

# Application of safety and security principles to flood event management in highly populated urban areas

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## Abstract

This paper refers to non-structural actions which are to be carried out on the Arno river basin (Italy). In particular the town of Florence is considered where 56 catastrophic flood events have been recorded in the last 1000 years, the latter in 1966 with damages estimated at 10,000 billion euros. A huge system of structural works is presently being carried out planned to the 200-year return period event in the next ten years. To manage the present and future residual risk, specific safety plans have been provided at the scale of single buildings in order to give residents an effective instrument to prevent and protect them from the major flooding risk. This paper illustrates how safety and security principles can be applied to the management of a flood event at the scale of several thousands of square kilometres. A specific Security Plan and, if needed, a Recovery Plan is linked to each building which is potentially subject to flooding. Based on analytical hazard assessment and mapping, techniques to improve or increase the safety-level as well as appropriated information are described. These local scale plans are interfaced with civil protection and disaster management plans at the regional scale by suitable procedures.

*Keywords: risk assessment, flood event, security plan, recovery plan, signs, procedures, building.*

## 1 Introduction

A study for a plan in order to provide the residents of the area of the Arno River basin (and in future perspective all the residents) with one useful instrument to



prevent and protect them from the risk of flooding has been carried out. The plan regards non-structural actions to manage the present and future residual risk, and complete the huge system of structural works already planned. General Flood Proofing Management Systems already exist [1, 2, 3, 4]; the realization of a specific Flood Proofing Management System plan at the scale of the single building situated in areas subject to flooding is possible by adapting safety and security principles to the management of a flood event.

## 2 Methodological approach

The application of safety and security principles to the management of the emergency in workplaces [5, 6] provides hazard identification and risk assessment at the scale of the single factory. The result of this analysis allows us to classify the risks and, consequently, to suggest appropriate actions to remove, minimise or control them.

According to the outcome of the analysis a Security Plan (to be kept inside the company) is defined it contains:

- the results of risk assessment;
- the consequent procedures for prevention and protection and the information about the suggested personal protective equipment;
- the selection of trained employees as responsible for the management of the emergency;
- the choice of safety signs and signals to expose inside the factory, that indicate with immediacy which are the actions to make or not to make, how to reach the emergency exit, etc.;
- a list of the appropriate risk reduction measures, written giving priority to those risks higher in magnitude or which could affect a larger number of persons (Recovery Plan).

The contents of Security Plan and Recovery Plan must be known by all the employees. Risk analysis and risk assessment must be reviewed in case of meaningful changes in productive processes, work equipments, building layout, etc.

These principles have been applied to the risk of flooding. Basically, a factory is replaced by a single building (house, school, factory, etc.), the employees are replaced by the occupants (of the building) and the hazard considered is exclusively flooding.

The general development of the project is illustrated in a flow-chart, fig. 1, and each phase is described in table 1.

## 3 Application of the method

According to the illustrated methodology, a Security Plan and, if necessary, a Recovery Plan are associated to every building situated in areas subject to flooding. Risk assessment, indication of the modifications to carry out in order to improve or to increase the safety-level as well as appropriated signs to expose in strategic places represent the innovation of the work.



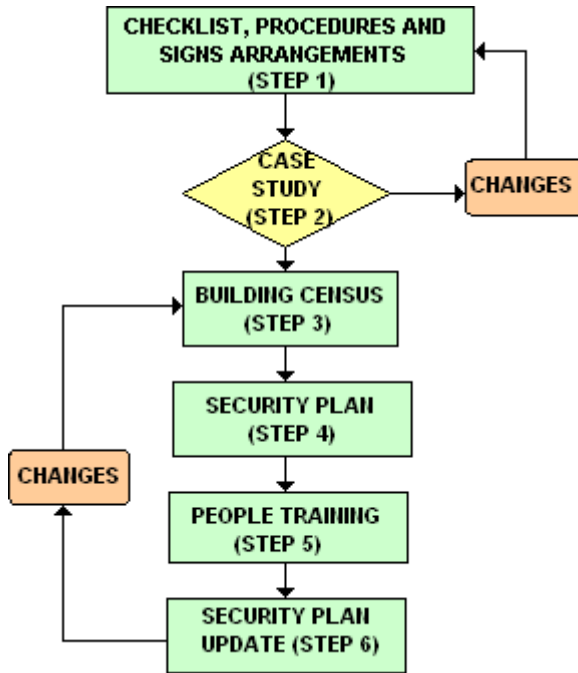


Figure 1: Development of the project.

Table 1: Phases of the project.

STEP	NAME	DESCRIPTION
1	CHECKLIST, PROCEDURES AND SIGNS ARRANGEMENT	Arrangement of a checklist containing the most outstanding data of a building to characterize its hazard level. Arrangement of general procedures to prevent and protect persons and properties from risk of flooding. Arrangement of signs to be exposed inside and/or in proximity of the building representing what to do in case of flooding.
2	CASE STUDY	Selection of an adequate number of various kinds of buildings to which apply the instruments defined in step 1 and eventually modify them
3	BUILDING CENSUS	Census of every building in the area of the Arno river basin using the checklist.
4	SECURITY PLAN	Using the data of the check list and the appropriated pattern; drawing up of the specific Security Plan and Recovery Plan for the building.
5	PEOPLE TRAINING	Informing all people about flooding risk and how to use Security Plan and signs.
6	SECURITY PLAN UPDATE	Updating Security Plan in order to guarantee its functionality in the time. Carrying out control operations on safety and security systems to keep them functional.

### 3.1 Security Plan

Different patterns of Security Plan have been drawn up for various kinds of buildings (houses, schools, factories, etc.). Every pattern has to be adapted to the single building. Especially for historic buildings or buildings with particular artistic and architectural value, the Security Plan has to be related both to architectonic ties and to the purpose to preserve structures and works contained in it.

Every Security Plan contains:

- the most outstanding data about the building that the inhabitants have to know, extracted from a checklist;
- useful notions and terms that the inhabitants have to know;
- general causes of flood and information about their consequences, historical reports about local past floods, notions about the procedures used to alert population in case of flooding;
- specific procedures to act being prepared in case of a potential alluvial event; these also suggest how to inform the authorities about the presence of not self-sufficient persons during an evacuation; an example for a school is explained in table 2;
- specific procedures to act during an alluvial event;
- specific procedures to act after an alluvial event in order to return to the building in safety.

In the case of public buildings (school, hospital, office, etc.) or factories, responsible persons are also indicated in order to manage an eventual flooding and, if necessary, an evacuation.

Table 2: Communication form.

<b>PEOPLE TO BE EVACUATED: COMMUNICATION FORM</b>			
School			
Address			
Kind of school	<input type="checkbox"/> nursery school	<input type="checkbox"/> secondary school	
	<input type="checkbox"/> primary school	<input type="checkbox"/> university	
Total number of students		Number of students with disabilities	
Total number of employees		Number of employees with disabilities	
Necessity of particular rescue vehicle (make a description)			
Number of accessible floors			
Rescue point position			
Date of compilation			

#### 3.1.1 Checklist

A checklist has been created to collect the data of interest for drawing up Security Plans.

The checklist contains five kinds of data:



- data about the technicians inspecting the building and state of review of the checklist (like as first extension, update, etc.);
- data about the building (as geographic position, level of hydraulic dangerousness, number of accessible floors, etc.);
- data about persons exposed to the risk (as number of persons occupying the floors exposed to the recurrent events, to the exceptional ones, number of not self-sufficient persons in evacuation case, etc.);
- data about systems and plants (as position and height of fuse boxes and breaker boxes, of the lift, of the heating system, etc.);
- data about existing civil protection and disaster management plans (as position and distance from the meeting point, road conditions, etc).

The checklist must be filled in during an inspection carried out by a trained staff. It is very important to carry out inspections with extreme accuracy, to find out all the peculiarities of the building and, consequently, to draw up a Security Plan strictly linked to it.

### 3.1.2 Procedures to manage an alluvial event

Procedures to act in different phases of the alluvial event have been developed.

To be prepared in case of flood is necessary to adopt a series of preventive rules as: to prepare an "evacuation kit", to inform the authorities about the presence of not self-sufficient persons, to protect the building with barriers or other devices to increase or improve the protection level.

In order to manage a recurrent and/or exceptional alluvial event a series of emergency procedures has been indicated: they include the actions to make or not to make in flooding case, how to communicate with the agencies to inquire about the event evolution, how to evacuate correctly and effectively the flooding area, etc.

Finally, procedures are drawn up in order to return into the building after the alluvial event, being careful of the possible effects of flooding, defining the procedures to control and bring back in efficiency and safety the structural and infrastructural elements of the building.

All these procedures are specific for the building, depending on the data collected in the checklist, and consider the specific elements of the single case.

## 3.2 Recovery Plan

Recovery Plans are defined if it is necessary to implement appropriate risk reduction measures, starting from the result of the risk assessment and of the structural characteristics of the building.

Recovery Plans describe measures as:

- changes to make to the building to minimize damages by floodwaters (like repositioning of system parts and plants, furniture, valuables, pollutants, tanks, etc.);
- measures that don't modify the building structure (like as elevation of several types of permanent barriers, use of movable barriers, etc.);
- measures that modify the existing structure in order to increase the building resistance to water (as making all areas of the building below the attended flood level watertight, etc).



### 3.3 Signs

Suitable signs have been designed, fig. 2, to represent the actions to make in flooding case.

These signs, together with useful data, are to be exposed inside and/or in proximity of the building, so that all the inhabitants can make use of them, according to safety and security principles.

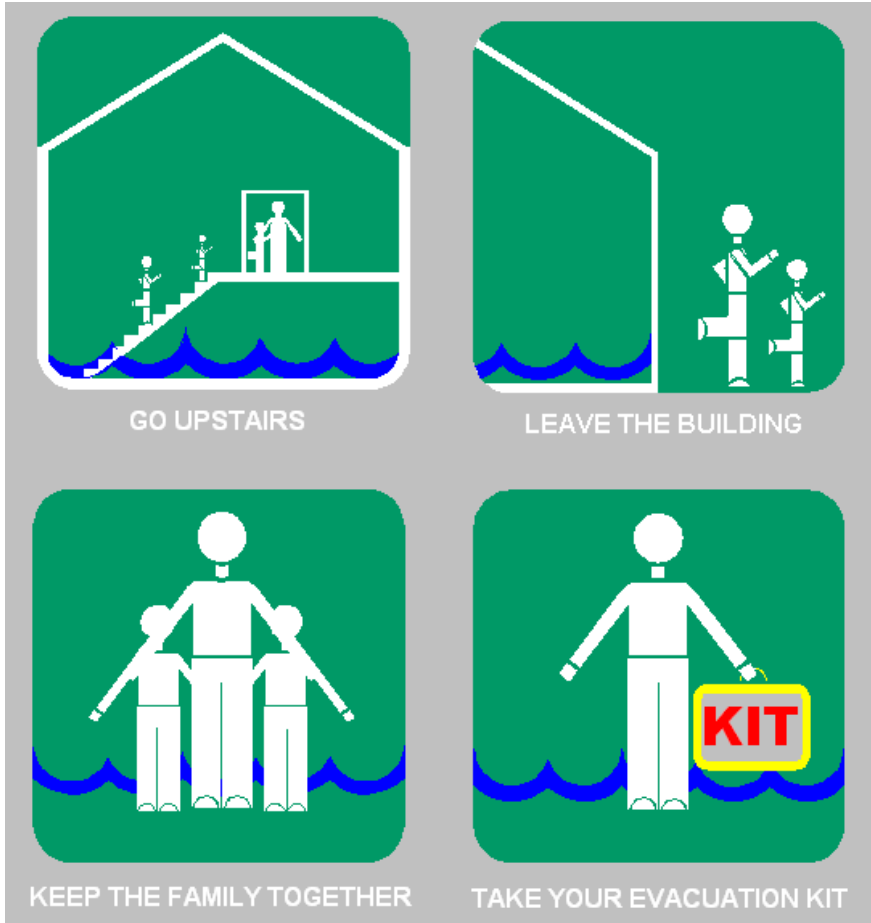


Figure 2: Example of signs.

## 4 Conclusions

The definition of patterns of Security Plans, Recovery Plans, check list and signs represents the first step of a wide project in order to give an effective instrument to prevent and protect persons and properties of the Arno river basin from the major flooding risk (Flood Proofing Management System).

The results of the first step of this project show that the application of safety and security principles to the management of a flood event is not only possible but also effective.

A series of accomplishments are needed. First of all, fitting the general existing alert system to the local ones, specifying how to coordinate them and how to inform the population. Then, a suitable training activity for the technicians which has to take a census of buildings, to fill in checklists and to draw up Security Plans, is needed. It is fundamental to inform all people in the area subject to risk of flooding (like residents, workers, students, etc.) about local procedures, for example by informative pamphlets. Finally, a Security Plan is not something static: it is good practice to review and revise it, in order to guarantee its functionality during time.

An extension of the project is represented by the definition of rules and standards to design new buildings or to restructure existing buildings situated in areas subject to risk of flooding, according to the principles of integration between comfort, security and ecology.

## References

- [1] Denver Office of Emergency Management, Urban Drainage and Flood Control District, *City and County of Denver Flood Protection Handbook*, 2003.
- [2] Missouri State Emergency Management Agency, *Missouri Floodplain Management Quick Guide*, 2000.
- [3] Di Tomizio-Moro B., Jasinski R.R., Tomassoli L., *Come deve comportarsi un cittadino prima, durante e dopo un'emergenza*, Associazione Nazionale Coordinamento Camperisti 2004.
- [4] DTLR, [www.safety.dtlr.gov.uk/bregs/index.htm](http://www.safety.dtlr.gov.uk/bregs/index.htm).
- [5] HSE, [www.hse.gov.uk/pubns/indg163.pdf](http://www.hse.gov.uk/pubns/indg163.pdf).
- [6] Luzzi S., *Vivere e lavorare in sicurezza*, Editrice San Marco 2002.

