in public awareness concerning flood risk might be considered a priority in the public agenda: the spread of information to the population living in flood prone areas might encourage citizens themselves to adopt protection measure, in the same way that lower prices for insurance policy could do (Boer et al, 2013). In the "Google era", when interaction with geographic data became user friendly, new channels for the communication of risk information opened up. Often we state that data produced at different level might be open and accessible, but we should start to consider that the meaning of the word "accessibility" is twofold: from a technical point of view accessibility concerns data availability and interoperability, and spatial information describing hazards should be easily retrieved and structured in a standard format, allowing a universal comprehension of information produced by different authorities (Messner and Meyer, 2005); from a social point of view accessibility concern the possibility to access knowledge and get a complete comprehension of events citizens and assets might be exposed to before these events take place, even without being a flood risk specialist. If, on the one hand, it is correct that risk reduction and mitigation become a public concerns that include not only public administrator but also the citizens, on the other hand the provision of clear and understandable information aimed to increase public awareness is due (Manfré et al, 2012).

The role of geographic information in this cultural shift

As mentioned in the project described, the restoration to spatial information led to a cultural shift in the management of an insurance portfolio. In the same way, and as recognized by the technical community, geographic information management systems allow an efficient and integrated territorial government: unfortunately, this is far from being a common practice and even the datasets integration is still an open issue (Tóth et al, 2012). If we think about built assets, information describing different aspects of buildings are stored in many databases: building ownership is registered in the land registry; its geometrical features are described both in technical cartography and cadastral maps and documents, with different level of detail and update, with no positional or semantical connection; the related address recorded in the civil registry and in use by the municipal administrator do not necessarily correspond with the one recorded in the land registry; it is possible to determine whether this building fall within a flood area only identifying its position in a specific hazard map. What is missing is a common framework that allow the interconnection among different datasets related to one specific object: the building.
One simple solution that could be adopted to overcome this problem is the indication of the coordinate pair, unique in the world and not subjected to changes, identifying the building that data are referred to.
Also, the ongoing cadastral reformation process represent the occasion to create a qualitative informative hub where to collect all information concerning buildings, making cadaster a tool that provides not only support for fiscal purposes, but that concentrate knowledge for an integrated territorial management and the provision of innovative services to the citizenry.
Year 2014 was a period when, due to the high number of flood events that took place on our country, the theme of the impact of natural hazard on society gained a lot of attention and the current awareness on the topic has to be exploited before that people lose interest on it: now is the right time for a cultural shift toward a collective commitment in risk reduction that may start from an increased awareness supported by the widespread of information, enabling all stakeholders to contribute in disaster reduction.

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ABSTRACT

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