EVANDE

BEST PRACTICES

EVANDE Project, Technical Booklet

Natural History Museum of Crete - University of Crete, CREECE

Technical University of Crete - Laboratory of Distributed Multimedia Information Systems and Applications, GREECE

Consorci de la Ribera, SPAIN

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PREFACE

The Best Practice Guide on earthquakes, floods and forest fires is produced by the European civil protection project EVANDE (Enhancing Volunteer Awareness and education against Natural Disasters through E-learning).

The EVANDE project is implemented the period 2015-2016 and is co-funded by the Union Civil Protection Mechanism (Grant Agreement No.ECHO/SUB/2014/693261). It is coordinated by the Natural History Museum of Crete-University of Crete, in Greece and involves also the following partners:

- *Technical University of Crete -Laboratory of Distributed Multimedia Information Systems and Applications, GREECE*
- *Consorci De La Ribera, SPAIN*
- *Beigua European & Global Geopark, ITALY*
- *Earthquake Planning & Protection Organisation, GREECE*
- *Fondazione Hallgarten - Franchetti Centro Studi Villa Montesca, Italy, ITALY*
- *Centre for Educational Initiatives, BULGARIA.*

The present guide is a synthesis of selected civil protection experiences and lessons learned in Greece, Spain, Italy and Bulgaria. It aims to present indicative examples of best practices on civil protection against earthquakes, floods and forest fires and stress the lessons learned. It focuses in all aspects of civil protection including prevention, response and recovery and covers institutional, economical, social and educational issues.

The guide is targeting local authorities' staff and civil protection volunteers and aims to offer insignts on how civil protection policies and initiatives could be improved.The contributors were both staff member of the EVANDE partner organizations as well as experts and external collaborations (e.g. civil protection volunteering groups). The synthesis of these experience indicate the diversity of approaches per country as well as the importance of prevention and awareness-raising on natural disaster risks.

Further information about the EVANDE project:
EVANDE website: www.evande.eu
EVANDE e-learning platform: http://evande.coursevo.com
EVANDE Facebook Group: https://www.facebook.com/evandeproject

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Table of Contents

1. BEST PRACTICES RELATED TO EARTHQUAKES AND LEASONS LEARNED

GREEK best practices to earthquakes and lessons learned

The Greek best practices presented in the current chapter include the following:

Chapter 1.1.1: It presents indicative prevention and mitigation measures and activities at national level in Greece. They focus mainly in the role and contribution of Earthquake Planning & Protection Organization, one of the partner organizations of the EVANDE project. More specifically: The sub-chapter 1.1.1.1. presents the institutional planning and the prevention and mitigation activities on seismic codes for new and existing buildings in Greece. The sub-chapter 1.1.1.2. presents how the pre-assessment of public buildings with regards to the seismic risks is conducted. The sub-chapter 1.1.1.3. presents the preventive measures on seismic risk in Greece referring to the operation of the National Network of Seismographs and Accelerographs.

Chapter 1.1.2.: It illustrates the preparedness measures implemented by Earthquake Planning & Protection Organization in Greece. These include the running of the national educational project “Protect Myself and Others” (sub-chapter 1.1.2.1.), the development of the Model School Emergency Plan (sub-chapter 1.1.2.2.) and the organization of workshops on preparedness for earthquake disaster management (sub-chapter 1.1.2.3.).

Chapter 1.1.3. It highlights the response actions to earthquakes in Greece. It illustrates how the earthquake post-assessment of buildings and infrastructures is conducted in Greece (sub-chapter 1.1.3.1.). Moreover, it presents the response actions implemented in the case of the earthquake that occurred in Athens, on 7/9/1999 (sub-chapter 1.1.3.2.).

Chapter 1.1.4.: It presents the successful recovery actions according to the New Urban Plan of the city of Kalamata in Greece, after the devastating earthquake that occurred in 1986.

1.1.1. Best practices on prevention and mitigation

1.1.1.1. Greek Seismic Codes for new and existing buildings

a) Greek Seismic Codes for new buildings

The Greek Seismic Design Codes are often upgraded including all state-of-the-art related issues. The revisions of the Seismic Codes for new buildings are the following: (1959) First Seismic Design Code (National level), (1985) Revision of Seismic Code, (1995) New Greek Seismic Design Code (NEAK), (2000) Greek Seismic Design Code (EAK 2000), (2014) Eurocode EC8 (parallel implementation). The Code for Concrete Structures was replaced in 2001 by the new “Greek Code of Reinforced Concrete EKOS - 2000”.

Earthquake Planning & Protection Organization, partner organization in the EVANDE project, assigns to relevant scientific committees the enactment of earthquake safety regulations, harmonized with modern data in the sector of manufacturing of buildings, as well as the processing of special subjects relevant to the seismic technology.

b) Greek Seismic Codes for existing buildings

The Greek Seismic Codes and the regulations for existing buildings concern concrete buildings, masonry buildings and historic buildings and monuments.΄The following part presents the main information about these standards.

- ***Code of Interventions (KAN.EPE.) for reinforced concrete buildings****:* The scope of the standard is the enactment of the assessment criteria for the structural capacity of existing structures, and of the application rules for the redesign, as well as for the potential interventions, repairs or strengthening. The code was put into force on 20-1-2012 (Greek Government Gazette 42, Issue B) and has been revised (5-9-2013, Greek Government Gazette 2187, Issue B).

  This code was prepared by an Earthquake Planning & Protection OrganizationCommittee composed by 17 professors from national universities and engineers that worked on it for more than 10 years. The first draft of this Code had been submitted for peer review to a 23-member committee of consultants, consisting of distinguished Greek engineers (3/2004). The second draft has been checked once more (from 6/2006 to 7/2007) by 9 esteemed structural design offices. The third one was put to public consultation until the end of 2009, before its final configuration as a National Standard.

  The forth version of KAN.EPE. (9/2010) was drawn up taking into consideration the conclusions that resulted from the public consultation as well as the most recent remarks and observations of the members of the committee. The present final version (5th) resulted after the necessary interventions in order to be compliant with the Eurocodes system.

  The application of the Code is not obligatory for every existing building. If and when the owner decides to upgrade a particular building (private or public), he has to follow KAN.EPE (or EC8-3).
- ***Code of Interventions for masonry buildings****:* This code is under preparation. Since 2014 a preliminary draft has been prepared by the relevant Earthquake Planning & Protection OrganizationCommittee.
- ***Regulatory Document for Structural Interventions and Seismic Protection of Historic Buildings and Monuments****:* A primary regulatory document concerning the general principles of structural interventions in monumental buildings has been completed by a scientific committee in 2010. The next step is the compilation of an Official Regulatory Document.

1.1.1.2. Pre-earthquake assessment of existing public buildings

Apart from the implementation of the above mentioned Greek Seismic Codes/Regulations for buildings, prevention and mitigation measures against earthquakes include also the pre-earthquake assessment of public buildings.

The pre-earthquake assessment is performed to public buildings to identify those ones that present inefficient earthquake performance and might pose a risk of loss or injury, or severe interruption of community services in the event of a severe earthquake. The inspection is carried out by the authority that is responsible for the operation and the safety of the building. The pre-earthquake assessment results give a first estimation of the bearing capacity of the building in order to identify priorities at national level to further control and measures' implementation.

In Greece the pre-earthquake assessment framework, strongly influenced by the relevant system of USA (FEMA 154) includes three degrees of assessment:

- The first degree was implemented in 2001. This is a Rapid Visual Screening procedure that gives a first estimation of the bearing capacity of the building.
- The second degree is an approximate seismic evaluation that is based on simplified calculations and non- destructive methods for buildings that were found insufficient from the first degree.
- The third degree inspection is a detailed assessment for buildings with local or general inefficient seismic performance.

Parallel to the first degree of pre-earthquake assessment, for each public building an inspection form, concerning the non-structural components, is filled. A checklist of non-structural earthquake hazards (FEMA 74/September 1994) is used to assess whether they pose a danger to the building occupants.

1.1.1.3. National Network of Seismographs and Accelerographs

Prevention planning on earthquakes requires also the study of seismic hazards. In Greece, Earthquake Planning & Protection Organization supports the following actions:

- the development and modernization of the National Network of Seismographs (Fig. 1.1.1.3-1) and the National Network of Accelerographs (Fig. 1.1.1.3-2) and GPS. These Networks operate on a basis of a 24/7 service. Earthquake Planning & Protection Organizationmaintains more than 200 free field strong motion instruments on a national scale,
- the development and update of the Greek Seismic Hazard Map, and
- the development and the publication of the Neotectonic Maps of Greece (sc. 1:100000).

Fig. 1.1.1.3-1: National Network of Seismographs, (Institute of Geodynamics)
Fig. 1.1.1.3-2: National Accelerometric Network (Earthquake Planning & Protection Organization)

References:

- Earthquake Planning & Protection Organization, (2014), Leaflet "Earthquake Planning Workshops", Athens, Website: http://www.oasp.gr/sites/default/files/Brochure%20on%20Operational%20Workshops_en.pdf
- Earthquake Planning & Protection Organization, (2012), "Code of structural interventions 2012 final harmonized text", Athens, 348p, Website: http://www.oasp.gr/sites/default/files/_%CE%95%CE%A0%CE%95_2012_teliko_FEK_42_B_20_01_2012.pdf (in Greek) and Website: http://ecpfe.oasp.gr/sites/default/files/files/ΚΑΝΕΠΕ_EN2013__FINAL(1).pdf (in English)
- Earthquake Planning & Protection Organization, National Accelerometric Network, Website: http://www.itsak.gr/page/networks/acc_network
- Institute of Geodynamics, National Network of Seismographs, Website: http://www.gein.noa.gr/el/diktua/ethniko-seismologiko-diktuo

1.1.2. Best practices on preparedness

In Greece, state's efforts aim to raise population awareness of the, improve its knowledge on earthquakes, educate relevant target groups and build a disaster prevention culture. In the following part two best practices on preparedness issues implemented by the Earthquake Planning & Protection Organization, are presented. These include the running of the:

- National Educational Project "Protect Myself and Others" (sub-chapter 1.1.2.1) and
- National School Earthquake Safety Initiative (sub-chapter 1.1.2.2.).

1.1.2.1. Educational National Project «Protect Myself and Others»

The National educational project «Protect Myself and Others» is running since 2001 in Greece (Fig.1.1.2.1.-1 and 1.1.2.1.-2). The coordinator of the project is the Institute for Youth and Lifelong Learning of the Hellenic Ministry of Education and Religious Affairs. National agencies and organizations (Earthquake Planning & Protection Organization, Hellenic Fire brigade, Hellenic Red Cross, Hellenic Coast Guard etc.) participate to the above-mentioned project as partners.

This project aims to train citizens (in their region) to develop skills on risk management and emergency response, in order to act as volunteers at local level. The thematology of this project is about earthquakes, fires, sea accidents, floods, etc. The duration of the training sessions comes up to 100 hours in 3 months. Earthquake Planning & Protection Organization is responsible for the earthquake session.

Fig.1.1.2.1.-1: *Training of volunteers during the national educational project «Protect Myself and Others» (Earthquake Planning & Protection Organization)*

The majority of 9,000 trained volunteers from all over the country has already participated in pre-disaster or response activities in their municipality or region, they communicate with other volunteers' teams, etc.

It is worth mentioning that the experience from the last decade earthquakes has showed that the contribution of volunteers is very important. Trained volunteers took part in the rescue operations, facilitated communications, helped the local authorities and communities, etc.

Fig. 1.1.2.1.-2: *National educational project «Protect Myself and Others» (Earthquake Planning & Protection Organization)*

1.1.2.2. National School Earthquake Safety Initiative

In Greece, the School Earthquake Safety Initiative has been undertaken by the Earthquake Planning & Protection Organization and has included the following actions:

- the implementation of seminars or lectures;
- the development of educational material and guidelines;
- the implementation of campaigns;
- the participation to school drills; and
- the participation to national or European educational projects.

The objective of this initiative is to develop disaster-resilient school communities through awareness, self-help, cooperation and education. School preparedness requires the participation of principals, teachers, students, parents, and competent authorities. Preparation and earthquake readiness include:

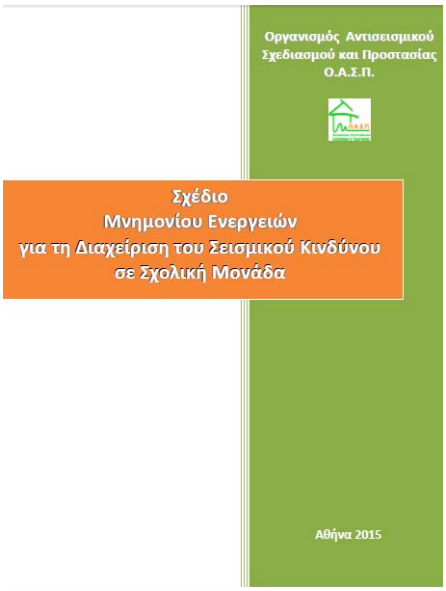
- learning what should be done before, during, and after earthquake;
- doing or preparing to do these things now, before the next earthquake; and
- developing teachers' and students' skills to cope efficiently in case of an earthquake.

In that framework, the Earthquake Planning & Protection Organization implements the educational project "Earthquake Protection at Schools" in collaboration with the Hellenic Ministry of Education. The project started right after the 1999 earthquake in Athens and aims to train principals of elementary, medium and high level schools and teachers (that are responsible for the development of school emergency plans) on earthquake protection issues.

The first phase of the project (1999 – 2001) was funded by Ministry of Education and the second phase (2001 – today) has been funded by the Earthquake Planning & Protection Organization. In addition, the Earthquake Planning & Protection Organization develops and updates the educational material for students, teachers and people with disabilities and the guidelines concerning the development of the school emergency plans.

According to the results of a survey (Kourou et al., 2013), a significant majority of teachers that participated to the Earthquake Planning & Protection Organization's training seminars reported that:

- had experienced an earthquake at school;
- were familiar with the standardized procedures that include prevention and protection behavior, as well as the response and mitigation actions at individual, family and workplace levels;
- had taken the appropriate preparedness measures concerning non-structural hazards at schools;
- had an emergency school plan; and
- held earthquake drills every year.



In the above-mentioned framework, the Earthquake Planning & Protection Organization developed a Model School Emergency Plan in 2012 and updated it in 2015 in order to adapt standard operating procedures at the Greek school community. This Model School Emergency Plan was notified to Hellenic Ministry of Education which in turn communicated it to all public and private schools of the country (Fig. 1.1.2.2.-1).

Fig. 1.1.2.2-1: Model School Emergency Plan (Earthquake Planning & Protection Organization, 2015)

According to the results of a survey that addressed to school principals from all over the country who were responsible for the preparation of their School Emergency Plan, 86% of the responders answered that the Earthquake Planning & Protection Organization's Model School Emergency Plan was very useful for the implementation of the school emergency plan (Kourou et al 2013, Fig. 1.1.2.2.-2).

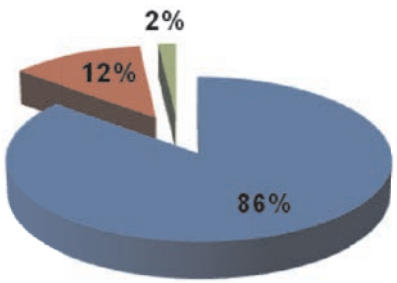


Fig. 1.1.2.2-2: Directors' responses concerning the usefulness of the Earthquake Planning & Protection Organization's Model School Emergency Plan. (■ Yes, ■ No, ■ No answer), (Kourou et al. 2013)

1.1.2.3. Workshops on preparedness for earthquake disaster management

Training is also a very important aspect of preparedness. The Earthquake Planning & Protection Organization implements workshops aiming to increase the interoperability in earthquake disaster management at local administrative level. An example of an indicative is presented as follows: In the first phase (9/2011 - 12/2012), workshops were performed in the 13 Regions of the country and their Regional Units. In the second phase (3/2013 –12/2014), operational workshops addressed to 325 Greek Municipalities in close cooperation with Decentralized Administrations, were implemented.

In the first phase of the workshops the topics of the presentations were the following:

- the Guidelines of the Rapid Visual Screening Program of Public Buildings and Public Welfare Institutions;
- the Guidelines of Shelter and Settlement areas; and
- the Emergency and Temporary Housing.

In the second phase, table-top exercises and field exercises were conducted with the following topics and activities:

- the simulation of the Local Coordinating Bodies in an earthquake scenario for each region;
- the working on local maps of representative – major towns; and
- the decision-making in realistic incidents with time constrains.

During the table-top exercises, the following activities took place:

- the partial testing of the emergency planning at local level;
- the participation of the local volunteering groups; and
- the familiarization of the locals with the emergency procedures.

References:

- Earthquake Planning & Protection Organization, (2015), "Model School Emergency Plan", Document, 29p, Website: http://www.oasp.gr/sites/default/files/OASP_SXEDIO_MNHMONIOU ENERGEION_2015_0.pdf (in Greek)
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- Official Website of the Earthquake Planning & Protection Organization: www.oasp.gr
- Official Website of the project «Protect Myself and Others»: www.ethelontismos.gr

1.1.3. Best practices on earthquake response

The current chapter presents indicative earthquake response actions in Greece. It illustrates how the earthquake post-assessment of buildings and infrastructures is conducted. Moreover, it presents some of the response actions implemented in the case of the earthquake that occurred in Athens, on 7/9/1999.

1.1.3.1. Earthquake Post-Assessment of Buildings and Infrastructure in Greece

After an earthquake, an operation of emergency inspection of buildings is carried out. The buildings are inspected in order to be classified in categories with regards to their usability. The primary aim of the assessment is to protect human life and save properties. The responsible organization for the buildings safety assessment is the Greek Seismic Rehabilitation Agency with the support of the local authorities (Engineering Department in the Municipality or Prefecture of the affected area).

Devastating earthquakes are not rare in Greece; therefore a lot of experience in building inspection procedure has been accumulated. The whole approach to earthquake disaster response and reconstruction was drastically reviewed after the 1978 Thessaloniki earthquake. It was the first time that a modern urban environment experienced a disastrous earthquake in Greece. Today, after several reviews, post-earthquake inspection procedure includes two degrees of inspection:

- The first degree inspection is a rapid usability evaluation. During this inspection buildings are classified into two categories: usable (use of these buildings is allowed) or unusable (these building should not be used until a second degree inspection performed). The first degree inspection lasts 10 or maximum 20 days, depending on the earthquake intensity and the extent of the affected area.
- The second degree inspection is performed only to buildings posted unusable to the first degree inspection. The inspections are carried out by two member teams. Buildings are classified in three categories:
  - 1st Category: Usable (posted in green). Buildings with no visible damages and/or whose original seismic capacity has not been significantly decreased.
  - 2nd Category: Temporarily unusable (posted in yellow). Buildings whose seismic capacity has been decreased and/or they pose a danger due to damage of non-structural elements. For buildings of this category all necessary safety measures should be taken immediately.
  - 3rd Category: Unusable / Dangerous (posted in red). Buildings with heavy damages imminent danger of sudden collapse. Entry is absolutely prohibited and all necessary measures should be taken immediately.

  School buildings are inspected by engineers of the Organization of School Buildings (now known as the Building Infrastructure Organization).

1.1.3.2. Response Activities, Athens earthquake, Greece, 1999

The earthquake of September 7th, 1999 occurred near the country's capital (18km north-west of the Athens city centre) and despite its moderate magnitude ($M_W = 5.9$; $M_L = 5.4$), caused the total or partial collapse of more than 50 buildings. In 28 of them people were trapped under the debris (Fig. 1.1.3.2.-1).

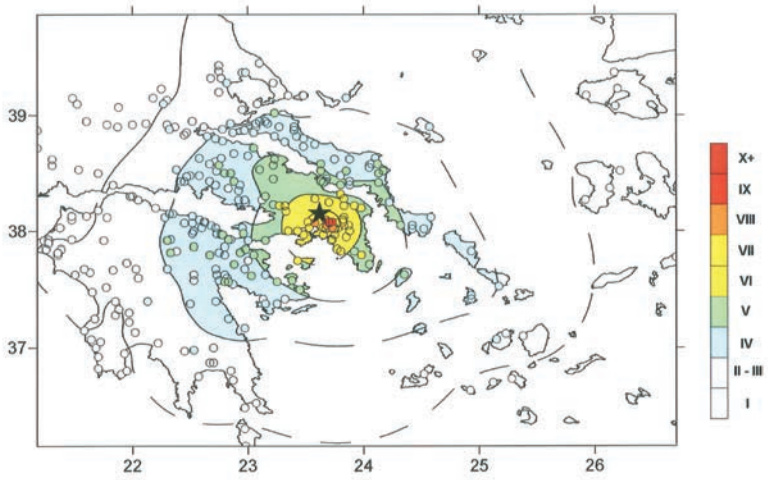

Fig. 1.1.3.2.-1: Athens Earthquake, 1999 (*Schenkova Z.* et al. *2005*)

Search and rescue (SAR) operations

Search and rescue (SAR) operations took place in 28 sites and 86 people were pulled out of the debris alive (all within the first 72 hours). In these operations the EMAK (Hellenic Disaster Response Unit: the Greek SAR unit) had the main role. The participation of SAR units from 8 other countries was also very helpful (Fig. 1.1.3.2.-2).

Fig. 1.1.3.2.-2: Athens Earthquake, 1999 (Earthquake Planning & Protection Organization)

Emergency relief

In the initial few weeks after the earthquake, 20,000 tents were distributed to the affected areas by the Army, the municipalities and the various non-governmental organizations. There were donations from other countries. Food distribution was also organized by local authorities with the help of various catering companies.

Financial immediate relief measures

One week after the earthquake government announced the following financial assistance measures to those affected:

- Every household in a red or yellow-tagged building is eligible for a grant of 587€ (200,000 GRD). This was intended for temporary assistance during the first few weeks after the disaster. It has been reported that eventually more than 120,000 households received such grants.
- For all households that had a life loss or injury that caused incapacity or lived in a collapsed building, a grant of 5,869€ (2,000,000 GRD) was issued.
- Every family owning or renting a property that has been characterized uninhabitable, was subsidized to move into alternative living accommodation. The subsidy ranged from 176 to 302€ (60,000 to 120,000 GRD) per month, depending on the size of the family (and could be extended up to 2 years for the home-owners and up to 6 months for renters).
- Pensioners living in red or yellow-tagged properties were eligible to receive a government grant of 302€ (120,000 GRD).

References:

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1.1.4. Best practices on recovery: the Kalamata Earthquake, Greece, 1986

The present chapter presents the case of the Kalamata devastating earthquake that occurred in 1986 in Greece. The city of Kalamata gained a prize from the European Commission for its New Urban Plan implemented after the disaster and presents a best practice on successful reconstruction based on resilience.

The decision to include the Kalamata earthquake disaster of 1986 in the best practice case study was based on the fact that substantial steps forward in earthquake protection policies and practices in Greece as well as in the reconstruction of Kalamata itself were identified in this case. Reconstruction of Kalamata after the 1986 earthquakes was comprehensive, integrating urban planning, development programming, social concerns and earthquake risk mitigation (Dandoulaki, 2008).

On September 13th at 20:24 local time, the city of Kalamata (Prefecture of Messinia, South Greece) and the surrounding villages were devastated by an earthquake of a Ms=6.0 R with intensities of XI on MM scale (Fig. 1.1.4-1).

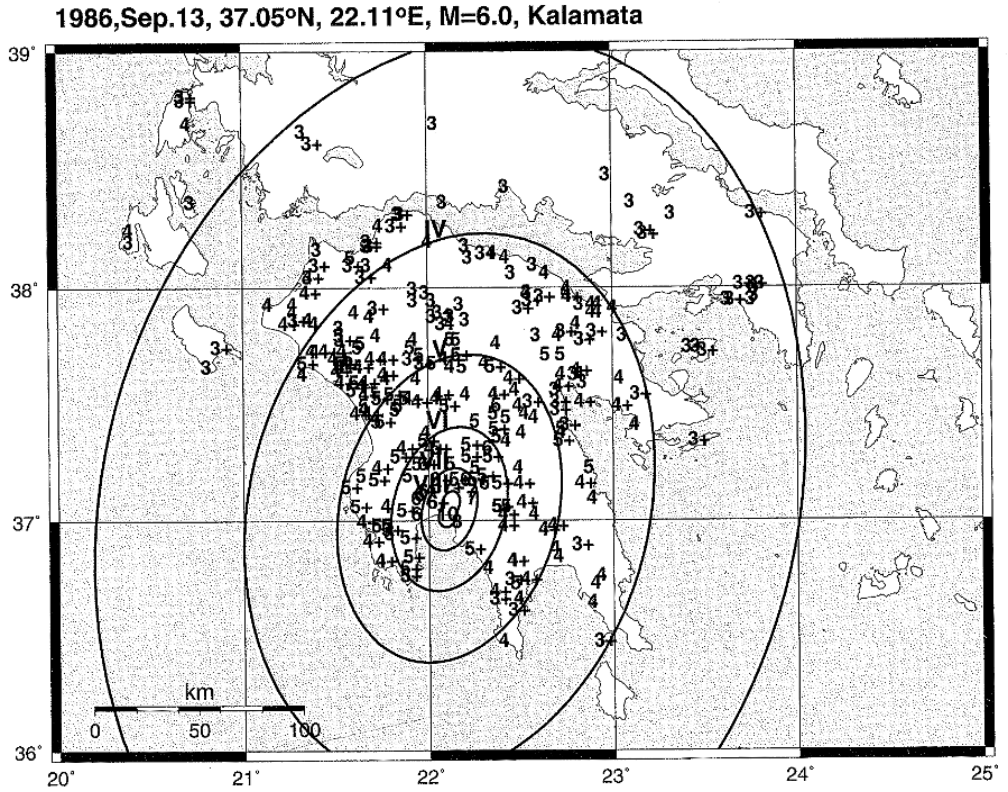

Fig. 1.1.4-1: Kalamata Earthquake (*Papazachos B.C. et al., 1997)*

The strongest aftershock of Ms=5.4 occurred two days later. Damage was huge. Out of 9.800 inspected buildings, 22% had collapsed or were damaged beyond repair, 21% suffered heavy structural damages and 26% light structural damages. Only 1/3 of the buildings were deemed safe to be used. In the historic centre around the Castle of the city about 2/3 of the buildings suffered damage beyond repair and about 80% of historic buildings and monuments were severely damaged (Dandoulaki, 2008).

Actually, Kalamata was in the process of transformation before the event.

The new urban plan of the city was passed shortly before the earthquake and was elaborated by a group of planners working together with the Municipality for many years. The plan was closely linked with development vision and had a far-seeing social perspective. The New Urban Plan was re-examined after the disaster so as to take into account the results of the micro-zonation study (committed by the Earthquake Planning & Protection Organization to different universities and research institutions) as well as the lessons learnt from the disaster. The New Urban Plan of the city was implemented, a series of facilities and infrastructure works were constructed and the historic character of the city was preserved, by employing financial and other resources for reconstruction (Figure 1.1.4.-2). The city's historic centre around the Castle of Kalamata was reconstructed preserving the traditional form and the urban tissue. This is today a lively place attractive for tourists and locals.

Fig. 1.1.4-2: The new urban plan of Kalamata (Dandoulaki, 2015)

The Municipality of Kalamata played a core role in the reconstruction putting into effect previous planning and capacity building (Know4DRR, 2013). All parties involved in construction (owners, engineers, builders, etc.) became more aware on earthquake risk. The built environment became safer because more strict seismic design standards were applied.

It seems that pre-disaster dynamism and overall circumstances were the base supporting a successful reconstruction based on resilience. A more comprehensive approach towards the economic development, the urban planning and the protection of cultural assets were already in place and was not triggered by the disaster, rather it was expressed during the reconstruction (Know4DRR, 2013).

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1.2. ITALIAN best practices to earthquakes and lessons learned

1.2.1. Best practices on school preparedness projects: the cases of the projects "At school of earthquakes" and "Civilino and the earthquake"

The current chapter presents two successful preparedness projects on earthquakes targeted to Italian schools (projects "At school of earthquakes" and "Civilino and the earthquake").

a) Project "At School of Earthquakes"

The project was managed by the Civil Protection Department of the Umbria Region and the Seismic Observatory "A. Bina". It aimed to make children aware of the seismic risk and to disseminate prevention activities for children. The project activities included earthquake school lessons by volunteers and civil protection operators, drills with children, and the publication of didactic materials.

During the 10 years of its implelementation, the project involved more than 6,000 children. A DVD was disseminated in all the Umbrian schools. Besides, the book and e-book "At school of earthquakes" was disseminated in all the Italian schools. In addition, there was further dissemination through the project "Civilino and the earthquake".

b) Project "Civilino and the earthquake"

The Project "Civilino and the earthquake" was realized by the Civil Protection Department of the Umbria Region in co-operation with the Pixel Cartoon production. It's a 13 minutes cartoon short-film to teach children how to behave on the occasion of an earthquake. It's realized in 3D animation (Fig. 1.2.1-1).

Civilino is the mascot of the Civil Protection of the Umbria Region and, together with Marco, shows the procedure to avoid risks in many dangerous situations during and after an earthquake. It is a useful and funny tool to teach children how to cope

with an earthquake with less fear and more responsibility. It was awarded as Disaster Manager of the year 2010 and it's available on You Tube.

Fig. 1.2.1-1: Cartoon "Civilino and the earthquake"

References:

- Civil Protection/Umbria Region, Official website: http://www.regione.umbria.it/protezione-civile
- "Civilino and the earthquake", Video available on You Tube: https://www.youtube.com/watch?v=f_TuvDSz9yk

1.2.2. Best practices on earthquake response: the case of Basilica of Saint Francis in Assisi

The current chapter presents the case of the reconstruction and restoration efforts of the Basilica of Saint Francis in Assisi, in Italy. The Basilica was severely damaged by the earthquake of 1997. An enormous effort has been made for its reconstruction and restoration by using technologies, never applied before in the field of restoration. Thus the case study presented offers new and interesting possibilities for the safeguarding of the architectural heritage.

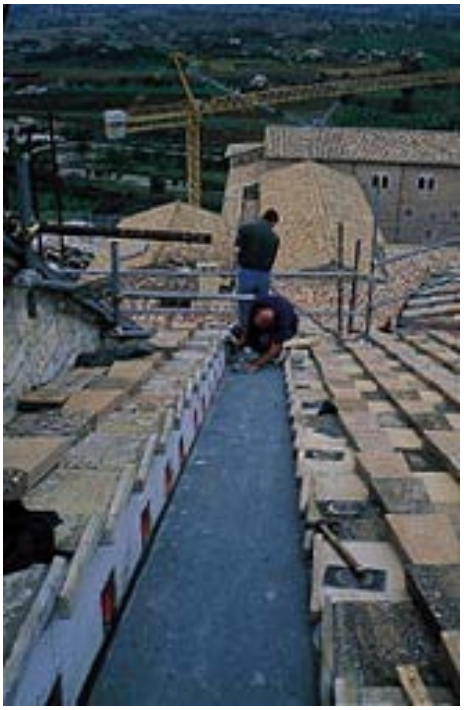
The case of Basilica of Saint Francis in Assisi

The Basilica of St Francis in Assisi was severely damaged by earthquakes and aftershocks in September and early October 1997. Clouds of dust invaded the nave, whole sections of the frescoes by Giotto and Cimabue were reduced to rubble, and a gaping hole, like a pool of light, appeared where the tympanum had once been.

After emergency measures had stabilized the structure, a detailed monitoring and mathematical modelling study was carried out. The case study is presented because it can be considered a sort of micro-surgery in relation to recovery, reconstruction and restoration.

The operations to save and then to consolidate and restore the Basilica of Saint Francis of Assisi (before the restoring of the Giotto and Cimabue frescos) have all followed this philosophy:

- to place the most up-to-date techniques and technologies at the service of culture in order to respect the historic value of the ancient building and
- to obtain adequate safety levels while changing as little as possible the original design.



Some of these technologies, never applied before in the field of restoration, were studied specifically for this occasion, offering new and interesting possibilities for the safeguarding of the architectural heritage (Fig. 1.2.2.-1).

Fig. 1.2.2.-1: Preparing the installation of the SMA devices, (*Angeletti P. et al.,* 2004)

Then a Structural Analysis was done**.** Various mathematical models have been prepared to study the structural behaviour under the worst scenario, the effect of seismic forces perpendicular to the axis of the basilica. The general model of the basilica shows that, in addition to the local effects due to the fill, the vaults close to the façade and the transept take supplementary stress caused by the restraint produced by façade and transept.

Research and Testing

The problem of the definitive restoration and consolidation of the basilica was complex.

Because of the presence of the frescoes it was impossible to reduce the deformation and to re-establish an adequate curvature and autonomous bearing capacity. Different solutions were modelled to decide how to best strengthen the vaults and secure their stability over time, without creating a risk to the frescoes and without compromising the historical value of the original vault's structure.

The solution chosen was to use composite materials to create a series of thin little ribs following a pattern typical of Gothic structures on the vault's extrados, leaving the original structure clearly visible. These ribs are built in situ, so that it is possible to follow the deformed shape of the vaults; while the width of the ribs remains constant, the height may then change in relation to the deformation of the vaults. The ribs are made of aramid fibres bedded in epoxy resins around a central timber nucleus. These fibres are light but very strong.

Reinforcement of the Vaults

The strengthening of the vaults consists of the new ribs connected at the extrados; the anchorage of the ribs at the roof; the grouting of the cracks; the connection of the arches, which support the roof, to the perimetral walls; and the steel beam placed in the nave over the cornice of the walls (Fig 1.2.2.-2).

Fig. 1.2.2.-2: The reinforcement of the vaults in the Basilica of Assisi (Provincia di Perugia and Servizio Sismico Nazionale, 1998)

Anchoring the Ribs

The ribs are connected to a system of tie bars, which are anchored to the roof. Each tie bar includes a spring, similar to the solution adopted for emergency stabilization measures. This reinforcement reduces the deformation under seismic forces.

Grouting the Vaults

The reinforcement of the vault's cracked structure, where continuity has been compromised, has been created using a specifically formulated mortar. This mortar is salt-free and compatible with the frescoes, sufficiently fluid to penetrate into all the cracks and micro-cracks.

Anchoring the Main Arches

The masonry arches supporting the roof stand on little vaults, which are situated over the springers of the main vaults without any structural connection and with a certain eccentricity with respect to the main pillars. Therefore, it was decided to anchor the base of the arches at the walls and the towers behind them, which in this very peculiar Italian Gothic structure have the function of abutments.

Reconstructing the Vaults

The reconstruction of the collapsed vaults was a major problem. Fortunately, after painstaking research, several frescoed bricks were identified that could be reused to re-build the vaults.

The operation has been particularly successful with regard to the pieces of ribs, which have maintained a good bond between the bricks, forming voussoir-like elements, even though they fell 25 meters. In the laboratory it was possible to re-assemble the broken parts of ribs in such a way as to create voussoirs 40 to 60 cm long. These voussoirs were then placed on a provisional centering to rebuild the ribs (Fig 1.2.2.-3).

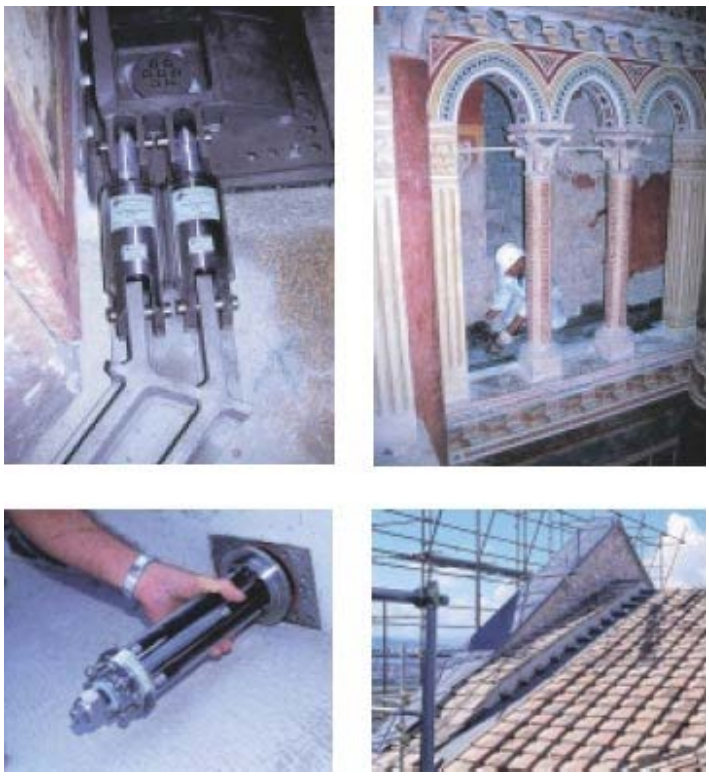


Fig 1.2.2-3: Operations of reconstruction and anchoring
(Provincia di Perugia and Servizio Sismico Nazionale, 1998)

Reconstructing the Tympana

The restoration of the basilica was completed with the reconstruction of the collapsed portion of the left tympanum and the removal of the deformation that both the transept tympana suffered. Stones from the original quarry were used.

References:

- P. Angeletti, A. Borri, F. Longhi, U. Nasini, A. Severi, (2004), "The law for seismic prevention in Umbria, Italy" - 2004 annual meeting Earthquake Engineering Research Institute, Los Angeles, California, USA
- Provincia di Perugia and Servizio Sismico Nazionale (SSN), (1998), "Terremoto in Umbria e Marche del 1997 – Criteri di Calcolo per la Progettazione degli Interventi" (Earthquake in Umbria and Marche Regions in 1997 – Parameters of calculation for the planning of the interventions), Editrice Sallustiana, Roma

1.2.3. Best Practices on preparedness and mitigation: the Italian Earthquake Damage Data Review

The Italian Earthquake Damage Data Review

Earthquakes in Italy often damage buildings that are centuries old, and historic preservation is a key consideration in the repair and retrofit methods used.

The Italian National Seismic Survey (SSN) gives a method for collection of damage data following an earthquake that examines different systems for structural classification and vulnerability assessment to determine potential improvements in earthquake damage prediction and to lead to better ways to identify vulnerable structures, predict earthquake losses, establish recovery policy, and prepare for and reduce earthquake impacts.

The method foresees *a Pre-Earthquake Condition Assessment* – Building inventory assessments designed to identify the pre-earthquake vulnerability and characteristic construction types of buildings in seismically active regions. In recent years, the Italian National Civil Protection funded these surveys as part of an earthquake damage prediction and risk mitigation program (Fig 1.2.3.-1).

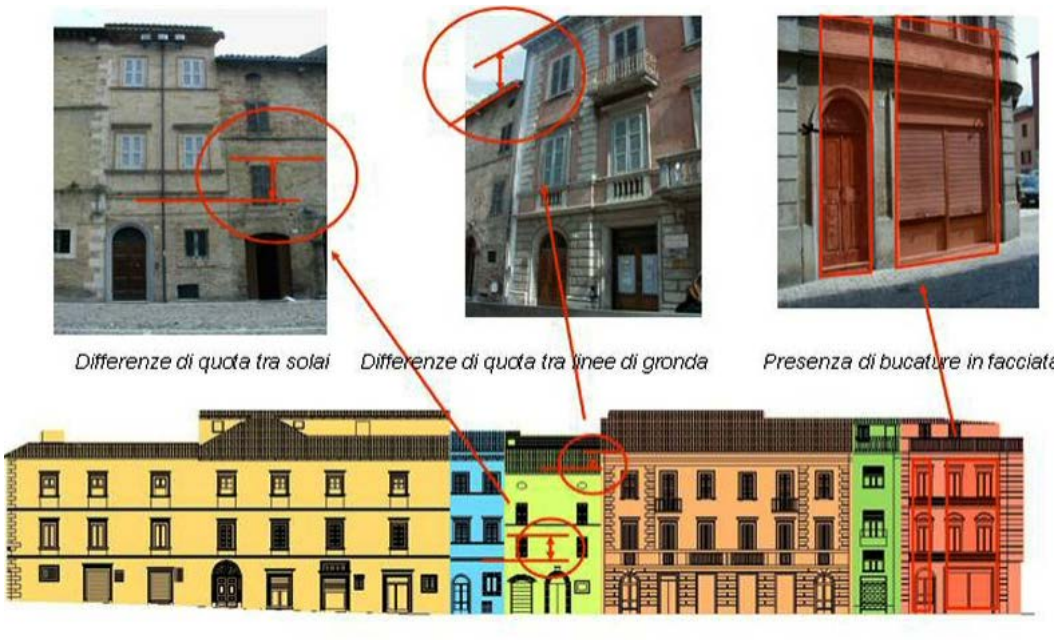


Fig 1.2.3.-1: Building inventory assessments **(**Servizio Sismico Nazionale, 2002)

Then Post-Earthquake Practices and damage assessment are analyzed. They can be divided into three distinct categories, based on when the assessment is performed (i.e., immediately after the earthquake or a few months later during the reconstruction process), the intended purpose of the assessment, and the ultimate use of the damage data:

- **Post-Earthquake Life-Safety Assessment**. Evaluations for the purposes of establishing the usability, or life-safe condition of a damaged structure. Many countries use both rapid, short-term assessment methodologies and more detailed assessments to establish a basis for repair or retrofit (e.g., ATC-20 rapid and detailed evaluation approaches). The Italians call the former Level I assessment procedures and the latter Level II and III assessment procedures.
- **Post-Earthquake Physical Damage Assessment**. Evaluations for the purposes of collecting statistical data on the damage to a structure for the purpose of better understanding the behaviour and seismic vulnerability of specific classes of structures. Collection of this data can also serve the purpose of estimating losses and reconstruction costs.
- **Post-Earthquake Financial Loss and Reconstruction Assessment**. Evaluation for the purposes of estimating financial loss in terms of physical damage to the building (often in terms of a percentage of the replacement value) and the cost to reconstruct. Italy is one of few countries that collect damage data for this purpose since the government typically provides funding for reconstruction and retrofit based on damage estimates developed from the collected data.

The extensive history of Italian damage collection forms and protocols, including their use in structural classification and vulnerability estimation, has capitalized the results of the “living laboratory” of earthquake damage experience creating a sophisticated methods of damage and vulnerability assessment with the aim of “being prepared” for future earthquakes and of mitigating future seismic risk.

References:

- Ermoliev Y., Ermolieva T.Y., MacDonald G., Norkin V. (1998), On the design of catastrophic risk portfolios, IIASA, Interim Report IR-98-056
- Source SSN (National Seismic Service), Website: http://www.protezionecivile.it edited by S. Castelletto (at the site of Italian Civil Protection Department)
- DPC-informa (a periodical of the Civil Protection Department).Umbria e Marche, quattro mesi dopo. Gennaio-Febbraio 1998, Anno III -Numero 8
- Provincia di Perugia and Servizio Sismico Nazionale (SSN), (1998), “Terremoto in Umbria e Marche del 1997 – Criteri di Calcolo per la Progettazione degli Interventi” (Earthquake in Umbria and Marche Regions in 1997 – Parameters of calculation for the planning of the interventions), Editrice Sallustiana, Roma
- Prof. P. Angeletti, Prof. A. Borri, Eng. F. Longhi, Eng. U. Nasini, Eng. A. Severi, (2004), The law for THE seismic prevention in Umbria, Italy, 2004 Annual Meeting Eartquake Engineering Research Institute, Los Angeles, California, 2004, USA
- Servizio Sismico Nazionale (SSN), 2002. “Attivita’ del Programma 2002 – Valutazione e Riduzione della Vulnerabilita’ Sismica degli Edifici, con Particolare

Riferimento a Quelli Strategici per la Protezione Civile (Activities in the 2002 Program - Evaluation and Reduction of the Seismic Vulnerability of Buildings), Final Report, Dept. of Civil Protection, Rome, December, 76 pp.

1.3. BULGARIAN best practices on earthquakes

1.3.1. Best practices on prevention and mitigation: the case of regulations and standards for new and existing buildings

The present chapter presents the Bulgarian regulations and standards related to the construction of new buildings in seismic areas and the inspection of existing public buildings in order to prevent and mitigate the earthquake effects.

a) For new buildings

With the Regulation № RD-02-20-19 of 29.12.2011 for the design of building structures in Bulgaria started the application of the European standards for the design and the construction in seismic areas. This is the so-called system "Eurocodes". By applying this system in the country has introduced the use of the latest construction technologies developed in the past two decades. The "Eurocode 8" approves the standards for construction in the following areas:

- general rules, seismic actions and rules for buildings;
- bridges;
- evaluation and strengthening of buildings;
- silos, tanks and pipelines;
- supporting structures and geotechnical aspects, and
- towers and stacks.

b) For existing buildings

District and municipal administrations form expert committees entrusted with verifying the structural integrity of the buildings which are state and municipal property. By 2016, every building in Bulgaria must obtain the technical passport where to put its parameters of exploitation seismic resistance.

According to the Disaster Protection Act and the Law for the spatial planning, the building and development of the territories should respected as mandatory the safety regulations at the level of seismic activity 9 on the Richter scale, which need to be granted with the relevant supporting documents and carry periodic inspections.

1.3.2. Best practices on preparedness at institutional, educational and training levels

The present chapter presents the Bulgarian best practices on preparedness that include the sector's institutional planning and the work of the training centres targeting at students, citizens and civil protection volunteers. In addition, detailed information about the school education to earthquakes prevention is provided.

1.3.2.1. General framework of strategic planning for disaster response

Bulgarian national legislation integrates into practice the European experience and traditions. In terms of earthquakes, prevention, preparation and response have been spelled out in detail on three levels - central, regional and local:

National Plan for disaster protection - Part 1 "Protection against earthquakes"

This is the main legal document regulating prevention, response and recovery of damages during and after earthquakes. The plan regulates the following:

- the measures for preventing or reducing the risk of earthquakes;
- the measures to protect the population;
- the allocation of duties to the responsible authorities and persons to implement measures to protect the population in an earthquake;
- the tools and resources needed to implement the activities;
- the type of interaction between the components of the URS; and
- the procedure for early warning and alert.

Regional plans for disaster protection, including the earthquake protection

In Bulgaria there are 28 existing regional action plans. The main objectives of the plans are the following:

- to perform analysis and assessment of disaster risk, including the risk of earthquakes;
- to define measures to prevent or reduce disaster risk, including the risk of earthquakes;
- to identify measures to protect the population in earthquakes;
- to allocate duties and responsible authorities and persons for the implementation of measures envisaged in earthquakes; and
- to determine and allocate funds and resources needed to implement the activities and others.

Municipal plans for disaster protection, including Protection against earthquakes

In Bulgaria there are developed 265 municipal plans for disaster protection. The plan shall enter into force in case of emergency or danger on the territory of a municipality.

References:

- Law on Disaster Protection of Republic of Bulgaria, (2006, updated 20.05.2011)
- National Plan for Disaster Protection, Council of Ministers of Republic of Bulgaria, Sofia, 2010 /part I – earthquake protection

1.3.2.2. Training centres and earthquake preparedness

The training centre of the Sofia Municipality and the Regional NATO Training Centre for South Eastern Europe offer training opportunities on earthquake preparedness to different civil society groups.

- The training centre of the Sofia Municipality of Sofia offers basic courses on preparedness for different types of disasters to students and citizens. It is expected that all pupils between the 1st and the 4th grade will go through specific training every school year. The Centre provides simulator of an apartment with two rooms. In it the children will be taught what to do in case of an earthquake and where to go between the first and the second shake. The Centre is available for all citizens and there is museum and theoretical halls. This is the first and yet the only one training centres of that type in the country.

- The regional NATO Training Centre for South Eastern Europe in the town of Montana is focused in the area of crisis management in cases of disasters. It provides an opportunity for education and training of the NATO member-states rescuers and its partnering countries for all kinds of disasters – earthquakes, crashes, industrial accidents etc. Special focus has been put on earthquakes. There is a simulation complex with obstacles and an environment really close to really damaged by earthquake area. All volunteering teams in Bulgaria are going through theoretical and practical preparation every three years (Fig. 1.3.2.2.-1).

Fig. 1.3.2.2.-1 : Volunteers in the training center, Adelina Yordanova, (Source: Mont-press, number 58 (2381), 23 – 29.08. 2016)

References:

- "Fire safety and protection of population" Training center – Montana, Website: www.montana.mvr.bg/OD_PBZN/training_center.htm
- "Security" department of Sofia municipality, Website: **http://sonet04.sofia.bg/**

1.3.2.3. School education for preparedness to earhquakes

1.3.2.3.1. National Policies in education in relation to natural disasters

The main reference documents related to the national educative policies to natural disaasters (including the earthquakes) are: the Disaster Protection Act (2006, updated in 2011) and the National Program for disaster protection (2009-2013). Both of them are presented shortly below:

Disaster Protection Act (2006, updated in 2011)

The Disaster Protection Act sets up the national framework for school education on natural disasters. It was established in 2006 and updated in 2011. The Article 16 of the Law states:

- *"Training for protection during disasters and giving first aid is being carried out in the national education system and in the higher education schools.*
- *Basic knowledge of the risks of disasters and ways to behave and act are being taught during primary school, and during secondary school and higher education – knowledge of protection relative to the profile and the specialty of the education.*
- *(...) The Secretary of Education, Youth and Culture after coordination with the Secretary of Internal affairs has implemented programs for training, educational materials and manuals for kindergartens and schools and plans for training and preparation for disasters of the leading personnel and the teachers in the system of national education".*

National Program for disaster protection (2014-2018)

In the National Program for disaster protection (2014-2018), (data from the Geophysical institute of Bulgarian Academy of Sciences, section IV.3.), the main issues related to the disaster protection education in the national education system in Bulgaria are described. Important aspects to highlight are the following:

- The education will be carried out in the following forms: class system (in a special weekly period dedicated to the class), after class and extracurricular.
- The education model has to be based on modern methods using interactive forms, methods and means.
- The possibility for education of people with disabilities and chronic diseases must be guaranteed.

References:

- National Program for disaster protection (2014-2018), Council of Ministers of Republic of Bulgaria, Sofia, 2013
- Disaster Protection Act, last modification in State Gazette, issue No 39, May 2011, Website: http://lex.bg/laws/ldoc/2135540282

1.3.2.3.2. School education

School education is an important aspect of preparedness. In the present chapter indicative examples of educative material and resources for all school age groups are presented. Moreover, the examples of children competitions are indicated as a mean to motivate children to get further involved in the study of earthquakes.

1.3.2.3.2.1. Educational materials and resources

Teachers' manuals produced by the project "Prevention of Natural Disasters and Accidents through the Secondary Education System in Bulgaria"

The manuals are result of the project "Prevention of Natural Disasters and Accidents through the Secondary Education System in Bulgaria" (within the Ministry of Emergency Situations and United Nations Development Programme; developed by Paideia Foundation), (Fig. 1.3.2.3.2.1.-1). The total circulation was 44,000 numbers of manuals and they were distributed for free among schools from the whole country. The manuals cover not only the need from theoretical material, but also a multiple number of suggestions for interactive methods and techniques (including also techniques for dealing with stress and emotions after having survived from a disaster). The main goal is to provide training by active learning, based on the "teacher - pupil – parent" principle of participation. As an additional activity under the prepared teachers manuals needs to be mentioned the 2 undertaken learning seminars with teachers from the country, representing the products and giving the common directions for work with them.

Fig. 1.3.2.3.2.1.-1: Methodological developments for training to protect Disaster, 2010, The Aston CRISIS Centre, Website: http://crisis.aston.ac.uk/

Children's Coloring Book "Disasters – important rules for little children"

A painting book, developed in 2007 by the National Training Centre (part of the Ministry of Emergency Situations) is designed for the smallest – kids from kinder garden (can also be used with younger pupils), (Fig. 1.3.2.3.2.1.-2). This is the first helping tool in this area, designed for the smallest. With it children learn the basic rules for reaction in case of different types of disasters in simple way. The book is published in circulation 20,000 numbers (followed by an additional because of the huge interest) and is distributed for free in kinder gardens across the whole country.

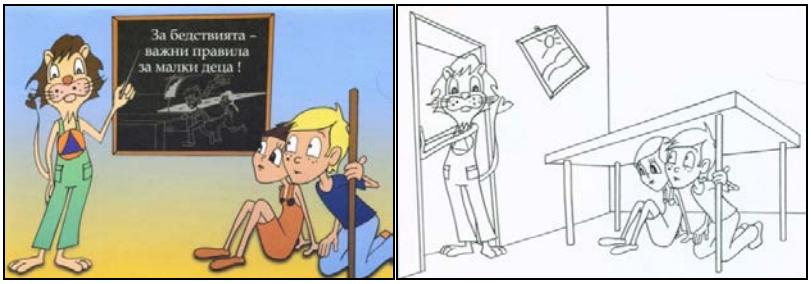


Fig. 1.3.2.3.2.1.-2: Developments for training to protect Disaster, 2010, Paideia Foundation, Website: http://rio-sliven.org/

Training set of boards and cards

The same year, the National Training Centre (again for the smallest age group) developed a set of boards and cards for 5 types of disasters. Four situations to each of the cards are included and illustrated basic rules for reaction in case of different types of disasters. The set of boards represent the algorithm for actions in case of different disasters (Fig. 1.3.2.3.2.1.-3).

Fig. 1.3.2.3.2.1.-3: A set of boards and cards, 2007, National Training Centre (part of the Ministry of Emergency Situations), Website: http://rio-sliven.org/

Practical classes and open lessons

The National Training Centre leads practical classes and open lessons in the kindergartens at regular basis, where children show their knowledge and skills for reaction in case of emergency situations (Fig. 1.3.2.3.2.1.-4).

Fig. 1.3.2.3.2.1.-4: Practical trainings, 2007, National Training Centre (part of the Ministry of Emergency Situations)

Good practices related to disadvantaged children

Printed brochures with the most important rules for defence against common disasters in Bulgaria - in Braille and in audio format as “talking brochures”, as well as recordings of noises accompanying disasters are produced by the National Training Centre (Fig. 1.3.2.3.2.1.-5).

Fig. 1.3.2.3.2.1.-5: Brochures for defence against disasters in Braille, 2007, National Training Centre (part of the Ministry of Emergency Situations)

Good practices related to coping children emotions

Unfortunately, there are not enough sufficiently qualified experts in this domain and additionally there is lack of coordination unit. As only positive step in this direction can be considered the book “Psychological help and support for children and youths in a disaster” (Guide book for parents, teachers and specialists) written by Yordanka Eneva, published in 2006. It is a theoretical and practical guide. Unfortunately, the book has long been exhausted on the market, and from talks with teachers we know the book is not available at schools’ libraries either (Fig. 1.3.2.3.2.1.-6).

Fig. 1.3.2.3.2.1.-6: Guide book: “Psychological help and support for children and youths in a disaster”, 2006, Yordanka Eneva

1.3.2.3.2.2. Educative competitions for children

The examples of two children completion in Bulgaria are presented in the current sub-chapter (the national drawing completion “Mission: Rescuer” and the competition “Protection in Case of Disasters and Accidents”).

National drawing competition for children: “Mission: Rescuer”

“Mission: Rescuer” is a continuation of the competition for children painting “I saw the trouble with my eyes…”, first held in 2002 by initiative of National Agency “Civil Defense”. From then till 2009 is lead by the Ministry of Emergency Situations. After the closing of the Ministry, the competition is taken up by the “Fire Safety and Rescue” Directorate General (Ministry of Interior). The competition is held with the partnership of The Ministry of Education, Youth and Culture and National Palace of Children (Fig. 1.3.2.3.2.2-1).

Fig. 1.3.2.3.2.2-1: Methodological developments for training to protect disasters, 2010, Program for Development of UN, Ministry of Emergency Situations, Republic of Bulgaria

In the competition participate children from the entire country from age 6 to 18, separated into 3 groups by age:

- from 6 to 9 years old;
- from 10 to 14 years old; and
- from 15 to 18 years old;

The competition is held in 3 phases:

- municipal competition;
- regional competition; and
- national competition.

Student Competition “Protection in Case of Disasters and Accidents”

The student completion “Protection in Case of Disasters and Accidents” is focused on safety in emergency situations (Fig. 1.3.2.3.2.2-2). Its basic goal is to check the level of the knowledge, skills and habits, gained in the basic training

course, as well as to motivate the participants for further preparation for acting in case of emergency situations. The competition is held every year in Bulgaria and ran in several rounds: at municipal, regional and national levels. Twenty-eight teams with 4 team-members participate in every round, which has a theoretical and a practical section. The theoretical section consists of a test to assess students' knowledge about correct reactions in emergency situations. During the practical part students show their skills in acting in case of an earthquake and also in case of chemical and radiation accidents. The competition has been held since 1998, and the organizers are the same as mentioned above.

Fig. 1.3.2.3.2.2-2: Student Competition "Protection in Case of Disasters and Accidents", 2015

References:

- Student Competition "Protection in Case of Disasters and Accidents", Website: www.pojarna.com

1.3.3. Best practices on response: the case of the Unified Rescue System

In Bulgaria, response to different types of disasters, including earthquakes was organized by the so-called Unified Rescue System (URS). It consists of departments, offices and other operational structures, ministries and agencies, municipalities, companies and sole traders, centres for emergency care of medical or health institutions, NGOs, armed forces. The structures of the URS successfully include voluntary formations. In case of earthquake special secure server generates voice messages with instructions to all those persons who, having put a personal code can hear information about the scale and scope of the earthquake, as well as where and when to appear to be involved in the rescue activities. The system is specially protected and operates in a situation of serious disaster.

URS is an example of good practice in response to the earthquake, because it allows centralized management of rescue from headquarters, but in the inclusion

of all institutions that have a clear conscious duty. The response time is minimized through the establishment of the system. An example of good practice can be seen in the early disclosure of the persons included in the structure of the URS - about 28,000 people.

References:

- Disaster Protection Act, last change in State gazette, issue No 39, May 2011, Website: http://lex.bg/laws/ldoc/2135540282

1.3.4. Best practice on recovery: the case of the European project "SAFE-QUAKE"

A good practice on recovery is the European project "SAFE-QUAKE - improving the behaviour of the population after the earthquake, living in urban areas with high seismic risk". The project was funded by the European Commission under the Civil Protection Financial Instrument. It was realized by the Chief Directorate Fire Safety and Civil Protection of Bulgaria, the General Inspectorate for Emergency Romania and the Directorate "National Protection and Rescue" of Croatia. During its implementation experts from the three participating countries identified and scheduled clear and precise rules concerning people's behaviour immediately after the earthquake, the provision of psychological and material assistance, etc.

References:

- "SAFE-QUAKE - improving the behaviour of the population after the earthquake, living in urban areas with high seismic risk", DG ECHO, Website: http://pojarna.com/bg/sections/rabota_s_deca/proekti_i_konkursi/proekt_safe_quake_/

1.4. SPANISH lessons learned from the Lorca earthquake, 2011

The present chapter presents the Lorca earthquake that occurred in Spain in May, 2011. This earthquake affected many buildings despite happening in a declared seismic area. The study of the Lorca earthquake offer important insights for the better understanding of the deformational structures in historical buildings. In addition, it contributed to the process of updating the seismic maps and building standards in Spain.

The main objectives of the present chapter are the following:

- to investigate the natural risk of an earthquake that has already occurred;
- to analyse the effects and damage to the population and buildings, whether homes or shelters;
- to analyse the short and long-term measures implemented; and
- to compare the Lorca earthquake with the most recent earthquake in Turkey.

Methodology

Firstly, and after defining terms such as magnitude, which will be the energy released by this natural phenomenon, we will briefly analyse the natural and specific risks of an earthquake. Next, we will analyse the risk elements and their vulnerability by analysing the consequences in the town of Lorca. And finally, we will briefly associate this event with the last similar event on 23 October 2011 in the town of Ercis and surrounding area, in Turkey.

Motivation

On 11 May 2011 there were two earthquakes measuring 4.5 and 5.1 on the Richter scale, as well as numerous replicas over the following days.

Natural phenomena such as this show how vulnerable we are to certain natural threats, such as flooding, volcanic eruptions, strong winds, land movements, tsunamis or earthquakes. The consequences are often the result of human factors such as:

- education and public awareness (e.g. how the Japanese respond to an earthquake alarm and how everyone knows what to do from a young age),
- town planning (after a natural disaster, settling near rivers, ravines or floodplains stands out),
- population density (complicating road evacuation),
- or buildings (with low structural maintenance and refurbishments that do not comply with earthquake-resistant regulations, for example)

Background

Each year natural disasters cause damage valued in billions of euros to settlements and economic activities and, more importantly, hundreds of deaths.

As for the economic impact of the most violent natural disasters, note the earthquake of Kobe in 1995 with a total economic loss of $65.099 billion, 0.33% of global Gross Domestic Product (GDP), another more recent example is Haiti in 2010.

Regarding the Lorca earthquake, as it was superficial and it directly affected a densely populated area, there were many personal injuries and material damages.

- Personal consequences: 9 deaths, 324 injured and thousands of people evacuated from their homes.
- Material consequences: extensive damage to infrastructures and buildings.

Development

Definition of risk

According to the United Nations Disaster Relief Organisation (UNDRO), risk is the number of victims, injured, damage to properties and effects on economic activity that may be caused by a disaster. But first we will analyse Natural Risk (Ayala, F.J. *et al.,* 2006).

Natural risk

Natural Risk is the expected loss due to the action of a natural danger. If we consider expected human loss, this is a social risk with different levels according to the number of people killed, injured, displaced, unemployed… On the other hand, expected economic losses are defined as the economic risk, which also includes various types depending on the structural damage, content damage, loss of profit, etc.

The existence of natural risks is therefore a result of all risk factors:

- Hazard, with a severity or intensity, and a probability of occurring.
- Exposure, of persons and goods.
- Vulnerability of this exposure, a level of the loss from 0 (no damage) to 1 (destruction or death).

Risk only occurs when all risk factors concur. To simplify, Risk can be expressed as:

Where: R= Risk, expected annual loss
P= Annual Probability of Occurrence
V=Vulnerability (0-1)
E=Exposure

Seismic risk

On 26 March 2010, Spain approved the Civil Protection Plan for Seismic Risk, which aims to establish an organisation and procedures for action for State resources and services in order to provide an efficient response to an earthquake. Although the seismic risk is moderate in Spain, the potential destruction of an earthquake is very high. The main seismic area lies in the southeast of the peninsula – the coast of Alicante, Murcia and Almeria – as shown on the map below (Fig. 1.4-1).

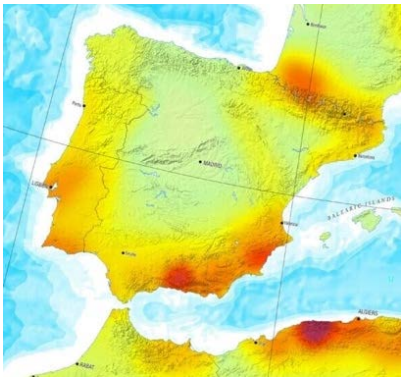


Fig. 1.4-1: Map of seismic risk in the peninsula (Source: www.alertaterremotos.com)

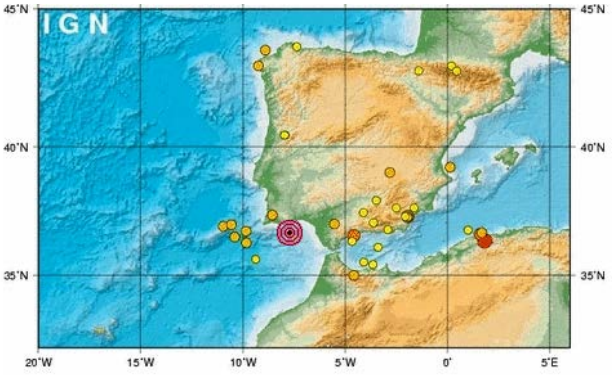


Fig. 1.4-2: Map of earthquakes detected in the last 10 years (Source: http://www.ign.es)

The National Geographic Institute (IGN in Spanish) is entrusted with monitoring earthquakes in Spain, and its website offers detailed information such as the above map (Fig. 1.4-2).

To end this section, we will call seismic risk a measurement that combines seismic hazard with vulnerability and the possibility of causing damage due to seismic movements during a specific period. This concept must not be confused with seismic hazard, which is the probability of seismic movements of certain importance occurring in a specific region during a specific period.

Therefore, seismic risk depends on human factors and refers to potential damage, and seismic hazard is a geophysical magnitude that gives the probability of a seism occurring in a specific geographical area during a time period.

A study on seismic risk in Spain

A few years before the last earthquake in Lorca, a study conducted by technicians from the Directorate-General for Civil Protection, among others, aided by complex computer programmes such as S.E.S. 2002, analysed some seismic areas and their tremors, for example in Lorca in 1992, to analyse seismic risk in Spain.

Seismic hazard is quantified using the values given for each town in Spain by the Spanish Earthquake-Resistant Construction Standard (NCSE-94), which was harshly criticised after the recent earthquake as this standard is old; it appears it shall be revised. The indicator used to characterise the population of each town in Spain: the number of inhabitants.

Buildings are primarily analysed and classified into four periods depending on the historic evolution of the building, and to the progress of Legal and Technical Regulations which has set major milestones in control and safety of structures against earthquakes, and which today is still under development.

In summary, this study shows that aspects such as the vulnerability of buildings have been characterised by interpreting EMS-98; and in relation to the population, simple formulas have been developed to show the following expressions:

- No. deaths = 0.30 x G5 x Average occupancy,
- No. injured = 6.0 x no. deaths

We must remember that an earthquake is a break or sudden movement in the Earth's lithosphere that releases accumulated tension or tectonic stress caused by the relative movement of two blocks along a fault.

Relating earthquakes to damage to buildings

Given the hazard values provided by the previous study, risk is expressed as expected damage for a period of 1,000 years (probability of 63%).

The spatial distribution of risk reflects the two most representative conditioning factors: hazard and the distribution of elements at risk (homes-population).

The well-known concentration of the population along the coast and in major inland cities represents a considerable increase in risk in these areas, particularly on the Mediterranean coast and in southern Spain, where seismic hazard levels are higher, as shown on the map (Fig. 1.4-3).

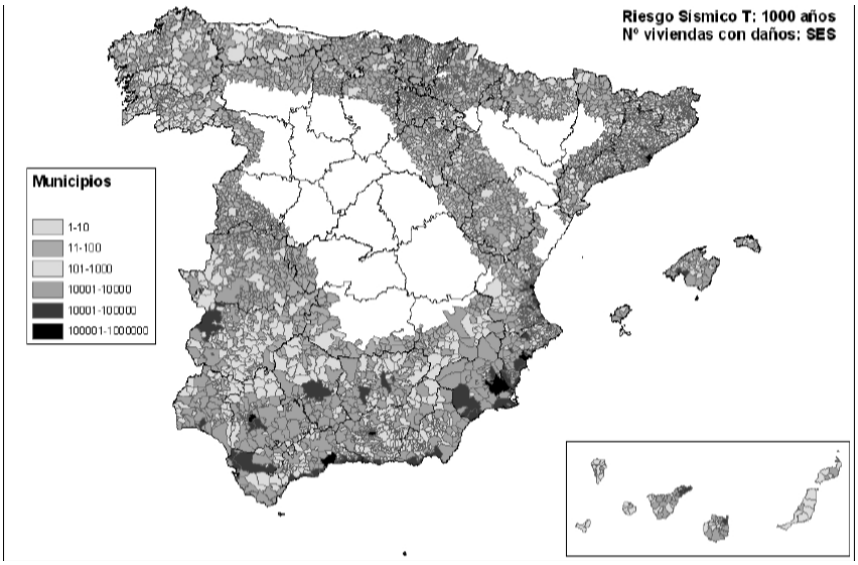


Fig. 1.4-3: Seismic risk analysing damage to homes for a T: 1,000 years (Barranco, L. et al., 2002).

Towns with greater values of damaged homes for a return period of 1,000 years are the most populated towns in the south, on the east coast and the coast of Catalonia.

Risk has also been represented as an estimation of the number of homes collapsed by town. These values are more indicative of the level of damage because, as indicated in the methodology, they are directly related to the population (Fig. 1.4-4).

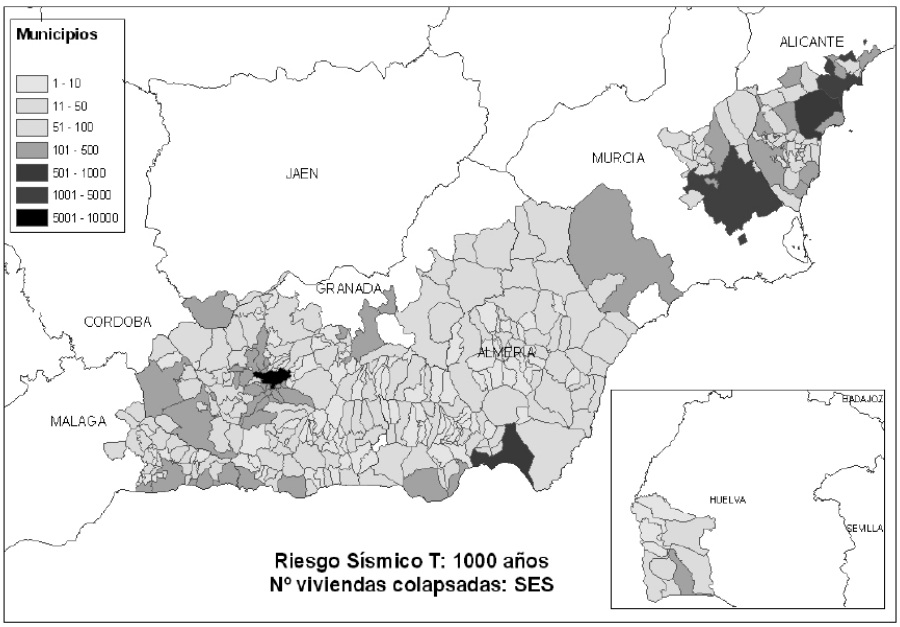


Fig. 1.4-4: Seismic risk analysing homes collapsed for a T: 1,000 years. (Barranco, L. *et al.,* 2002).

Thus, the town with the highest risk would be Granada, followed by the larger towns of Granada, Malaga, Alicante, Murcia and Almeria.

Situation in Lorca

Geological conclusions taken from the preliminary study:

- The Alama-Murcia Fault (FAM in Spanish) is the fault with the greatest evidence of quaternary activity in the area, with paleoseismic evidence of surface breaks of earthquakes with magnitudes over 6.0 in the last 1,000 years, thermal springs associated with its surface route and localised destructive historic seismic movements along its route in the 17th, 18th and 19th centuries.
- The high intensity suffered in Lorca (intensity VII on the EMS-98 scale, data from the IGN) associated with a magnitude of 5.1 Mw may be caused by a propagation of the earthquake from the Sierra de la Tercia mountains (epicentre) towards the SW (Fig. 1.4-5).

Fig. 1.4-5: Panoramic view of the city of Lorca taken from the epicentre. The lines show the main faults and various unique points in the town are shown (Martínez, J.J et al., 2011)

The Lorca earthquake of 11 May 2011 caused a high level of damage and seismic activity, particularly to the entire range of buildings in Lorca, including the city's historic buildings.

Throughout the old town, damage can be seen to the oldest buildings such as the San Antonio portico, which dates back to a 13th century defensive wall, and different churches and convents spread around the cultural centre of Lorca. From above, we can see that damage is concentrated to high towers, mainly affecting arches, flying buttresses, bollards and some domes. Loose decorative elements such as bollards and obelisks are also rotated, such as the obelisk in the small

square next to the church of San Francisco.

Initially, and according to experience in past earthquakes in other parts of the world, an earthquake with magnitude of 5.1 should not have generated such a high seismic intensity (according to the study of previous earthquakes of the Instituto Geográfico Nacional). However, as the source was shallow, with a hypocentre located in the first kilometres of the Earth's crust and propagated from the epicentre towards the SW, much of the rupture of the fault that caused the seism occurred directly under the town. On the other hand, detritus deposits under the city come from colluvial and alluvial material next to the glacis of the Sierra de la Terciamountains, and deposits from the courses of the river Guadalentín, which are deposits that amplify the passage of seismic waves.

While it is true that the Lorca earthquake did not cause the widespread collapse of buildings in the town centre (only two buildings collapsed), during the first hours of on-site inspection over one hundred effects to buildings were detected, classified and described, mainly deformational structures.

These structures are defined as Earthquake Archaeological Effects, more commonly known as EAE. Analysing these deformational structures in historic buildings is a study used to recognise and quantify the damage of historic earthquakes on archaeological sites.

During field work, which took place in the 72 hours after the main quake, deformations were primarily detected in the main unique buildings in Lorca old town, such as churches, convents and cathedrals. The study divided the team in two working groups who entered all the damaged buildings in order to detect, classify and mark the damage caused in an EAE quantification system. Figure 5.1 shows the EAE classification table as proposed by the authors; the keys used in the map of these deformations are as shown in the attached map (Fig. 1.4-6).

Fig. 1.4-6: Map of Lorca historic and town centre with the distribution of the main EAEs classified during the field work following the earthquake (Rodríguez-Pascua, M.A. et al 2011)

The most relevant aspect of the archaeoseismic study applied to this instrumental earthquake is that it enables us to correlate the EAEs defined from historic earthquakes that affect archaeological sites with heritage and modern buildings.

Furthermore, this information can be correlated with the seismic and geological parameters shown in this report, both with the magnitude and focal mechanism of the earthquakes, and with the seismogenic fault and the effect due to the geology of the subsoil of Lorca.

The Lorca earthquake is an ideal example for studying deformations associated with the surrounding area during a seismic event, and it enables us to correlate the damage with the seismic intensity, as well as parameters inherent to the earthquake, magnitude, depth and geometry of the seismogenic fault. Thus, we can extrapolate these results from the Lorca earthquake of 11 May to studies of archaeological sites that interpret a historic earthquake in the surrounding area.

The preliminary report (Martínez, S.J. et al, 2011) compiled the main EAEs measured and marked in the cultural and historical heritage. It also described similar structures in modern buildings such as the controlled collapse of the Las Viñas building and other modern brick buildings.

This preliminary information shows a clear area with specific positions that concentrate the greatest damage to buildings (Fig. 1.4-7).

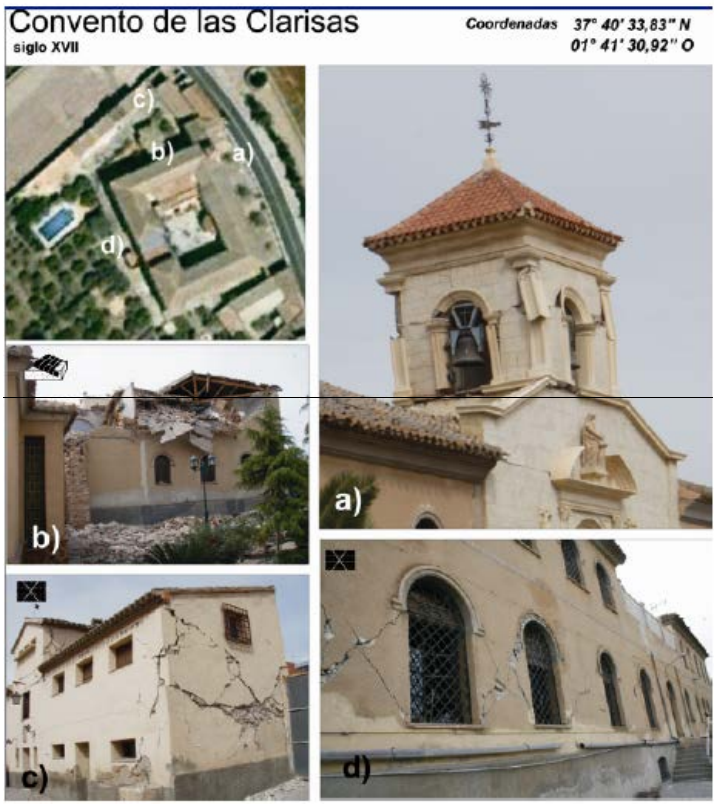


Fig. 1.4-7: Example of studied cases and how they have been recorded (Martìnez, S.L. *et al.,* 2011)

Comparison with the Turkey earthquake

In Lorca, on 11 May 2011, there were two earthquakes measuring 4.5 and 5.1 on the Richter scale, as well as numerous replicas over the following days.

Various victims were rescued, many received medical assistance and almost 8,000 buildings were inspected. Three temporary camps and a field hospital were set up in less than 24 hours, over 2,000 troops were mobilized, with a total cost of €2,016,179.

Of the 33,000 homes, a total of 23,855 could be rebuilt or repaired.

In summary due to the extension of this paper, these are the differences between Lorca and Turkey.

Note that the greater intensity of the disaster in Turkey, 7.2 on the Richter scale, has caused to date a total of 601 deaths and thousands of injuries with many buildings collapsed, the main cause of death and injury. By contrast, in Lorca almost half of the deaths were due to partial breakages of façade elements such as projections or parapets, all non-structural elements.

Conclusions

Finally and in summary, note the following conclusions:

- Earthquakes are very difficult to predict despite being able to study the risks depending on the area of impact. Damage similar to that caused in Murcia and southern Alicante were advanced in 2002 in the Study on seismic risk in Spain.
- Vulnerability and the impact on the population are related to exposure to these natural phenomena, focusing on areas of population in seismically active areas. Furthermore, preliminary studies show that Lorca is geologically located on one of the most active faults.
- Finally, note that the most damaged buildings are historic buildings with a construction model not suited to these phenomena. However, there are also several buildings that should be adapted to earthquake-resistant standards, which are somewhat dated and are now being revised. This standard does not prevent significant damage to the structure, but limits the resistance of the structure to ensure full evacuation. This is why around 27% of the buildings are no longer habitable.

There is much to learn from this experience and recently, after the final report of the Lorca earthquake, it has been communicated that seismic maps and building standards will be updated.

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2. BEST PRACTICES RELATED TO FLOODS AND LESSONS LEARNED

2.1. GREEK best practices on flood preparedness: the case of the European project "RISK" and the area of Giofyros river basin

The present chapter presents the results of the European civil protection project RISK (2013-2014), which was a project that offered tools for risk assessment. These tools could be used for the better planning of civil protection measures. The project studied several hazard and climate change risks in the selected project areas, including the flood risks. The following text summarizes the results of the implementation of the RISK project in the case study area of the Giofyros river basin in Crete, Greece.

General information about the RISK project

The European civil protection project RISK deals with the development of a new software tool to monetarily assess the cost and benefits of risk reduction measures aiming at reducing the risks associated with natural hazard events. In specific, the project aimed at analysing the vulnerability to natural hazard in five case study areas, including the Giofyros river basin in Crete, Greece, the Vallo di Diano area in Italy and the Ajdovščina area in Slovenia. For the purposes of this task, the Natural History Museum of Crete, Greece (partner organization of the EVANDE project) focused on producing local datasets of the area of interest where the availability of Geographical Information System (GIS) data is poor. These datasets were transferred into an appropriate geodatabase that contained the derived project products as well (Fig. 2.1-1).

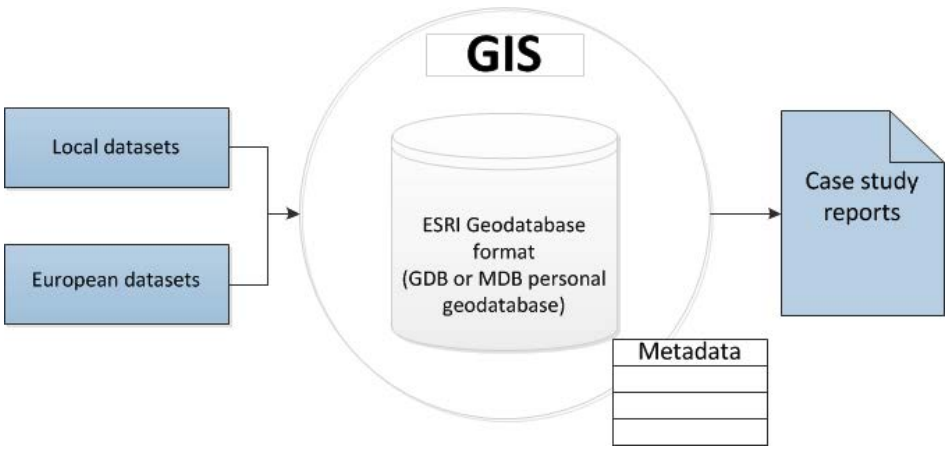


Fig. 2.1-1: Role and components of the RISK-GIS
(Source: Natural History Museum of Crete-University of Crete, illustration)

Under RISK project the impact of climate change, according to the various model proposed, in Giophyros river basin in central Crete, Greece have been examined through former thematic studies. The geographical, geomorphological, geological, environmental, demographic and urban features of the basin had been extensively described under the C.2 and C.3 reports produced by the project.

The project tried to combine data and information concerning floods, earthquakes and other natural hazards in the study areas in order to assess the risk from natural hazards but also from climate changes. For this reason projections of all crucial assets and components for the year 2030 were used and then the total and individual, for each hazard costs were estimated for the case of no action. A projection and downscaling of the existing climate change models had been implemented for the area of Crete in general and the expected scenarios for the 2030 had been presented under the C.1 project report. In addition based on the former reports a projection of the urban agglomerates had been undertaken under the C.4 and the C.5 project reports.

All the above data have been used under the project implementation to evaluate the socio-economic costs of the impacts of climate change and natural disaster risks in Giofyros basin. The methodology followed the guidelines and the methodologies proposed by the University of Sannio, especially on the economic formulas that have been used.

Description of the Giofyros River basin

Giofyros River is a typical Mediterranean river with run off during winter months, which is suffering by winter flash-floods due to heavy rain. It runs off into the sea north of Crete and just at the western suburbs of the biggest city of Crete, Heraklion and it has a surface water flow from autumn until spring, as most of the rivers of the island. Giofyros basin extends to the interior for about 25 km and occupies a large part (with its tributaries) of the municipality of Heraklion (approximately 190 square kilometers), is wider in the southern (about 17 km) and narrower in the coastal zone (about 1,000 m), (Fig. 2.1-2).

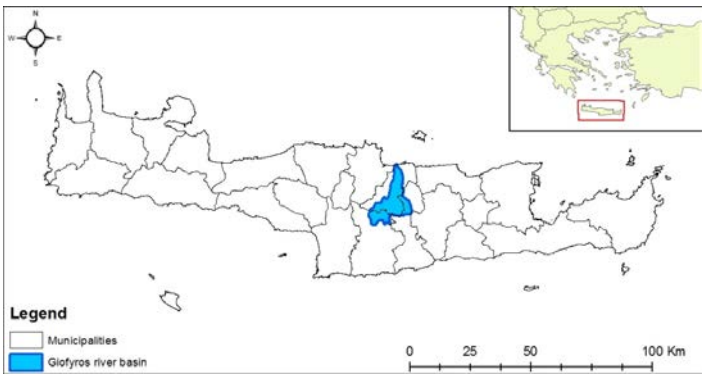


Fig. 2.1-2: Giofyros basin map
(Source: Natural History Museum of Crete-University of Crete, illustration)

Within its catchment occur about forty small sized settlements and villages, with Aghia Varvara being the second biggest with 2,115 inhabitants, resulting in a total of 12,500 inhabitants excluding the suburbs of Heraklion town.

Landscape is mainly mountainous and hilly at the uppermost part with agricultural and live stock rising uses. The central and lower part of the basin is formed into an oblong flat central valley with 11 km length and width of 600-1,000 m, with high productivity land fully cultivated, which results in the southwestern suburban area of Heraklion. In most of the basin area there are rural farming uses, but at the lower, to the mouth portion of the terrain is formed into an oblong flat central valley with 11 km length and width of 600-1,000 m, with high productivity land fully cultivated, which results in the southwestern suburban area of Heraklion. The remaining portions of the basin compose hilly terrains and semi mountainous areas.

At this lower part and just outside the town occur low industrial activities like the Waste Water Treatment Station, small industries, workshops and crafts, as well as large night entertainment and catering centers, the Olympic stadium and several tourist activities.

The urban areas (within the urban planning zone of Heraklion) extend east of the valley of the river to the highway at a distance of 1,500 m from the sea and periurban (off the urban planning zone) areas extend west of the river and south of the highway to its intersection Tributaries 'Chrysovalantou' about 2,200 m from the sea. In both these areas illegal construction is a common practice, plus the installation of commercial uses are key factors of environmental degradation. Thus, this area can be classified as one of the most deprived in the wider area of Heraklion, taking also into account the frequent floods, the most significant of which, was the one of January 1994.

Farming uses are dominant, about 90%, while residential and other uses ranging around 10%. Main agricultural cultivation, especially at the plain, are vine yards, while olive groves are more frequent at the slopes. There are also vegetable and other crops to the bottom of the valley where the land is irrigated.

Demographic data of the area are hard to be estimated in detailed mainly due to the fact that the basin is covering a part of Heraklion that is hard to be distinguished from the rest population of the town. We have studied however the demographic growth trends using the censuses of 1971, 1981, 1991, 2001 and the most recent 2011 for the Heraklion municipality as well as the rest 20 settlements of the basin. Generally the population of Crete, the Heraklion Prefecture and especially Heraklion town was continuously increasing. The population of the Heraklion prefecture and Municipality were particularly increasing in higher rates than the rest of the country. The higher rate (36%) was observed between 1971-1981 when the town actually grew up and the second higher was between 2001-2011 with 26%, even though the last decade a decrease in the population of Greece, due to the economic crisis, has been recorded. The real population of Heraklion town in 2011 was 179,993 inhabitants, which is the fourth largest in Greece.

The population of rural area of Giofyros basin (excluding the town of Heraklion and its suburbs) is continuously increasing till 2011 reaching 16,101 inh. Almost all

settlements of the inland semi-mountainous and mountainous area the last 30 years present a more or less constant population. In addition, settlements existing at the lower (northern) part of the basin which is closer to Heraklion present a continuous increase in their population even in the census of 2011.

The urban development in the area is mainly governed by the development of the town of Heraklion which is the capital of Crete since 1971. The rapid population increase in the decade of 1971 – 1981 resulted in an illegal construction of residences and large expansion of built – up environment around the town. Local authorities were not prepared for this expansion and thus the Town Planning regulations appeared much later in the '00s. The main Land use and town plans refer to the Heraklion General Master Plan that covers the northern part of the basin, the General Urban Regulatory Plan that covers the majority of the Heraklion prefecture and the whole Giofyros basis, as well as other minor regulations.

The built up environment of the town of Heraklion from the '70s to present day has been increased up to three times (358%), whereas the sparse built up zone up to eleven times (1127%). Regarding the rest settlements of the Giofyros basin no significant changes were recorded.

The trends for the year 2030

The trends for the 2030 scenario considered the present conditions and plans in the area of Giofyros basin, the models developed under the General Regulatory Plan and the General Guidelines of Special Adjustable Urbanisation studies, as well as the implications of the Greek economic crisis. The demographic growth for the area of Giofyros river basin is thus expected to follow the decreasing rates of the country. It is very possible that the total population of Heraklion town might slightly increase but the population of broader rural area probably will decrease in higher rate. Thus, the new Heraklion Municipality is expected to have 196,517 inh. In total, we expect that Giofyros basin will retain the same population as in 2011 and will not affected by the general decrease due to its proximity to Heraklion.

Furthermore, the most optimistic scenario for the land uses and the town planning in the broader area suggests that no significant changes are expected. As for the urbanization trends, it is expected that the town of Heraklion will be increased slightly with the expansion of town plan to the southern neighbourhoods by 8 km^2. The smaller settlements are expected to present no clear urban changes.

Identifying risks for the Giofyros area

The most expected and dangerous natural hazards for Giofyros are floods and earthquakes, however the the impact of climate change is considered also as very important. The risk of other natural disasters like landslides or wild fires is mainly concentrated at the uphill of the river basin and mainly at the central and southern parts, namely the areas that are characterized as rural and less populated.

According to the 2030 scenario for climate change impact it is expected that Precipitation will decrease at about 20%,whereas the same models predict that warming will continue at a rate somewhat greater than its global mean, and thus for

south-eastern Mediterranean is expected to range at +1,6 to +2 °C.

The same models predict some other qualitative changes that might have an important impact in the climate of Eastern Mediterranean and thus of Crete. Regardless the reduction of mean annual precipitation it is also expected a reduction of the "wet period" meaning that rain will have shorter duration and thus probably storm characteristics. In general this can facilitate the appearance of intense droughts especially in summer time.

For the area of Giofyros river basin expected climate changes might accelerate flooding events, but also will influence water balance in the basin. As the majority of the rocks in the high lands are permeable infiltration will be reduced in contrast to run off and that storage of water underground will be less than today. Both irrigation and potable water needs of the area, and in general of the Heraklion town and its suburbs is based in water drills and thus underground aquifers (Fig. 2.1-3). We thus expect that reduction at about 20% of precipitation, reduction of infiltration due to the heavy and storm rain and the increased temperatures that accelerate evaporation may result in a total reduction of available water in the basin of about 30%.

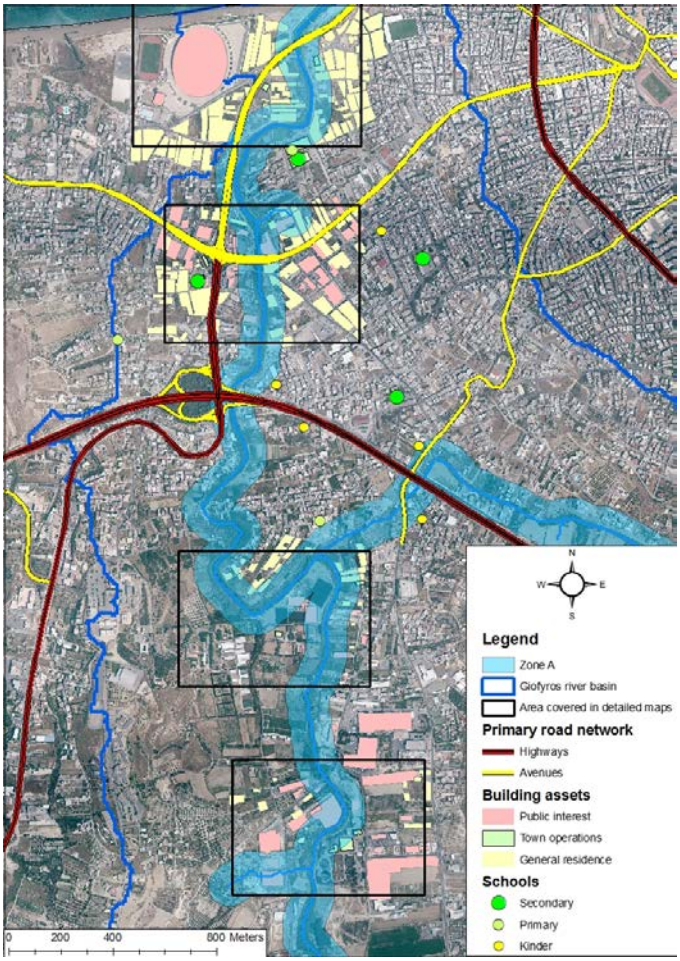


Fig.2.1-3: Vulnerability map of flooding threat in the study area, (Source: Natural History Museum of Crete-University of Crete, illustration)

Flooding risk

In the last thirty years two major flash flood events occurred with significant damage output in private properties and public infrastructures. The first one was in the 17th of January 1985, after intense rainfall in middle and north Crete for a short period of time. The second one was in 13th of January 1994. The flood event was bigger than 1985, even though in Heraklion the rainfall did not exceed 36 mm. Cattle, cars and other goods were swept away and traffic was interrupted. The

estimated cost of the event was 30 million Euros of which ~0.6 million Euros was the estimated cost to the sewage process unit under construction at that time. Since 1994 there were several days of high alert due to the dangerously high level of water in the river. Last one was in the early days of January 2012, when again rainfall in Heraklion was low but there was intense rainfall in hinterland. Only small scale damages from flooding occurred. All of the above incidents occurred after a short period of intense rainfall, while the ground was saturated due to previous mild but prolonged rainfall and snow melting.

Risk analyses (Ministry of Environment, Energy and Climate Change, Preliminary Study of Flooding Risk in Greece 2012) indicate that the whole coastal area west of the town of Heraklion is facing the risk of a flooding event.

Seismic risk

In the past, several strong earthquakes have affected the island of Crete and some of them have also caused considerable damages to the Giofyros area. Thus regarding the seismic risk, the area of Giofyros basin is classified at the second zone by the Greek Anti-seismic Regulation of Earthquake Planning and Protection Organization of Greece, with expected seismic acceleration of 0.24 g.

Assessing costs

As benchmark scenario the data that have been presented in the C.4 project report that estimated the trends and changes of the Urban agglomerates for the 2030 were used. The future scenario used in this report was based on the prediction for the climate change presented in the C.1 project report for the area of Crete and thus of Giofyros. In addition the vulnerability study of the Giofyros river basin that was undertaken under the C.3 project report, which identified the main threats for Giofyros, i.e. earthquakes and flooding was also considered. For the cost assessment the possibility of an earthquake disaster, which of course is not climate change dependent, of flooding and of water scarcity that is the direct effect of climate change, were studied. Using the methodologies proposed under the C.6 project report guidelines the socio-economic costs for these threats were defined then.

For the water scarcity which is a threat following climate change scenarios, In order to estimate the cost of the mean annual water loss of Giofyros basin the mean consumption cost of water for the irrigation purposes was used, which are the main needs in the area. It was taken into account for the 2030 scenario the -30% reduction in precipitation, and was estimated a water loss of about 35,5 X 10^6 m^2. As the irrigation consumption cost in total (according to data of Decentralized Regional Authority of Crete, Water management dep.) is about 0,15€, the estimated overall cost for the water loss is about 5.325.000 € per annual.

In order to estimate the cost needed to cover the irrigation needs loss, the total irrigation consumption was considered, which for the area of Giofyros mainly comes from water drills, and is about 3,3 X 10^6 m^2. A -30% of water available for irrigation is thus expected due to climate change scenario, which should be covered from other resources or from over pumping. This cost was thus estimated, using the

same as above water costs, at about 148.500€ per annual, and this is a real cost that farmer should undertake by themselves.

In order to estimate the damage cost from a possible earthquake the method proposed by the C.6 guidelines (Hwang et al. (1994) for the urban area of Giofyros river basin was used which actually represents the suburbs of Heraklion town. The considered seismic scenario that was studied was, according to the Greek Anti-seismic Regulation for a Peak Ground Acceleration (PGA) of 0.24g. We have considered that the damage cost for the general residences, town operation construction and public buildings using the Fragility curves discussed under C.3 report and the methodology proposed by the C.6 guidelines. The overall damage cost was thus estimated at about 298.583.070,00 €.

Finally, for the possibility of a flooding event the Vulnerability zone A presented in C.3 report was considered which exposes the highest possibility for facing a flooding and we considered the replacement cost for electric equipment and household for each of the residences existing within this zone. The total replacement cost was thus estimated at about 686.000€.

References:

- Websites of the RISK project: www.risk-project.eu, http://nuke.risk-project.eu, http://www.clab.edc.uoc.gr/RISK

2.2.ITALIAN best practices on preparedness to floods

One of the main goals of the Beigua European & Global Geopark in Italy, project partner in the EVANDE project, is the promotion of its geological heritage and the awareness-raising on the existence and importance of the hydrogeological hazard in their territory.

Communication is crucial for promoting and advertising the Beigua Geopark and informing about the hydrogeological risk in the area, particularly through the use of popular communication instruments, such as the social networks, the internet, etc. It is therefore fundamental to plan appropriate communication and cultural mediation strategies, in order to involve local residents and social and economic operators.

In the current chapter, two best practices on preparedness projects related to the public information and education on the hydrogeological risk of the Beigua territory are presented. The first concerns the geo-educational project “Hydrogeological Hazard” and the second the communication campaign targeting the schools and the general public in relation to the new system of weather warning approved by the Liguria Region in Italy.

2.2.1. Geo-education: the project “Hydrogeological Hazard”

Following the flood event of 4th October 2010 that hit areas of Beigua Geopark, the educational project “Hydrogeological hazard” about flooding has been designed for schools. “Hydrogeological hazard” is an education project that deals with the

following:

- the vulnerability of the territory;
- the causes and effects of the urbanization;
- the hydrogeological risk connected to extreme precipitations events in own city, and
- the self -protection rules.

Firstly, the project was presented to the teachers of all the schools in Beigua Geopark. Following this, free of charge activities with students were organized. Finally, a final event with teachers and students was organized to present the project results (Fig. 2.2.1-1).

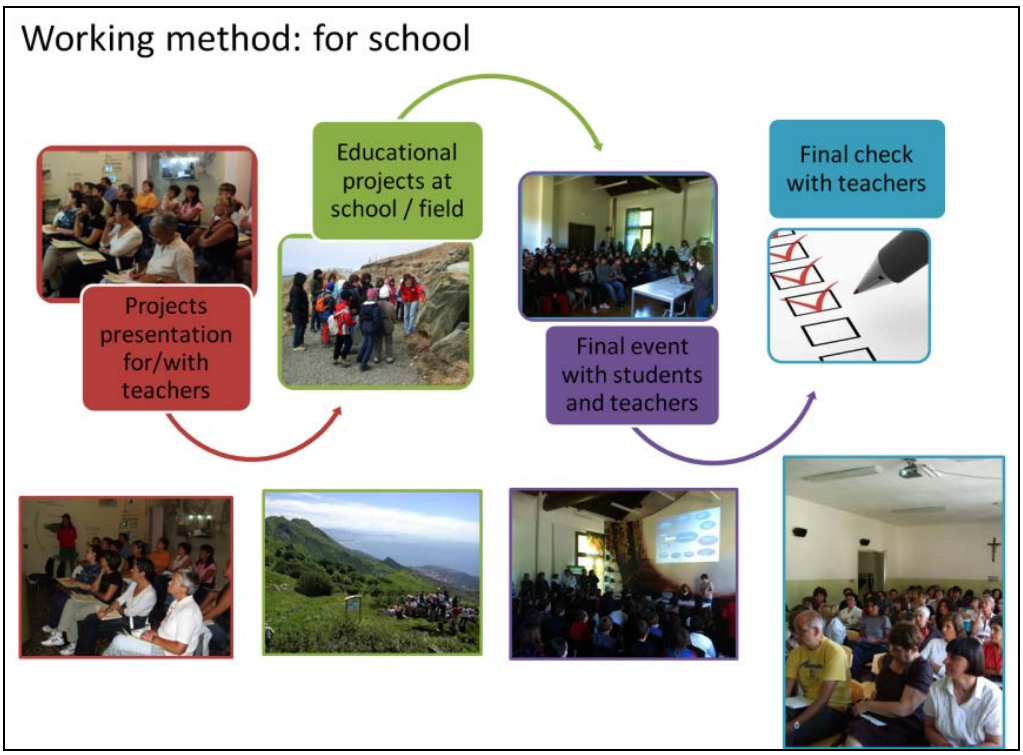


Fig. 2.2.1-1: The working method, Beigua Geopark Inventory, 2014

Methods and techniques

The methods and techniques used included:

- the observation of phenomena and geological processes on the territory and the encouragement of understanding by experiments on field;
- the discovery activities and the laboratory in the classroom, with the Geopark's Rangers;
- the field work during an excursion in the flooding area;
- the design and production of materials to understand and to exploit the geological heritage; and
- the publication of geo-educational materials for children.

In detail, the educational activity with students was an initial presentation in school, to explain to pupils what a flood is and what happened in the territory during the flood of the 4th October 2010. It focused not only on the geological phenomena, but above all on emotions felts by students during the flood and on the self-protection rules. Then students had a trip in the flooded area. During this trip the facilitators and guides of the Beigua Geopark showed to students the rivers, the urbanizations of the city and all the geomorphological aspect that produced the flood. On the beach of the city, where the river flows into the sea, students studied in depth the risk map of the city, trying to underline the flooded area. The activity "Where is my home" was a special "game" that helped students to paint the area of own home in the flood risk map (Fig.2.2.1-2).

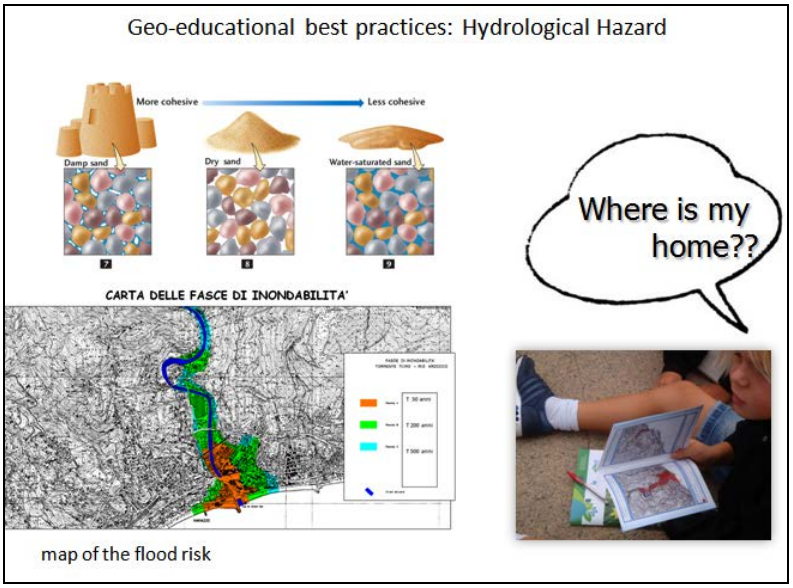


Fig. 2.2.1-2: The activity "Where is my home?", Beigua Geopark inventory, 2014

In addition, another special game was created for the project: “The game of hydrogeologic hazard” (Fig. 2.2.1.-3). It’s a large table game where students can discover all the potential hydrogeomorphological risk in the Beigua Geopark area. It’s a simple and funny way to test with students the results of the project and the knowledge learned during the activities.

Large **table game** to play together testing the results of the project.

Fig.2.2.1-3: The game of the hydrogeological hazard, Beigua Geopark inventory, 2014

Goals and outcomes

The goals and outcomes of the project can be summarized as follows:

- Children have increased their perception and sensitivity to the hydro-geological problems of the territory.
- Several materials were produced: booklets, guides, brochures, PowerPoint files, billboards and posters.
- The Beigua Geopark printed the series of brochure “Weather warnings in natural Park” and “Behaviour in the Park” to summarize the project results (Fig. 2.2.1-4).

Fig.2.2.1-4: Brochure about weather warnings realized by Beigua Geopark in 2012

References:

- Environmental education in the Beigua Geopark, Website: http://www.parcobeigua.it/Eedu.php

2.2.2. The new system of weather warning

Following the approval of the Regional Resolution no. 1057 of 5th October 2015, the Liguria Region introduces, from 15 October 2015, the new classification of alerts by codes colors yellow - orange - red alert in place of the classification 1 and 2 alert.

The following simple scheme (Fig. 2.2.2-1) is used in the Beigua Geopark's social networks to explain the alert during a meteorological event.

Figure 2.2.2.-1: Explanation of the new classification of alerts approved by the Ligurian Region in 2015

The facilitators and guides of Beigua Geopark realized a lot of lessons in different schools of the Geopark to explain the new classification alerts system. Lessons were completely gratuitousness for schools. In the part that follows, the main information about the new alert system that was communicated to students is presented.

GREEN: NO ALERT

YELLOW ALERT: Significant phenomena; beware and informed.

ORANGE ALERT: Intense phenomenon; remember the rules of self-protection and get ready.

RED ALERT: Very intense phenomena; put in place all the expected behaviors for situations of risk.

GREEN - NO ALERT

Scenario Event: Absence or low probability of significant phenomena locally predictable:

(in case of rain and thunderstorms) localized lightning, hail and isolated gusts of wind, localized flooding due to difficulties on the disposal of rainwater or small canals / rivers and small landslides; falling rocks.

Effects and damage: any damage punctual.

YELLOW ALERT

Scenario Event: Hydrogeological / hydraulic rains spread.

Effects may be localized to the ground:

- erosion, landslides and mudslides surface debris or mud in basins of limited size; surface runoff with possible transport phenomena of material;
- raising the water levels of rivers draining basins small and medium, with flooding of surrounding areas, partly due to critical local (tombature, narrowing, occlusions of the lights of the bridges, etc.); and
- superficial flow of water on roads and possible phenomena of regurgitation disposal systems stormwater with overflow and involvement of depressed urban areas, falling rocks.

Even in the absence of precipitation, there may be occasional landslides also rapid linked to the hydrogeological conditions especially fragile, due to the saturation of the soils.

Phenomena may occur localized: increased levels of the basins large, typically contained within the river bed.

Even in the absence of rainfall, the transit runoff basins Department can determine critical.

Hydrogeological to thunderstorms: The scenario is characterized by high uncertainty estimates. The scenario is characterized by high forecast uncertainty. It can occur as provided for the green hydrogeological scenario, but with phenomena characterized by an increased punctual intensity and speed of evolution , as a result of strong thunderstorms . There may be additional effects due to possible lightning strikes , hail , strong gusts of wind.

Effects and damage: Occasional danger to the safety of persons with possible loss of life for incidental causes.

Local effects:

- flooding of basements and those placed on the ground floor along routes potentially affected by water flows; damage to infrastructure, buildings and agriculture, construction, industrial and civil settlements affected by landslides; mudslides or run-off water;
- temporary interruption of the road network and/or train near watersheds, channels, depressed areas (subways, tunnels, sags in the road, etc.) and downstream portions of the slope affected by landslides;
- limited damage to water projects and defense of the banks, agricultural activities, construction sites, industrial and civil settlements in the river bed.

Additional effects in case of case of storms:

- damage to roofing and temporary structures with transport of materials because of strong gusts of wind;
- broken branches, fallen trees and felling of poles, signs and scaffolding with consequent effects on roads and on overhead networks of communication service delivery (in particular telephone, electricity);
- damage to agricultural crops, the insurance coverage of buildings and vehicles due to hailstorms;
- trigger fires and injuries from lightning.

ORANGE ALERT

Scenario Event: Hydrogeological / hydraulic rains spread.

You may occur widespread phenomena of:

- slope instability locally even deep in geological contexts particularly critical; shallow landslides and mudslides of debris or mud; significant runoff surface, also with transport material, chasms possible to erosion phenomena;
- significant rises in water levels of rivers draining basins Small and Medium, with phenomena flood surrounding areas, partly due to critical local (tombature, narrowing, occlusions of the lights of the bridges, etc.).
- significant run-off of water on roads and possible phenomena of regurgitation on the disposal of rainwater and overflow with involvement of deprived urban areas; rockfall in most parts of the territory.

Even in the absence of precipitation, there may be significant landslides also rapid linked to the hydrogeological conditions especially fragile, due to the saturation of the soils.

You may occur widespread phenomena of:

- significant rises in water levels of rivers draining basins with large phenomena flood surrounding areas and floodplains, involvement of the banks;
- erosion of the banks, sediment transport and digression of the riverbed; and
- occlusions, partial or total, of the lights of the bridges of the waterways more.

Even in the absence of rainfall, the transit run-off basins department can determine critical.

Hydrogeological to thunderstorms: The scenario is characterized by high uncertainty estimates.

You can occur as provided for scenario hydrogeological, but with phenomena characterized by a greater intensity timely and rapid evolution, with possible sudden floods of small and medium basins, in consequence of heavy thunderstorms, widespread and persistent. Effect is possible due

to possible lightning, hail, strong gusts of wind.

Effects and damage: Further effects and damage compared to the scenario code yellow:

- danger to the safety of persons with possible loss of life;
- widespread effects: flooding of basements and those placed on the ground floor along routes potentially affected by water flows;
- flooding and damage to individual buildings or settlements, infrastructure, buildings and agriculture, construction, industrial and civil settlements affected by landslides or mudslides;
- disruption of the road network and/or train near watersheds and downstream of landslides and debris flows or in low-lying areas near the river network;
- damage to the containment works, water drainage and crossing of waterways; and
- damage to infrastructure, buildings and agriculture, construction, industrial and civil settlements located in areas prone to flooding.

Additional effects in case of storms:

- damage to roofing and temporary structures with transport of materials because of strong gusts of wind;
- broken branches, fallen trees and felling of poles, signs and scaffolding with consequent effects on roads and on overhead networks of communication and distribution services;damage to agricultural crops, the insurance coverage of buildings and vehicles due to hailstorms; and
- trigger fires and injuries from lightning.

RED ALERT

Scenario Event: Hydrogeological / hydraulic rains spread.

Phenomena may occur numerous and/or extended (typically on an entire area Alerting) of:

- slope instability, too deep, too large;
- shallow landslides and mudslides of debris or mud;
- large surface runoff with widespread phenomena of transport of material, possible chasms to erosion;
- significant elevations of the water levels of rivers draining basins small and medium, with widespread phenomena of flooding;
- partial or total occlusion of the lights of the bridges of small waterways; and
- rockfall in most parts of the territory.

Phenomena may occur numerous and / or extended (typically on an entire area Alerting), such as:

- river floods of rivers draining basins with widespread phenomena great flood even areas far from the river, widespread erosion of the banks, sediment transport and digression of the riverbed;
- phenomena overflow, siphoning or burst their banks, bridges and other works overlap of crossing, and jumps to meander; and
- occlusions, partial or total, of the lights of the bridges of the waterways more.

Even in the absence of rainfall, the transit run-off basins department can determine critical.

Hydrogeological to thunderstorms: Code not expected to just temporal (applies to phenomena extended over the entire zone alerting, already the subject of critical hydrological / hydraulic).

Effects and damage: Further effects and damage compared to the scenario of orange code: Serious danger to the safety of persons with possible loss of life.

Effects huge and extended:

- damage to buildings and residential areas, activities and crops, building sites and settlements of civil and industrial, both neighbors is far from waterways, to flooding or affected by landslides or mudslides;
- damage or destruction of rail and road infrastructure, embankments, bridges and other water projects;
- damage to goods and services;
- damage to roofing and temporary structures with transport of materials because of strong gusts of wind;
- broken branches, fallen trees and felling of poles, signs and scaffolding with consequent effects on roads and on overhead networks of communication and distribution services;
- damage to agricultural crops, the insurance coverage of buildings and vehicles due to hailstorms; and
- trigger fires and injuries from lightning.

The classification with the use of colors is based on a quick and intuitive perception of danger level and aligns the Liguria Region to a single national model being implemented. To ensure that the accessibility of information, the alert color must always be communicated in text form. The alert system using color codes issued by the Liguria Region is a prediction up to the event and cannot therefore take into account how the event develops. The alert system is based on the forecast of the City of Genova Active System of Civil Protection. All citizens contribute to the system by adopting the standards of conduct for self-protection. Based on the alert color code, specific precautionary measures will enter into force according to the Municipal Emergency Plan and other safety ordinances.

How to stay informed:

Before, during and after the event the citizens are the updates and all relevant information on the channels of communication provided by institutions and local media (TV, radio, newspapers, online and on social networks).

Institutional channels

- Web sites:
  www.comune.genova.it
  www.allertaliguria.gov.it
  www.meteoliguria.it
- Social Network:
  Facebook and twitter Civil Protection Municipal.

Facebook and twitter of the City of Genoa.
- SMS: subscribe for free by sending the message “allerta meteo on” to the number 339 9941051 or through the online service.
- “I do not risk” App.
- Electronic panels road.
- Information displays at bus stops.
- Civil Protection toll for Emergencies 800 177797.
- Number Operations Centre Municipal Police 010 5570.

References:

- Civil Protection Alert, Liguria Region, Website: http://www.allertaliguria.gov.it/
- Environmental education in the Beigua Geopark, Website: http://www.parcobeigua.it/Eedu.php

2.3. BULGARIAN best practices and lessons learned on prevention of flood risks

The current chapter presents best practices on prevention of flood risks in Bulgaria. More specifically:

- The sub-chapter 2.3.1. presents the planned establishment of the National Centre for Water Management that will coordinate activities and collaborations on water management and extreme events such as floods.
- The sub-chapter 2.3.2. presents the operation of the internet platform for citizen alerts that can alert authorities on disaster events in real time.
- The sub-chapter 2.3.3. highlights the efforts for the integration of the volunteers to the flood risk prevention activities conducted by the Municipality of Sofia in 2015 (through the example of the Municipal Voluntary Formation for protection in disasters and emergencies).

2.3.1. National Centre for Water Management

One of the major projects which will be implemented in Bulgaria is associated with the prevention of flood risk. It foresees building a National Centre for Water Management, which through a single system for monitoring, forecasting and processing of incoming data will provide effective solutions for water management, particularly in the occurrence of extreme events. Actions will be distributed between all involved in the management and operation of hydraulic structures, and of course the emergency response services.

The project foresees a web-based system for monitoring and forecasting of river flow, including the operation of dams in order to optimize the discharge of water for different purposes, as well as providing better control at high water or even in periods of drought.

The system will be based on the existing hydrological real-time data information system and incoming data will be processed around-the-clock at the duty centre,

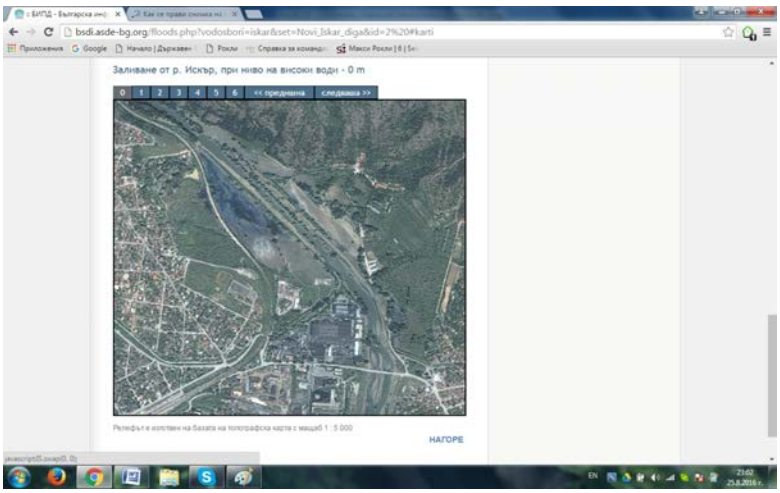
which will be in direct contact with local chapters of emergency response services.

The timely submission of necessary information will help stakeholders to prepare and take the necessary actions in case of predicted flooding or water shortages. Predicting river flow and defining the zone of flooding will help in making decisions such as the pre-evacuation of potentially threatened areas.

Moreover, monitoring the system of dams will improve integrated water use in order to best satisfy priority needs and to provide free capacity to meet the expected influx.

Until December 31st, 2015 a pilot area will be constructed along the Iskar river, and later on further 13 main Bulgarian rivers. The system will work through a set of riverbed sensors, placed in different risk areas that will transmit real-time information to the Control Centre, which will monitor the situation throughout the country, receive information about imminent rainfalls and take immediate action to curtail the risk of floods.

The construction of the pilot section along the Iskar River will complete the monitoring system for the capital's river levels (Figure 2.3.1.-1). In 2014 Sofia Municipality build their own system, observing 28 critical areas of the currents of the local rivers. The Municipal Operational Centre monitors the levels of all rivers in the capital in real time, including the Iskar dam, receiving information three times a day. The role of the centre is to trigger the flood action plan if needed, immediately notifying all interested bodies - the mayor, the fire department, etc., thereby minimizing response times. If necessary, evacuation of the population can be initiated without wasting unnecessary time.



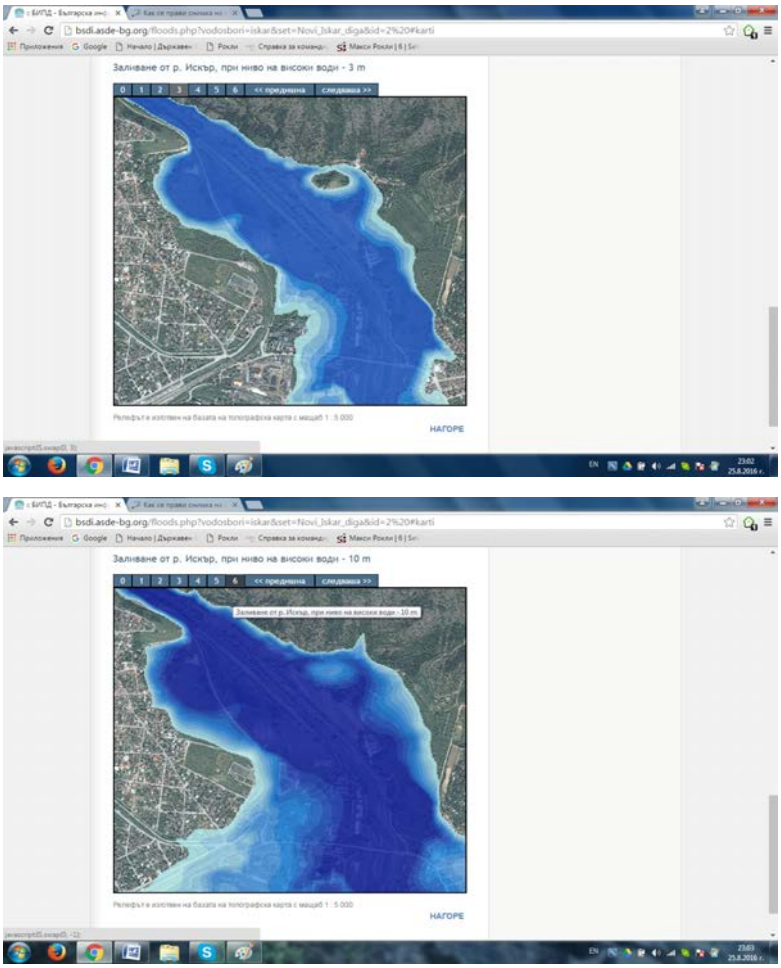


Figure 2.3.1.-1: Simulation models for flooding from the Iskar River – 0; 3; 6 m level of the river above the standards (Bulgarian spatial data infrastructure)

References:

- National Centre for Water management, Website: http://ope.moew.government.bg/
- Bulgarian spatial data infrastructure), Website: http://bsdi.asde-bg.org/

2.3.2. Internet platform for citizen alerts

In the past year Sofia Municipality introduced a system, allowing civilians to report irregularities, hazards and disasters in real time. Except by calling 112, citizens can use the internet platform for alerting the authorities (Fig. 2.3.2-1). The developed application is compatible with all operating programs of modern smart phones. With just one click the Control Centre can receive information about the type of problem, its exact location (using GPS coordinates from the mobile phone), and

the degree of danger. Although there is a certain amount of false or misleading signals, this is another way for citizens to promptly and conveniently alert for disasters in the making. The application appeals especially to adolescents and students who are familiar with new technologies.

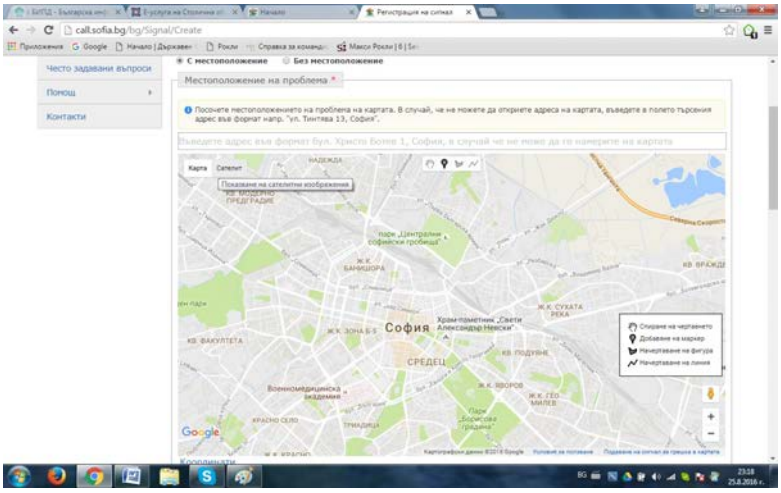


Fig. 2.3.2-1: Overview of the platform for citizen alerts of Sofia municipality

References:

- Internet platform for citizen alerts, Website: http://call.sofia.bg/

2.3.3. Municipal voluntary formation for protection in disasters and emergencies

Flood risk prevention activities are defined on a national level and are aimed at potential risk areas. However, the specific activities are carried out and organized locally by the municipality. This is positive, seeing that local authorities know best which the critical points in their area are and where to intervene as a priority.

Municipalities in Bulgaria have obligations to build dikes and other protective equipment, and to maintain riverbeds in good condition. Here we can give another example of a job well done. During the last 3 years Sofia Municipality uses volunteers from its own Voluntary Formation in Risk Prevention Activities. Volunteers, together with municipal personnel and equipment regularly participate in cleaning and maintaining the gutters of Sofia's rivers. So far they have cleared hundreds of tons of garbage and silt from riverbeds, thus seriously reducing the risk of clogging and overflowing of rivers. On the other hand, by going through the riverbeds, volunteers become familiar with the terrain and its potentially dangerous flashpoints, which play the role of informal practical training as well.

References:

- Website of the Municipal Voluntary Formation for Protection in Disasters and Emergencies, Website: www.sofia.help

2.3.4. Coordination of preventive activities against the flooding risk in the Sofia Municipality, 2015

The most recent example of successfully carried out preventive activities against the risk of flooding comes from the spring of 2015. It can be said easily that municipal and rescue services have done a great job to prevent and avoid flooding. A huge amount of snow fell in winter. The last heavy snowfalls continued until end of March, with snow in the mountains reaching record levels. On the other hand heavy rainfall started during the period of April-May with temperatures rising abruptly. This led to an immediate rise in the level of rivers and dams near the capital. It became clear that the largest dam in the country is almost filled to capacity and there is an urgent need to release part of it, in order to be able to take in water expected from intensive snow melt in the mountains.

Cooperation and coordination between institutions that mobilized huge resources is an example for good practices. Meteorologists predicted intense snowmelt and serious risk of flooding. Swiftly, the mayor called in a meeting with staff from all institutions and voluntary organizations. Representatives of the municipality, fire control services and water management, forestry, representatives of the companies included in the emergency plan of the city and others. Volunteers and staff, all were mobilized. Immediate action was taken by clearing out the Iskar riverbed of silt and garbage, emergency construction and reinforcement of dikes in critical areas. Volunteers and firefighters raised temporary dikes in many places or elevated old ones with bags filled with sand. The most important element was still good institutional coordination. While cleaning and strengthening riverbeds and dikes, the release of dams was minimized. Release began at the moment in which these activities were completed. The actual release took place in a very reasonable way under exclusive control.

Teams of firefighters, municipal employees and volunteers were deployed all along the river on the territory of Sofia Municipality (Fig. 2.3.4-1). Every team was allocated a bridge or critical section to monitor the water level. Municipalities downstream of the river were warned of possible high waters in order to release volumes in reservoirs and strengthen defences. The monitoring team had constant radio contact with the municipal headquarter and reported any change in water levels.

The draining itself began gradually. Volumes were released along the entire cascade. First dam Pancherevo was drained to take in part of the wave. Then they released volumes in Pasarel and only then the actual Iskar dam was released. This was a sensible move, since the released volumes in the two smaller dams made space for the incoming wave. Given that the dangers of silting and breaking of the dams were removed in advance, institutions and volunteers actually prevented flooding in Sofia, which would have caused enormous damage. This is an example of successful preventive work and good internal coordination. With the construction of the National Monitoring Centre it will become possible for this to happen in a similar way throughout the country.

Weak prevention is the main point of discussion and the biggest problem faced

by institutions. In many places riverbeds are not maintained in good condition for lack of resources and voluntary units, which leads to negative consequences for the population. Therefore, it is necessary to focus greater resources on the prevention of flooding, building effective voluntary units in each municipality, training of state and municipal experts to work in disaster and emergency situations in order to reduce and overcome the risk of flooding.

Furthermore, we must pay attention to the exchange of information and cooperation with our neighbours. Overall coordination is unsatisfactory. The example of Sofia Municipality may be extended to other municipalities and successively to neighbouring countries, to ensure timely risk reduction and mutual protection.

Fig. 2.3.4-1: The role of the volunteers in preventive activities – dike building, March 2015, (Source: Yasen Tsvetkov, personal gallery)

References:

- Website of the Municipal Voluntary Formation for Protection in Disasters and Emergencies, Website: www.sofia.help
- Civil protection in Sofia Municipality: Security Department (Website: http://sonet04.sofia.bg/) and Contact Centre for citizen alerts (Website: www.call.sofia.bg)

2.4. SPANISH best practices to floods and lessons learned

The present chapter presents the case of floods in Beniarbeig, in Valencia region in 2007 that leaded to the revision of Action Plans and risk maps and stressed the importance of urban planning (sub-chapter 2.4.1). Furthermore, it presents PATRICOVA, the Territorial Action Plan for Prevention on Flood Risks of the Region of Valencia, that is an innovative preventive tool for dealing with flood risks in future land use planning. PATRICOVA that was awarded with the IV European Planning Award in 2002 (sub-chapter 2.4.2).

2.4.1. Lessons learned: The case of floods in Beniarbeig, Valencia, 2007

The present chapter presents the case of floods in Beniarbeig town in the Community of Valencia that occurred in 2007. The damage caused and the lessons learned resulted to the review of the existing local administration's action plans and risk maps used. Additionally, the disaster stressed the importance of awareness-raising on natural risks and the need for integrated urban planning.

Introduction

Beniarbeig is a town in the Community of Valencia, located in the north-east area of the Alicante province, in the Marina Alta region. According to the 2009 census, the municipality has 1,997 residents and covers an area of 7.4 km^2. It is set at an average altitude of 42 metres and only 3 km from the beach, as shown in the following image (Fig. 2.4.1-1).

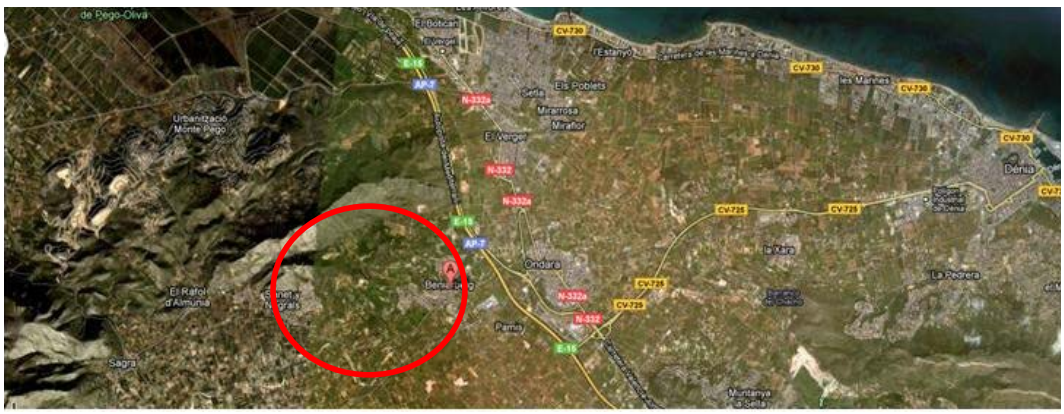


Fig. 2.4.1-1: Satellite image (Source: www.maps.google.es)

It is located between the Rectoría Valley and the Marquesado de Denia, at the base of the Segaría Mountains and split by the Girona River, which runs through the town. The bridge that crossed the river dated back to the early 20th century, but it was washed away by the 12 October 2007 flood.

The 12 October 2007 flood, due to rains that surpassed 400 mm in certain areas, caused the Girona River to swell and reach the highest water levels ever documented. This affected a number of villages, and the Beniarbeigbridge was destroyed and most of the town was flooded.

Concepts

The risk assessment contains three fundamental elements to be considered (Fig. 2.4.1-2):

Fig. 2.4.1-2: Risk factors and types of risk (Ayala, F.J. and others, 2006)

The existence of natural risks (summarised in this graphic) is therefore a consequence of all the risk factors:

- The hazard, with a severity or intensity and a probability of occurrence (including the terms “phenomenon intensity” and “probability of occurrence”).
- The exposure (of people or goods).
- The vulnerability of this exposure, with a degree of loss ranging from 0 (no damage) to 1 (destruction or death).

Risk only exists when all the risk factors coincide, and this conceptual reality is shown in the graphic.

This integrated risk analysis document will address in greater detail the risk factors for this event, which can be summarised as strong rains. Rain in itself is an adverse hydrological situation, and it was combined with hydraulic deficiencies due to ravines that had not been cleared and questionable urban planning.

In a matter of hours, these factors caused serious flooding and building collapses, and left a town isolated when the bridge connecting Beniarbeig was washed away.

Analysis

Chronology

Below is a brief summary of the sequence of events (Crespo, M.J. 2009), (Fig. 2.4.1-3 & 2.4.1-4).

- The pre-emergency was declared on Wednesday, 10 October, at 10:30 a.m.
- The emergency was declared on Friday, 12 October, at 1:00 p.m., with major damage due to the swelling and overflowing river. A total of 31 people were rescued (some via helicopter).
- Seriousness: One death, three injuries from being washed away, evacuation of asylum and camp sites, structural damage, etc.

Fig. 2.4.1-3: Aerial image of the Beniarbeig region (Source: Citizen platform: Girona River, 2007)

Fig. 2.4.1-4: Simulations of the Girona River swelling as it passes through Beniarbeig (Source: video Part I, Citizen platform: Girona River, 2007)

- 18 October: Second round of rains that also affected Costera, Canal de Navarrés and Ribera Alta.
- 12-22 October: Extraordinary intervention, logistics and cleaning efforts (professionals and volunteers).
- Saturday, 20 October: End of emergency.

Other information

- A disaster area was declared.
- Record rain levels: 300-400 L/m2 in the mountains.
- September had been a rainy month, resulting in significant water accumulations on the ground.
- Overflowing rivers and unregulated ravines.
- The reservoirs of regulated rivers had laminar flows.
- The second round of rains generated additional alarm.

Development

As mentioned earlier in the explanation of this document, floods are complex phenomena that result from multiple and interrelated factors.

The meteorological causes (extraordinary precipitation), the physical characteristics of the basin, the topography of the flood zone and the condition of riverbeds are changing elements in each incident.

Extraordinary precipitation (responsible for the floods) is a common occurrence along the Mediterranean coast. The intensity and volume of the rain that falls, combined with the physical characteristics of the basin and the additional information specified earlier, create an interrelation of all these factors that tend to result in flash floods with flow volumes that exceed the capacity of riverbeds and cause serious floods.

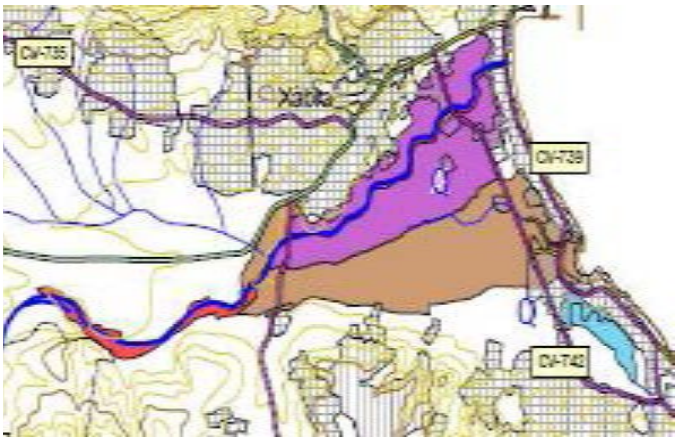


Fig. 2.4.1-5: Map of the area affected by the alluvial fan
(Colors show the different areas affected by the flood), (Crespo, M.J., 2009)

The image above (Fig. 2.4.1-5) shows the areas affected by the flood, where the alluvial fan can be seen in the Marina area.

In general, the Mediterranean coast contains many populated areas that have historically been densely occupied by humans. The strong economic growth of these regions after the 1960s changed the traditional agriculture and resulted in intense urban development that has indiscriminately occupied flood zones. This has modified the natural geometry of flood plains.

At the same time, in the hope of protecting urban areas, riverbeds have undergone construction work, which in many cases has simply increased the damage caused by flooding.

In addition, building infrastructures inside riverbeds, shoring-up riverbanks or making rivers narrower are practices that tend to have repercussions on water flows and result in alterations with significant consequences during floods. As a result, it is foreseeable that in the near future, the Mediterranean basin will become increasingly vulnerable against river floods, in connection with the uncontrolled occupation of flood zones (Segura, F. 2009).

All of the transformations that have taken place in the region, especially those in urban areas, will modify hazard maps, and floods will affect exposed elements and vulnerability.

For example, modifications such as containment dykes on riverbanks cause changes to the course of water flows associated with a certain return period. If done in an uncontrolled manner and without proper land ordinances, they modify the hazard map so it is no longer valid.

As a result, any developments or activity changes in flood zones must be subject to restrictions and precautions. Hazard maps must be updated, but all too often this will not be possible, so outdated maps that do not include important changes will be used to manage the land in the region.

The changes resulting from the river's swelling must be taken into consideration because they create transformations, which are sometimes significant, such as changes in the course of the river, cut bends, the creation of new waterways (and therefore areas with strong drainage flows to be considered in maps), increased slope (greater speed, less depth, more energy) in erosion zones, but also the opposite, slope reduction due to silting up or aggradation (lower speed, greater depth, less energy) (Segura, R and others 2008). In summary, there are many details that specialised technicians must pay special attention to.

Conclusions

In this case, the vulnerability factor was extremely significant because the area in question is primarily focused on tourism, it has a high level of human occupancy, the strongest pressure is on riverbeds and a scattered urban development (with detached homes), and the land has a wide variety of uses.

Fig. 2.4.1-6: Images of reeds dragged by flood waters because the ravines had not been cleared. (Source: video Part I, Citizen platform: Girona River, 2007)

An aspect to take into consideration is that the strong rains were preceded by a very rainy September, so the ground was soaked and unable to absorb the first precipitations.

Due to the constant rains and a lack of maintenance, the edges of the ravines had a great deal of vegetation, primarily reeds, as shown in the photos above (Fig.

2.4.1-6). This made it difficult for the water to flow properly through canals, channels or under bridges, to the point of obstructing and even destroying them, as shown in the following images (Fig. 2.4.1-7).

Fig. 2.4.1-7: Images of the bridge affected by the water pressure and the obstruction of its arches. (Source: Citizen platform: Girona River, 2007)

It is clear that in a populated area, certain risks must be foreseen, their consequences analysed, and responses planned, especially if there is significant occupancy level, urban development pressure in the area with the highest risk and a regular population of non-locals.

As a result of this event, the Action Plans for coordinating with the various administrations were reviewed and the Risk Maps were updated. The event also helped stress the importance of education on the risks in question, and of land ordinances and urban planning.

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2.4.2. Good practice on prevention: the case of the Territorial Action Plan for Prevention of flood risks (PATRICOVA) in Valencia

Floods in Spain

In Spain, there are generally three climatic zones distinguished: a clear Atlantic influence, continental Mediterranean influence, and the specific peculiarity of the Canary Islands. This is due to the weather conditions that prevail in the general atmospheric circulation, although the varied topography significantly affects the development of areas with very different characteristics within this general context form.

This climatic diversity of the peninsula and the two islands, results in precipitation show a great variability in terms of its intensity and its spatial and temporal distribution. In addition, a geomorphological diversity makes our country leads to serious emergencies caused by flooding incurred.

For the purposes of the Spanish Plan facing floods risks, as required by the Basic Directive on planning civil protection against the risk of flooding, all the floods liable to look for danger to people and property are considered, produce basic infrastructure damage or disrupt essential services community.

The National Plan of Floods established general aspects, functional and organizational, that are complementary to the autonomous plans managed by Spanish Regions. One of the most considered plan in Spain is PATRICOVA, approved in 2003, which includes a series of measures for dealing with flood risk in future land use planning.

The Region of Valencia/Background information for the Territorial Action Plan for Prevention of flood risks (PATRICOVA)

Fig. 2.4.2-1: Calpe City (Alicante Province), 2015

The Region of Valencia is one of the most flood risk affected area in the whole of Spain because of the Mediterranean climate and the type of territory. Historically, very populated areas have been frequently located inside risk zones since risk has not been considered during the planning processes (Fig. 2.14).

Moreover, some of the main expected impacts of climate change, such as hydrological irregularity in flood patterns of the Mediterranean basin and the increase of the mean sea level (MSL) in coastal areas, could aggravate this problem.

The main objective are: to develop a preventive action against floods based on an action programme and, consequently, to better orientate the investment policies; to obtain the actual and future impacts produced by floods; and to try to reduce these floods levels to acceptable ones.

Therefore, it can be clearly considered and adaptation initiative since it could be useful for avoiding risks from a changing climate and related extreme weather events.

It is for this reason that the Law on Land Use Planning in the Comunidad Valenciana (1989) envisioned the “Plan de Acción Territorial de Carácter Sectorial sobre Prevención del Riesgo de Inundación” (Sectorial Regional Action Plan on the Prevention of Flood Risk in the Comunidad Valenciana), the so-called PATRICOVA, as one of the tools of land use planning. Through this, a survey of all the flood-prone areas of the region was carried out, according to risks of frequency and depth of flooding. Then a set of remedial measures and their estimated cost was proposed.

In 1997 the Ministry of Public Works, Town Planning and Transportation published the Regional map of Flood Risk, which serves as the basis for developing the action plan proposed by PATRICOVA, approved in January 2003.

Prevention tool

PATRICOVA mainly consists of establishing risk limits for floods. The risk map contemplates 6 levels by the combination of two variables: the flood frequency (3

levels) and the draft or height reached by the waters (2 levels) (Fig. 2.4.2-2). The actual flood impact is obtained by crossing the risk level with the actual use. By doing the planned uses, the future impact is calculated. Then, three interventions have been designed to react against this impact: Structural interventions (corrective character); Hydrological-forestry restoration (double character as the risk is reduced and the environment is improved); City planning and territorial arrangement (preventive character).

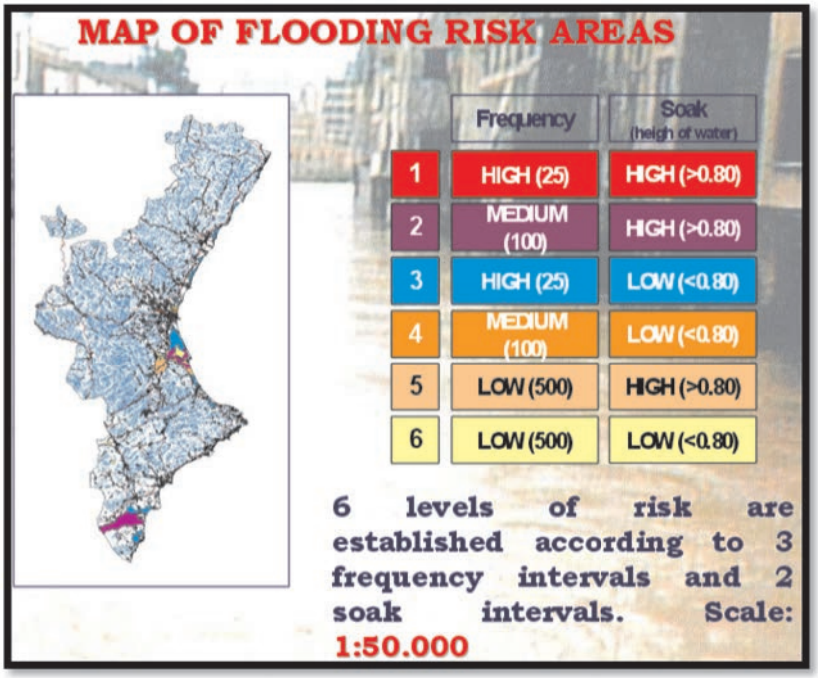


Fig. 2.4.2-2: Map of flooding risk areas, (Source: Regional Ministry for environment, water, urban planning and housing, Regional Government of Valencia, 2003)

The PATRICOVA is being reviewed to incorporate new criteria for the definition of flood risk, as the European directive on this matter recommends, and to integrate recent advanced in cartography, since the agricultural and insurance sectors deeply suffer the effects of flood episodes:

- Relevance: Medium. It is aimed to prevent and reduce flood damage in a very sensitive region, since the agricultural and insurance sectors deeply suffer the effects of flood episodes.
- Innovation: Medium. The degree of innovation is medium. The cartography systems are being actualized and improved with greater detail.
- Effectiveness: Medium-High. Since 2003, this instrument has been used for evaluating the flood risk in 8595 hectares of land, both urban and non-urban areas. The 56% of this land has obtained favourable reports whereas the 27% required some corrective actions to prevent floods. The other 17% was rejected as useful area since the flood risk was significant.

- Reproducibility: Medium-High. This strategy could be transferred to similar regions with similar characteristics and vulnerabilities. The costs of implementation will mainly depend on the available cartography.

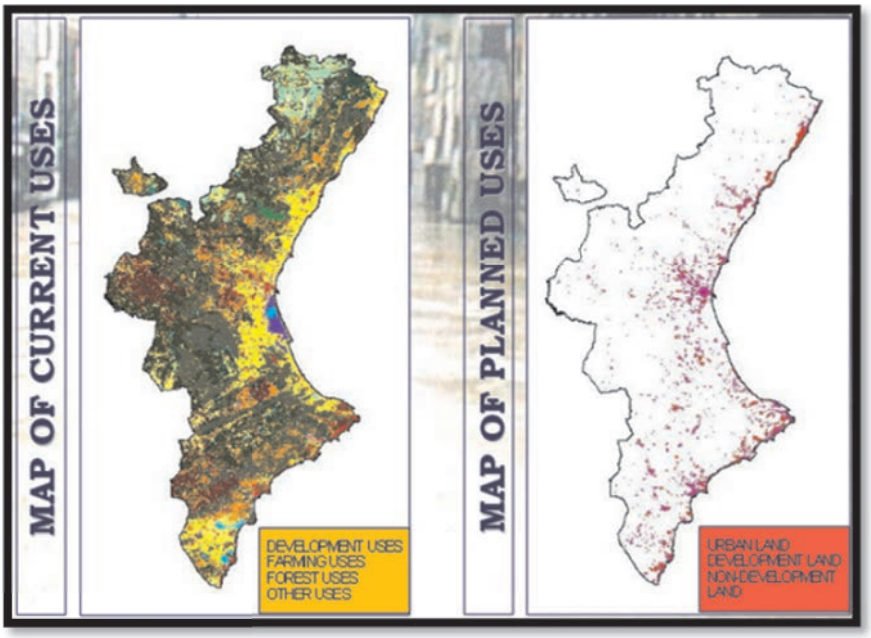


Fig. 2.4.2-3: Map of current and planned uses, (Source: Regional Ministry for environment, water, urban planning and housing, Regional Government of Valencia, 2003)

Since 2003, the instrument has been used for evaluating the flood risk in 8.595 hectares of land, both urban and non-urban areas (Fig. 2.4.2-3). The 56% of this land has obtained favourable reports whereas the 27% required some corrective actions to prevent floods. The other 17% rejected as useful area since the flood risk was significant. According to this, a 79% of the current impact of floods in the Region of Valencia corresponds to urban uses whereas a 21% is linked to agricultural use. It is an essential preventive tool that involves a step forward in territorial planning, in a practical approach. This strategy could be transferred to similar regions with similar characteristics and vulnerabilities. The cost of its implementation will mainly depend on the available cartography. It was also awarded with the IV European Planning Award in 2002.

The main problems in the Region of Valencia are related to the foreseeable changes in the coastal dynamics and the increase of the mean sea level (MSL). The increase of MSL will mainly affect deltas and confined beaches, while coastal cliff areas do not seem to face particular risks. With maximum projected increases of 0.5 m, the most threatened low-raising coastal areas are not located in the Region of Valencia. Impacts may be specifically significant in ports due to sea level rise and the modification of other climate-related parameters.

Objectives

- To develop a preventive action against floods based on an action programme and consequently, to better orientate the investment policies.
- To obtain the actual and future impacts produced by floods.
- To try to reduce these floods levels to acceptable ones.

Methodology

The methodology used is summarized in the Figure 2.4.2-4 below:

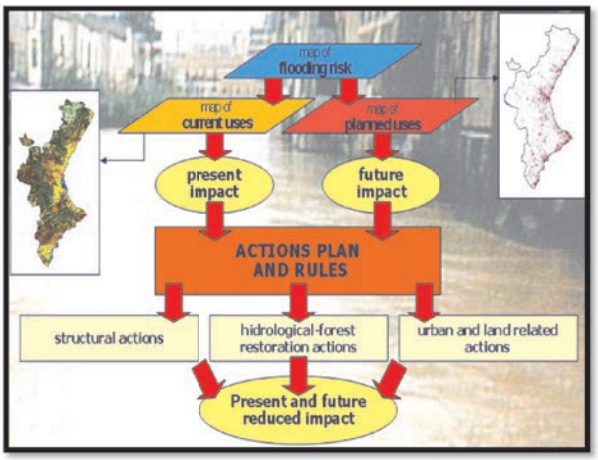
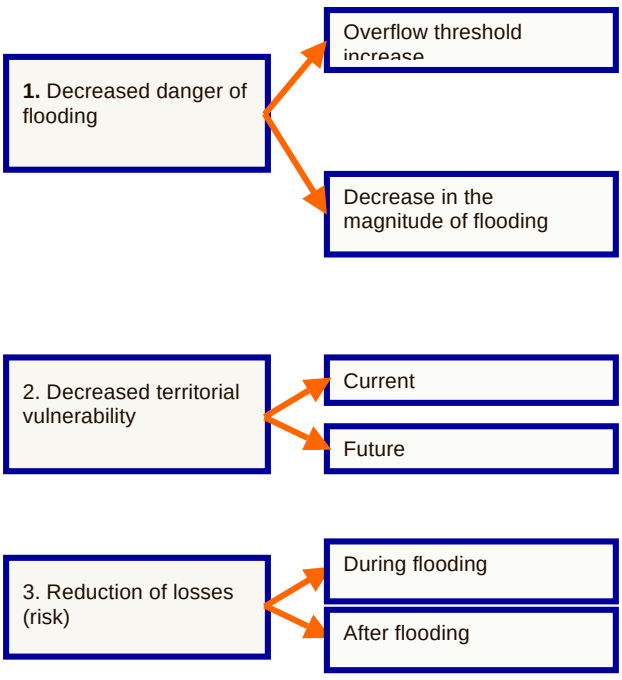


Fig. 2.4.2-4: PATRICOVA Methodology, (Source: Regional Ministry for environment, water, urban planning and housing, Regional Government of Valencia, 2003)

The proposed actions in the Action Plan are divided into 3 measures, as indicated in the figure below:



- dikes, walls and motes
- channeling
- bypass flow
- improved surface drainage
- cross drainage improvement

- reservoirs
- cross dikes
- hydrological-forestry
- correction
- conditioning zones sacrifice

- adequacy of the building
- adequacy of infrastructure
- relocations
- information and signage
- insurance policy
- modification and revision of planning
- territorial and sectoral planning
- anti-flood regulations

- prevention and warning
- emergency intervention
- replacement of normal
- compensation grants, aid
- compensations
- reconstruction plans

Figure 2.4.2-5: Actions defined by the Action Plan (Source: Regional Ministry for environment, water, urban planning and housing, Regional Government of Valencia, 2003)

Hydrological and forest actions:

- Of double nature: risk decreasing and environmental improvements
- 64 actions (16 of high priority).
- € 13.2 million (high priority ones).
- Reducing present impact by 2%.

Urban and land actions:

- Of preventive nature,
- aimed at reducing future impact,
- included in the Plan Rules,
- regulating land use and building requirements
- With no financial cost.

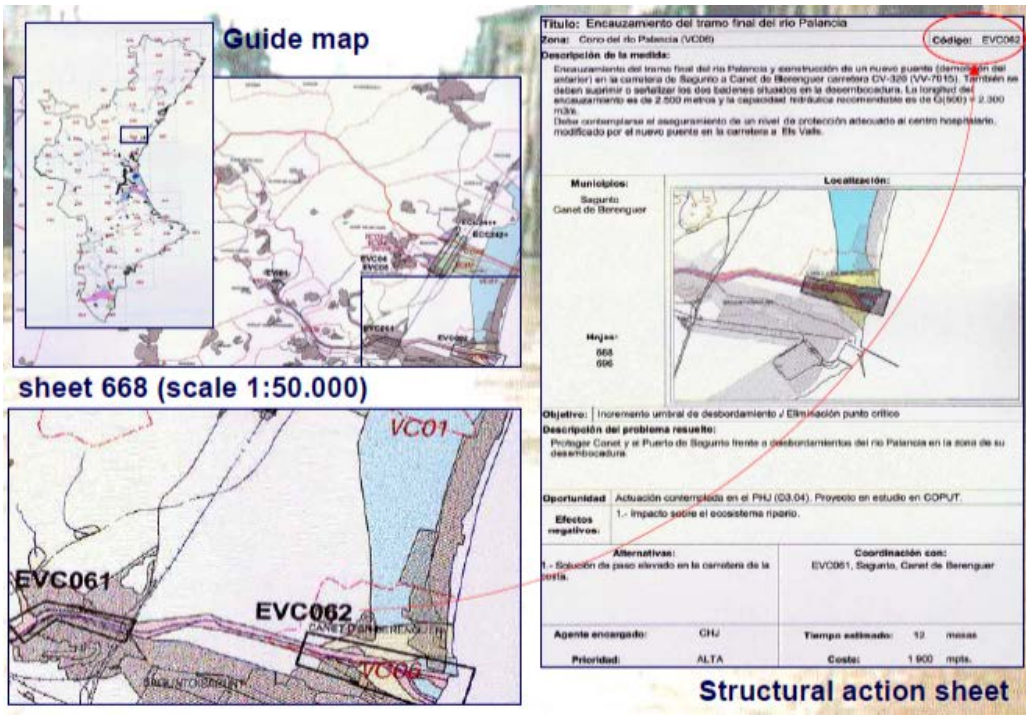


Fig. 2.4.2-6: Guide map and structural action sheet, (Source: Regional Ministry for environment, water, urban planning and housing, Regional Government of Valencia, 2003)

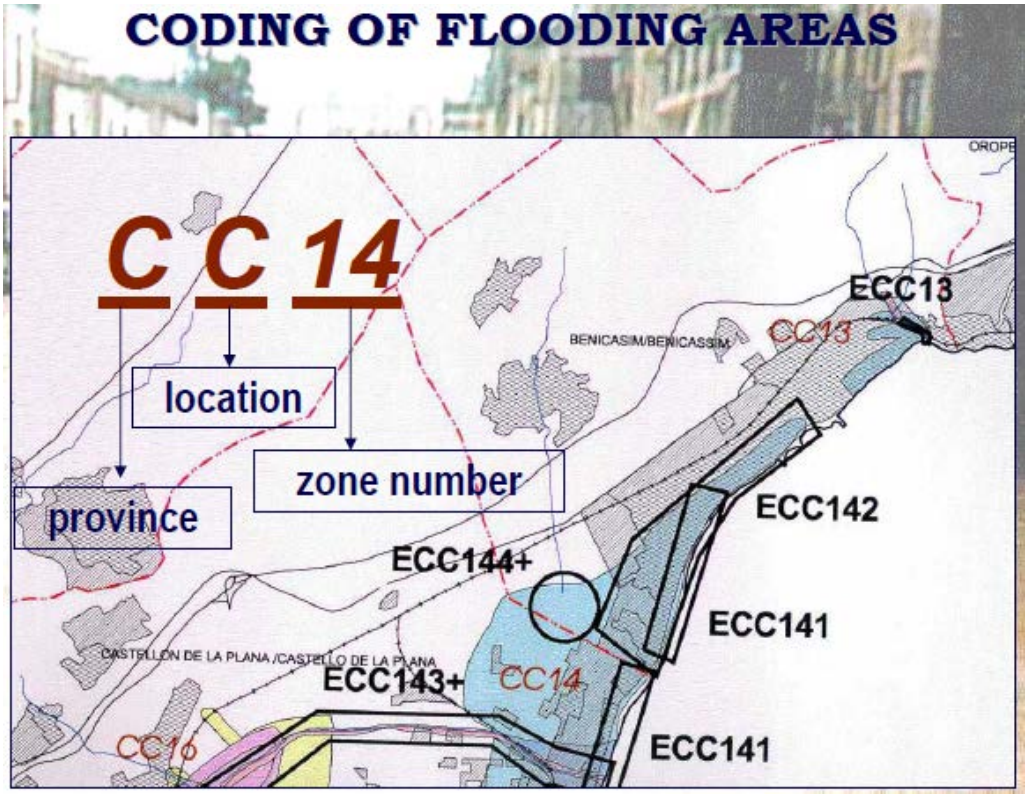


Fig. 2.4.2-7: Coding of flooding areas, (Source: Regional Ministry for environment, water, urban planning and housing, Regional Government of Valencia, 2003)

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3. BEST PRACTICES RELATED TO *FOREST FIRES* AND LESSSONS LEARNED

3.1.GREEK best practices on prevention of forest fires: the case of the European project "INCA"

The present chapter summarizes the aims, the methodology used and the results of the European project "INCA", which aimed to offer tools for a better spatial planning to prevention of forest fires.

General information (project description, element of innovation)

The European project "INCA" ("Linking civil protection and planning by agreement on objectives"), implemented in the period 2009-2014, was co-financed by the Civil Protection Financial Instrument of the European Community. It was a pilot project which used a collaborative; output-oriented risk management approach in two hazard cases and three administrative contexts: the city of Dortmund (Germany)/case of floods, the East Attica region (Greece)/case of forest fires and the Lazio Region (Italy)/case of forest fires.

The innovation of the project approach was its methodological approach, the "agreement on objectives" approach. This approach put into practice a structured communication path and a decision-making process among stakeholders that is based on consensus (Fig. 3.1-1). It represented a win-win situation where all involved actors reached an agreement on common goals and committed into actions of risk prevention and mitigation to achieve. The "agreement on objectives" approach is thus participatory and adapts the legal-administrative system to the risk characteristics of the specific territory, by paying particular attention to the spatial planning. On the contrary, the conventional top-down approaches of decision making in the risk management sector are hierarchical and adjust the risk management process of a specific territory to the rigid, often restrictive and fragmented, existing legal-administrative framework. In addition, the "agreement on objectives" approach pays particular attention to the spatial conditions, which usually play a minor role in actual risk management practice.

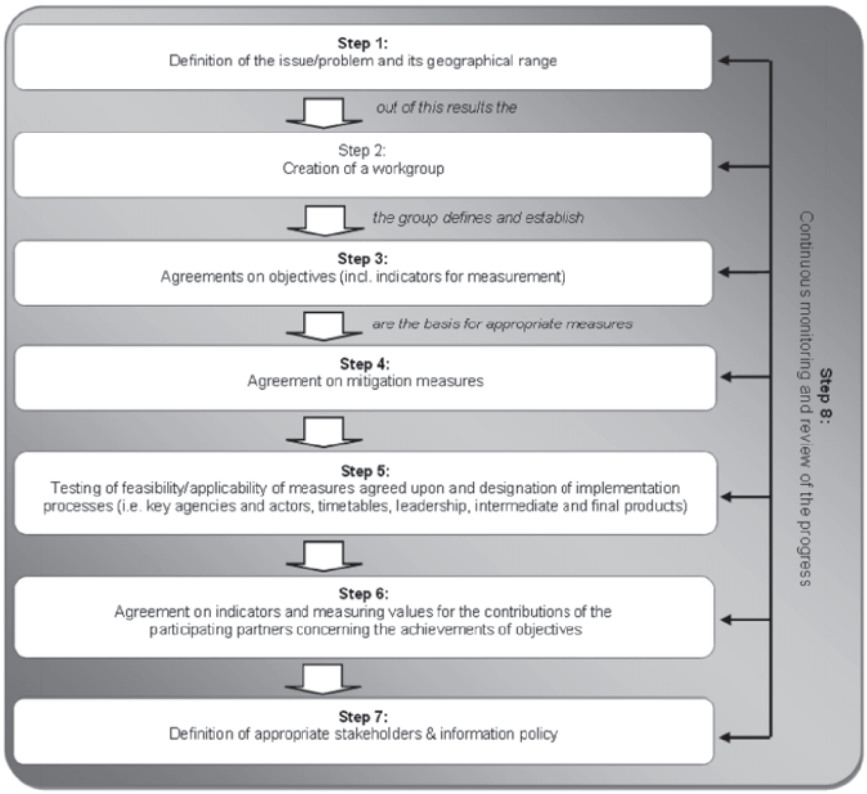

Fig. 3.1-1: "Road map" proposed by the "Agreement on objectives" approach (Source: Greiving S. et al., 2012)

The case study of Attica Region in Greece

The implementation of the "agreement on objectives" approach in the East Attica region (Greece) will be presented shortly: The area was chosen (according to the Step 1/Fig. 3.1.-1) because of the failures documented in its risk management system: Despite the fact that the forest fires are connected to the urbanization and high land speculation of the area, spatial planning has remained absent from the forest fire risk management plans. Moreover, the lack of horizontal interaction among public authorities involved in civil protection is significant.

The implementation of the "agreement on objectives" approach tackled these problems by creating a working group among public authorities and scientists (the three Directorates of the Region of Attica, the Harokopio University of Athens and the Greek Agricultural Research Foundation), according to the Step 2. Four meeting of the working group were organized with the aim to eliminate the risk of forest fires in the region. In the first meeting, the concrete objectives of the reduction of the forest fires and the indicators to be used concerning the achievement of these objectives were defined (Step 3). In the following meetings (Steps 4-7), the working group agreed on the communication channels to be used in order to involve the civil society and other public authorities. Furthermore, the working group agreed

on the concrete measures to implement including the running of seminars for schools and the creation of a geo-data base to support spatial planning. Concrete indicators to measure the efficiency of measures taken were also defined and implemented.

In the case of measure related to the creation of a geo-data base, a field survey of 86 buildings was conducted. The information collected resulted into a thematic map classifying houses and roads in base of the level of vulnerability of residence (Fig. 3.1-2). The results were also communicated to the owners of buildings. The thematic map constitutes a potential tool to be used in spatial planning procedures with the aim to reduce the risk of forest fires. The dissemination results of the projects have been also wide during the project and after its end through its official website.

Fig. 3.1-2: Thematic map with Houses and roads are classified as to the level of vulnerability of residence (T) (Source: Greiving S. et al., 2012)

References:

- Greiving S. *et al.* (2012), Linking the actors and policies throughout the disaster management cycle by "Agreement on Objectives" – a new output-oriented management approach, Natural Hazards Earth Systems Science, 12, 1085–1107
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3.2. ITALIAN best practices to prevention of forest fires: the case of the brochure of the Regional Prevision and Firefighting System, Liguria Region

Education on wildfire prevention is among the best practices of the Ligurian Regional Department. It includes different activities that are aimed at changing people's behavior by increasing their awareness and understanding of the issues. In particular, the Regional Department created a simple, free and user-friendly brochure about prevention of wildfire. The brochure is includes the following thematic information:

a) A resume of wildfire in Liguria region.
b) Information about the regional prevision and firefighting system.
c) Information about the "Save the Forests!" Campaign.

The main points of the brochure per thematic category are presented below:

a) A resume of wildfire in Liguria region

In the brochure, thanks to simple graphs as shown in the picture, it's possible to underline the number of wildfires in Liguria over the period 1987-2012 (Fig. 3.2-1). Showing the negative trend of fires is a simple way to disseminate the importance of the regional forecasting and fire-fighting system.

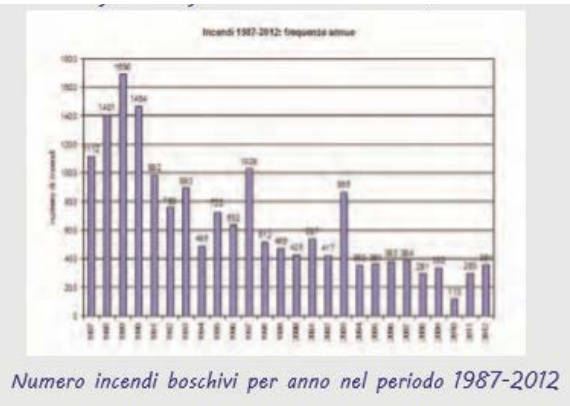

Fig.3.2-1: The number of fires in Liguria over the period 1987-2012: a negative trend (Source: Liguria Region, Agricoltural Assessorship, 2013)

Moreover some maps of wildfires risk are shown (Fig. 3.2-2). Reading maps and images, it can be seen that almost all the territory is covered by forests, even in areas very close to homes. The aim is to emphasize the importance of cleaning the forest to avoid a possible fire right next to the houses.

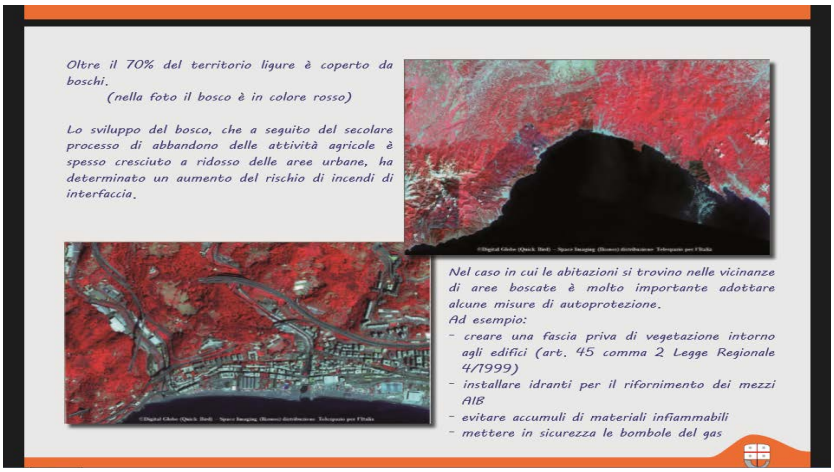

Fig. 3.2-2: Maps of the vegetation: in the picture wood is in red
(Source: Liguria Region, Agricultural Assessorship, 2013)

b) Information about the Regional Prevision and Firefighting System

The forecasting activities in Liguria

For planning prevention activities through active monitoring of the territory of Liguaria, done by volunteers and coordinated by the Firefighting Center (Anti- Incendio Boschivo, AIB), the Daily Bulletin concerning the prediction of the firedanger is used. This document is issued by the Fire Service Forecast of the Liguria Region (Servizio Previsione Incendi Regione Liguria, SPIRL).

The information comes from a complex model that simulates the ignition and spread of fires in Liguria, on the basis of weather conditions, topography and vegetation present and planned in the reporting period. The Daily Bulletin, conveyed through the portal SPIRLWEB, is an essential information tool to support operational decisions, reserved for the staff of the State Forestry Department and the competent regional structures.

The forest fire prevention

In Liguria prevention is accomplished through both direct and indirect interventions. Direct interventions are carried out in the woods and consistmainly in making thinning vegetation, firebreaks, forestroads, water points (for instance, for suction tanks with helicopters and water cannons for the supply of groundvehicles).Indirect interventions consist in the organization of monitoring activities on the part of the teams of volunteers who, with firetrucks, are alerting the system and can act quickly on outbreaks sighted. The Liguria Region supports prevention activities both through its own funds and the E.U. structural funds.

Voluntary prevention of forest fires

Units of volunteers coordinated by the State Forestry intervene in the actions of

extinguishing forest fires. Volunteers are people who, in a spirit of selflesness and love for their land, provide an essential contribution to the prevention and active fight against forest fires. The volunteers specializing in extinguishing forest fires must be properly trainined and equipped with appropriate personal protective equipment as well as work in team. The volunteers participate in the activiites of forest fires completely free of charge.

To become an operative volunteer for firefighting is necessary to:

- pass the medical examination of fitness;
- attend the basic course (planned and financed by the Region of Liguria and organized by local authorities or volunteers), and
- have the personal protective equipment.

The organization of regular exercises improves the efficiency and effectiveness of local intervention and the operating agreemen between the volunteer and the civil protection authorities.

The actions for the prevention of fires and the support of the firefighting volunteers are also supported through the financial resources of the Region of Liguria.

The Liguria Region provides the service of fire suppression through the use of two helicopters operating throughout the year. The Liguria Region purchases the vehicles used in the operations of prevention and firefighting, assigning them to the municipalities and the volunteer organizations. Regional system of reporting forest fires. The regional system of reporting forest fires in Liguria region is illustrated in the the following Figure 3.2-3.

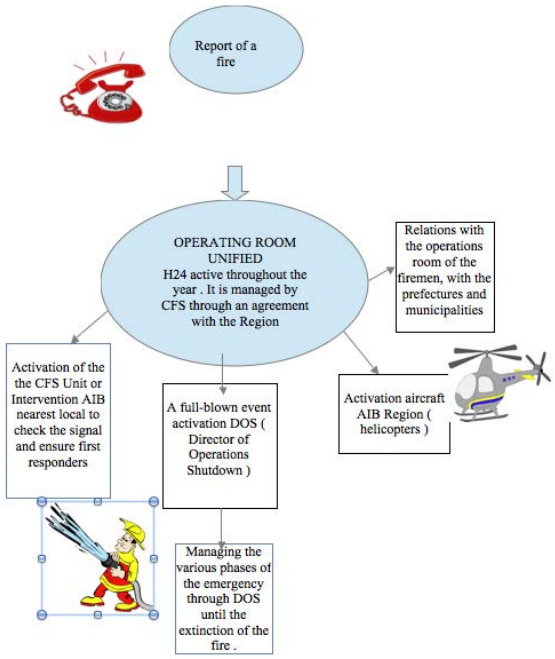

Fig. 3.2-3: Regional system of reporting a fire
(Source: Liguria Region, Agricultural assessorship, 2013)

c) Information about the CAMPAIN (Save the forests!)

The Liguria Region, with the collaboration of highways company of Italy has launched the campaign “Save the Forests!” (“Diventa un Salvaboschi!”). The campain aims to the provsion of information and the awareness-raising for the prevention of forest fires along the Ligurian highway network. It invites the motorist and his traveling companions to respect, the rules of the road, including those of defending forests.

Several brochures (translated also into English) spread to the public (even among tourists and foreign residents staying in the Ligurian region) techniques and tips for the prevention and protection against forest fires. A membership card with the contact number of the Regional Prevision and Firefighting Service is given to every person who takes part in this imitative. The card is a symbolic membership that aims to involve citizens in the fight and forecast fires and especially in making the citizen more aware of the fact that forest is essential for everyone (Figure 3.2-4).

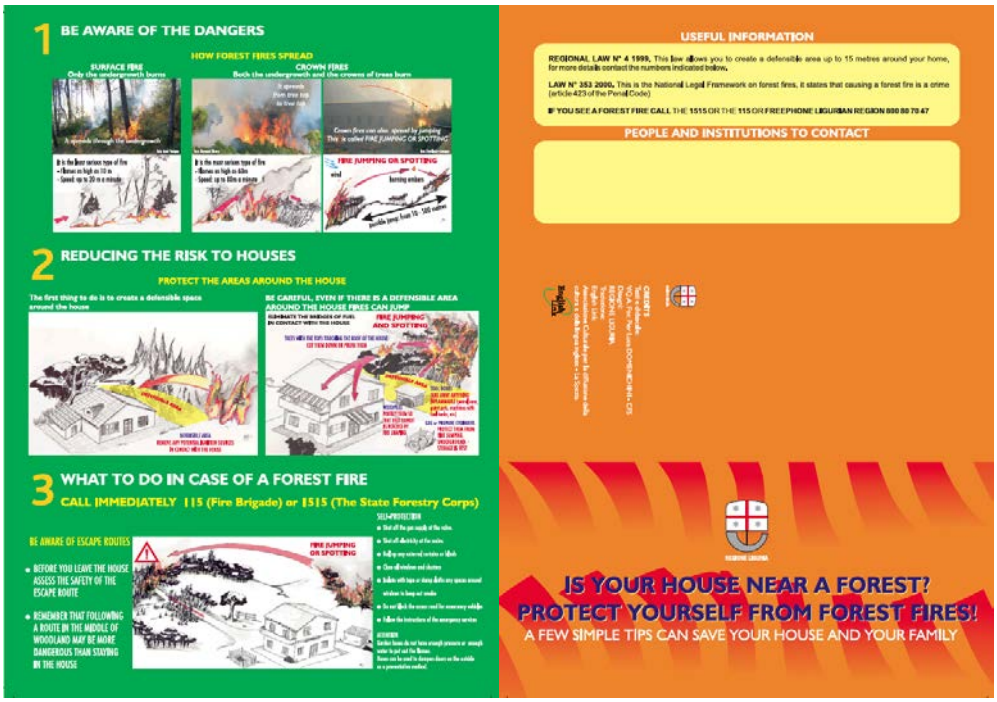

Fig. 3.2-4: Membership Card and brochures of the "Save the Forests!" Campaign, (Source: Liguria Region, Agricultural Assessorship, 2013)

References:

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3.3. BULGARIAN best practices on forest fires

3.3.1. Best practices on prevention and response to forest fires: technological systems used

The present chapter presents the technologically advanced systems used in Bulgaria to prevent and monitor forest fires. More specifically, it presents the monitoring system of forest massifs of the Sofia Municipality (sub-chapter 3.3.1.1), the Riskwatch system (sub-chapter 3.3.1.2) and the RiskMan multi-user web-based system (sub-chapter 3.3.1.3).

3.3.1.1. Monitoring system of the Sofia Municipality

As indicative example of good practices in prevention of wild fires we could point out the system for monitoring of forest massifs in the mountains around Sofia that was built up by the Sofia Municipality. There are 5 towers, 25 m height, on which there are cameras with range of 5 km. Special software command the rotation of the cameras in every 5 minutes (Fig. 3.3.1.1-1).

Fig. 3.3.1.1-1: The video-control centre of Sofia Municipality, 2016, Nadya Krasteva, (Source: www.cio.bg)

The picture provided by the cameras, mounted on the towers, is being translated in real time to the Municipality's Center for video monitoring. In the moment of fire identification the sound signal starts. The duty operators in the Center are able to direct the cameras. This technology shortens the time for reaction and prevents abuse of the emergency phone number, because every signal could be instantly checked. Often citizens are able to see smoke, but are notable to locate the fire.

This system is able by itself to locate the exact coordinates of the fire. Along with this the system allows to predict how the disaster will go on, because it has certain sensors installed for velocity and direction of wind; humidity; atmospheric pressure and air temperature.

3.3.1.2. Riskwatch

Riskwatch is a system (aggregator), which monitors continuously, filter and extract news from 20 Bulgarian news sites for disasters happened on the territory of Bulgaria. The system uses RSS technology (Really Simple Syndication), which is a software mechanism for exchanging news between two sites or between site and user. Riskwatch is a fully automatic system that uses artificial intelligence methods. As with any fully automated system, thus in Riskwatch exists a potential possibility of inaccurate assessments of the events (Fig. 3.3.1.2-1).

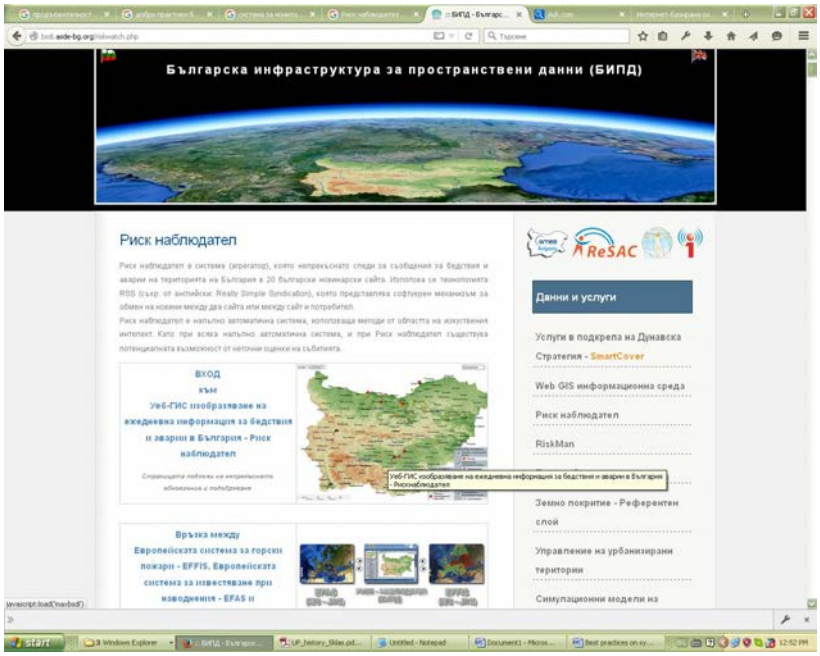

Fig. 3.3.1.2-1: Screenshot of the main page of the website of Bulgarian Spatial Data Infrastructure, 2016, (Source: http://bsdi.asde-bg.org/)

References:

- Bulgarian Spatial Data Infrastructure, Website: http://bsdi.asde-bg.org/

3.3.1.3. RiskMan

RiskMan is a multi-user web-based system with different access levels enabling registration, data collection, visualization, and use of data and analyses provided through the RkFMEA method for risk assessment, monitoring and preventive resource management of risk. The system is developed under the project of the Executive Agency Electronic Communication Networks and Information Systems in the Ministry of Transport, Information Technology and Communications of Bulgaria (Fig. 3.3.1.3.-1).

RiskMan system allows the collection and compilation of data by areas of risk and tendency to change the risk after happening of different crisis events such a floods, forest fires, earthquakes, landslides, drought, etc. The data collected for areas of damage and maintenance of technica lequipment (such as bridges, dams, reinforcements, etc.) are summarized and automatically the system calculate the risk factors of certain disaster for a mayor, municipality or district. The results are used to produce maps of the risk of disaster for the territory.

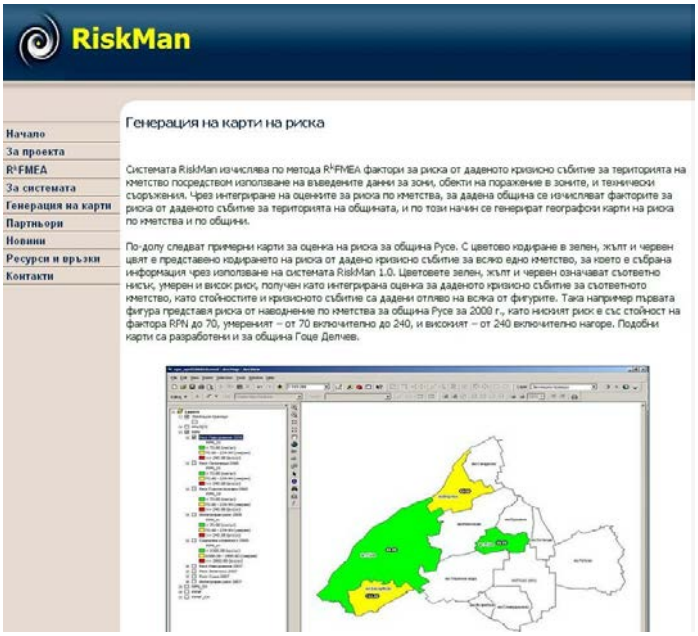

Fig. 3.3.1.3-1: Screenshot of the RiskMan project's web page, 2010

References:

- RiskMan Official Website: http://www.riskbg.org/

3.3.2. Best practices on response to forest fires: the case of the common emergency telephone number 112

Bulgarian national legislation integrates into practice European experience and traditions. Civil protection prevention, preparation and response have been spelled out on three levels: the central, the regional and the local.

Common emergency telephone number 112

Serious positive effect has occurred since the introduction of the common emergency number 112, and the creation of the Unified Rescue System. On the one hand, via the emergency signal, fire alerts are automatically transferred to all the institutions that are relevant. This seriously shortens the reaction time. Good practice is that there are included the duty in the municipal administrations, which can quickly enforce municipal plans for response in case of a major fires, as well as to mobilize the resources of people and equipment.

Moreover, good practice is also created after the creation of the Volunteer Formations in 2011. In some municipalities (Sofia, Plovdiv etc.) the voluntary formations pass through special training under the Chief Directorate Fire Safety and Civil Protection. The volunteers were actively involved in all disposal activities over the last 4 years (Fig. 3.3.2-1).

Fig. 3.3.2-1: The firefighters in an wildfire, 2011,
(Source: www.desastresnaturalesohumanos.wordpress.com)

3.4.SPANISH best practice to forest fires

The present chapter presents the fire prevention campains implemented by the Spanish organization Asociación de Voluntarios de Emergencias y Catástrofes (VEC, Association of Emergency and Disaster Volunteers) in the Region of Valencia, in Spain.

The Association of Emergency and Disaster Volunteers (VEC) is registered in the Home Office's National Registry of Associations with number 586222, Civil Protection section. The association has participated in several fire prevention campains of the Valencian region.

References:

- Asociación de Voluntarios de Emergencias y Catástrofes (VEC, Association of Emergency and Disaster Volunteers), Website: http://www.iae.org.es/

Background information

The anthropic factor is key in explaining the forest fire phenomenon in the Mediterranean basin. The weather conditions, the neglected rural areas and the urban population's irresponsibility with fire create a perfect scenario for this type of phenomenon that results in deforestation and lost land in these areas.

The increased recreational use of forest areas, along with the urban population's lack of criteria in using, enjoying and caring for forests, endangers the survival of this natural resource.

On the other hand, the traditional practices (burning stubble or the accumulation of stubble in agricultural land plots) of the few local farmers that remain or of part-time farmers (from urban areas), the progressive abandonment of farmland (which

helps keep forest fires from advancing) and the neglected maintenance of the sides of roads, paths, and country roads increase the risk of fires and the size of the area affected by them.

As a result, it is extremely important to train and inform the individuals who use natural spaces and forest areas.

Through a call for aid that is published before the beginning of summer, when begins campaign to prevent forest fires, the Government of the Valencian Region aims to support groups, associations and local entities to conduct their fires prevention work (through the financial contribution for transport, lodging, awareness-raising events, etc). In addition, the Valencian Body Conselleria, Habitatge i Medi Ambient, coordinates the wildfire prevention activities of existing entities in the territory.

3.4.1. The fire prevention campaing of the Sierra Calderona National Park, 2012

The case of the fire prevention campaing at Sierra Calderona National Park in 2012 is presented shortly as follows. Inspired by the Word Health Organization's famous slogan "An ounce of prevention is worth a pound of cure," the campaing borrowed these words in order to inform the users of the forest areas about the importance of not leaving marks on the ecosystem that needs to be conserved.

Main objective

To interact with people (agents of the rural world and visitors of the Sierra Calderona Natural Park) with the aim of increasing awareness of forest fire prevention and providing them with guidelines on the appropriate and safe use of forest resources.

Specific objectives

- To increase the population's awareness of the serious environmental consequences of forest fires.
- To highlight the close dependence of humans on the sustainability of human resources.
- To promote active attitudes aimed at protecting the environment.
- To promote active attitudes aimed at preventing forest fires.
- To promote the safe use and enjoyment of our natural surroundings.
- To promote training in the area of citizen self-protection so residents may resolve/avoid risky situations related to forest fires.
- To involve the population in resolving and managing the environmental issues caused by forest fires.
- To encourage participation in the information, surveillance and control campaigns carried out in our natural surroundings aimed at preventing forest fires.

Informative strategy

The purpose was to inform the rural population and urban visitors of the preventive actions aimed at eliminating or minimizing the risks associated with using, managing, and enjoying forest areas, and to take the necessary precautions that ensure the sustainable use of the forests.

Campaign's specific objectives per target group

a) For users who carry out leisure activities in the National Park.

- To encourage/promote positive behaviours for conserving the ecosystem.
- To encourage/promote preventive behaviours related to the cause of forest fires.
- To encourage/promote preventive behaviours regarding the activities carried out in natural settings.

b) For users who carry out economic activities in the National Park.

- Preventing forest fires.
  - Regulating, restricting and controlling agricultural burning.
  - Regulating, restricting and controlling the use of dangerous machinery.
- Promoting a commitment to conservation.
  - Promoting sustainable practices in the area of preventive silviculture.
  - Cleaning the sides of roads and paths.
  - Maintaining infrastructures for watering: irrigation canals, ponds, watering holes, etc.
  - Maintaining the land: steep banks. Country roads and paths, etc.

Informative brochure

A three-panel brochure was created (Fig. 3.4-1) and distributed to the Natural Park's users. The brochure promoted preventive habits and safety for the activities that are carried out in Sierra Calderona Natural Park. It was accompanied by information about the park's ecological, landscape and ethnological values (recommended routes).

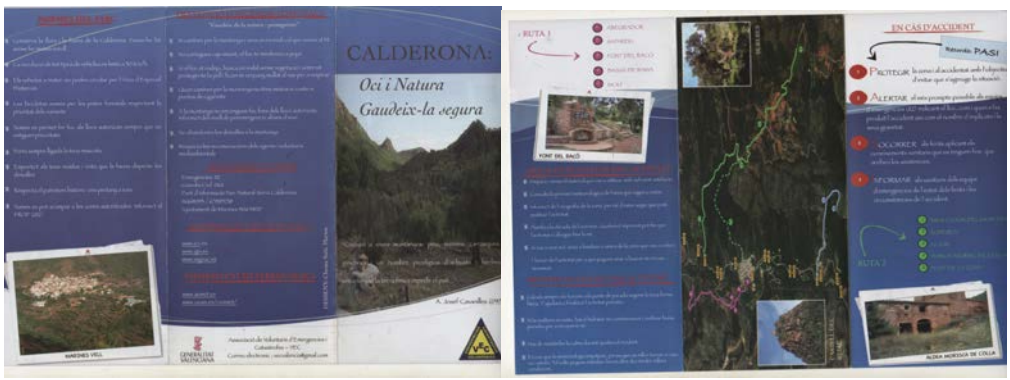

Fig. 3.4.1-1: Informative brochure entitled "Calderona: Oci i natura. Gaudeix-la segura" (Source: VEC, 2012)

Campaign support

The campain was funded by the Government of the Valencian Region (Departments of Environment and Education) in collaboration with companies such as Aumar, la Caixa, etc. The campaing was also supported by other entities and implemented along with other similar campaings, such as the following:

- "We can prevent it" campaign, Generalitat Valenciana – AUMAR.
- "Fire prevention is in your hands" campaign, Generalitat Valenciana – CAM.
- "Good environmental practices" campaign, Generalitat Valenciana – La Caixa.

3.4.2. Forest surveillance in the Siera Calderona-West Natural Park, 2012

The present chapter presents the forest surveillance and fire prevention projects in the Sierra Calderona Natural Park (Los Moriscos Route), in the municipalities of Olocau, Marines and Gátova, in Spain. The project was funded by the Government of the Valencian Region in collaboration with the Local Municipalities, and several other public and private bodies, volunteers, etc. It was implemented in 2012.

Human resources

Most of the volunteers who participated in this project were members of the Municipal Group of Civil Protection Volunteers of Valencia and Pobla de Vallbona. This means that they had completed training in a variety of areas (citizen services, communication, life-saving and first aid, emergency driving, rescues, psychological assistance, etc.) and hadextensive environmental surveillance experience in Sierra Calderona (Sierra Calderona Natural Park, La Manguilla Park) as well as in the El Saler Natural Park and the Moratillas forest area. They also had experience in forest fire prevention campaigns under the coordination of Civil Protection, the Association of Emergency and Disaster Volunteers, the Vicente Blasco Ibáñez Foundation, etc.

The Valencia Group combined this activity with the PREVIFOC-SALER 2012 Campaign by participating in the environmental surveillance of El Saler Natural Park as part of the operations designed by the Valencia City Council.

Participation in the project was open to all citizens who have the time and the commitment for the surveillance activities.

Project's specific objectives

- Information and control of visitors at areas.
- Surveillance and control of sensitive areas in the Natural Park for the matters pointed out.
- Training volunteers and collaborators in the values of environmental sustainability and knowledge.
- Coordinating with other organizations and entities involved in Forest Fire Prevention, Control and Extinction efforts in the Natural Park.
- Coordinating auxiliary nature conservation and sustainability tasks with other socio-cultural entities in the municipalities.
- Awareness campaign for using and enjoying the Park in a safe manner that is respectful of the environment.

Preventive actions

- Volunteers provided information, control and surveillance services in a variable shift schedule involving two to three people. Volunteers travelled to the surveillance area in a four-wheeled motor vehicle. They always travelled along paths and ravines by foot (to prevent their deterioration) or by bicycle (when possible).
- The regular service hours of volunteers were in morning and afternoon schedules, although the environmental agent may requested additional hours at other times, depending on availability.
- Each shift consisted of an average of eight hours between 9:00 a.m. and 9:00 p.m.
- The following Info day took place taking into account tke risk and availability. Depending on availability, days may be substituted during the same period, with a minimum of 30 days between 1 June and 15 September 2012.

April (3 days)
Saturday the 14th, Sunday the 15th and Monday the 16th

June (11 days)
Saturday the 2nd, Sunday the 3rd
Wednesday the 6th, Saturday the 9th, Sunday the 10th
Wednesday the 13th, Saturday the 16th, Sunday the 17th
Wednesday the 20th
Wednesday the 27th, Saturday the 30th

July (10 days)
Sunday the 1st
Saturday the 7th, Sunday the 8th
Saturday the 14th, Sunday the 15th
Saturday the 21st, Sunday the 22nd
Saturday the 28th, Sunday the 29th
Tuesday the 31st

August (10 days)
Saturday the 4th, Sunday the 5th
Saturday the 11th, Sunday the 12th
Wednesday the 15th, Saturday the 18th, Sunday the 19th
Saturday the 25th, Sunday the 26th
Friday the 31st

September (4 days)
Saturday the 1st, Sunday the 2nd
Saturday the 8th, Sunday the 9th

Physical resources

The physical resources used for runing these project included the following:

- Conselleria Territori i Habitatge two-way radios.
- Cage for transporting animals.
- UHF-VHF two-way radios (4).
- Conselleria Territori brochure.
- ICV aerial photograph of the Natural Park.
- Fire spades (2).
- Backpack fire extinguishers (2).
- Powder extinguishers, 6 kg (2).
- First aid kits (2).
- Evacuation stretcher.
- Torches (2).
- Vehicles:
  - All-terrain vehicles (2).
  - Regular vehicles (2).
  - MTB bicycles (2).
- Garmin GPS devices (2).
- Monoculars (2).
- Mobile phones (2).
- LCD camera with recording system.
  - One fixed station (Marines Viejo).
  - One possible all-terrain station.

Execution plan

The execution plan consisted of training, informative and preventive actions, as describted in details below.

1. Training actions

- Organization of the conference/course: Volunteers and the environment. Thursday, 17 May 2012. AMVPC Fire Station – Valencia.
- Attendance at the presentation of the training manual for the Forest Fire Prevention campaign. PREVIFOC. Emergency Department – Valencia City Council. June 2012. Estany de Puchol.
- Attendance at the volunteer course organised by the Conselleria de Territori. (Tragsa).

2. Informative actions

- Presentation of the Forest Fire Prevention campaign and the “Calderona: Oci i Natura. Gaudix-la segura” brochure about Marines. 14 April 2012. Marines Viejo-Antic Marines Residents Association.
- Distribution of a brochure with guidelines on the correct use of forest areas and what to do if a fire is detected. Conselleria de Territori.

- Ethnobotanical route in Font de la Salut-Castell del Reial-Font del Frare. 27 May 2012.
- Information for citizens who visit the area, with a special focus on drivers.
- Creation of the "Calderona: Oci i Natura. Gaudix-la segura" brochure about Gàtova.

3. Preventive actions

- Dissuasive in-person surveillance using human resources and vehicles.
- Visual inspection routes. There were two dissuasive and inspection routes (route 1 is done daily and route 2 is done every other day) with the following planned itinerary:
  1. West Route or Route 1 (Puntal de Baix Roundabout, Cavanilles Roundabout on CV-25, Els Puntals, El Campillo, Les Forquetes, Puntal dels Llops, Font del Frare, La Pinaeta, Montes de Alonso CV-25, Pozo Negro, El Real, Huerta de Abajo, El Abrevador, Barranco Tello, Fuente del Tormo, Molino de la Ceja, El Rodeno, La Tejeria, La Chirivilla, La Alameda, Fuente del Rebollo, Los Algepsares, El Rincón).
  2. East Route or Route 2 (L'Arquet (Font del Frare), Racó de Cotanda, Puntal del Roig, Castillo del Real, Els Canyaris, La Poderia, Masía de l'Olla. Gascon Ravine, Gorgo, Tello Ravine, Peñarroya, Fuente del Tormo, Molino de la Ceja, Pico del Águila, El Rodeno, La Alameda, El Rincón, Balsa de Rama, El Abrevadero, Huerta de Abajo, El Quemao, El Real, Pozo Negro, L'Alcalá, La Pinaeta, El Puntal del Llop).
- Vehicle controls: parking and traffic.
- Visitor controls and services.
- Information for visitors and rules for use.
- Control of rules for use and management (agricultural burning, risky activities, etc.).
- Other: As proposed by the environmental agents in terms of the programme and within the areas of responsibility of volunteers.

Indications for forest surveillance volunteers

Certain indications were given to the monitoring groups of volunteers to establish fixed routes to pass by, become visible, inform the population and control and keep zones free so that they won't impede access to means of fire prevention or extinction. These routes were chosen for being the busiest and have breakpoints plus good views for surveillance. During these routes and if the case arises, the indications given are:

1. Call 962759112 to inform the Forest Ranger 112CV of the "Start of West Calderona Volunteer Shif" and request the "Pre-emergency level" for the day (level of allert for forest fire risk)
2. Note the start time and the pre-emergency level on the route sheet.
3. On days with pre-emergency Level 3 (highest allert for forest fire risk), barbecue cooking areas must be sealed off (Figure 3.4-2) and their use is

prohibited along with all other types of fires/flames in the cooking areas (portable stoves, grills, etc.). Inform users. If visitors have lit a fire, ask them to put it out and explain the risk of fire and the ban. If they do not comply, move away and inform the Forest Ranger 112CV so the corresponding authorities may be notified (The Forest Ranger 112CV is the highest authority on forest protection and surveillance who depends directly on the ground volunteers and who knows perfectly the area of action in addition to all protocols and procedures to follow).

Fig. 3.4.2-1: Barbecue cooking areas that have been sealed off, (Source: VEC, 2012) due to pre-emergency level 3 in Sierra Calderona, 2012 (Source: VEC, 2012)

4. Agricultural burning is not permitted between 1 June and 30 September. If smoke is detected, approach the area, locate the fire and inform visitors of the risk and the ban. They must put it out. If they do not comply, move away and inform the Forest Ranger 112CV so the corresponding authorities may be notified.
5. Throughout the day, incidents and the location of volunteers must be noted every 30 minutes.
6. At the end of the shift, call 962759112 to inform the Forest Ranger 112CV of the "End of West Calderona Volunteer Shift".

Informative material

Fig 3.4.2-2: Example of information provided to volunteers that indicate monitoring positions, leisure areas, popular paths, etc, (Source: VEC, 2012)

Fig 3.4.2.-3: Part of lealfet used by volunteers for dissemination and awareness-raising of forest users and visitors, (Source: VEC, 2012)

Fig. 3.4.2-4: Material produced by the forest fire prevention campaing in Comunitat Valenciana, (Regional Governement, 2012)

Fig. 3.4.2-5: Material produced by the forest fire prevention campaign in Comunitat Valenciana, (Regional Governement, 2012)

Fig. 3.4.2-6: Waste along the CV-25 Road, (Source: VEC, 2012)

Fig. 3.4.2-7: Waste in recreational areas, (Source: VEC, 2012)

Fig. 3.4.2-8: Waste in recreational areas, (Source: VEC, 2012)