

# School Emergency Drills Evaluation through E-PreS Monitoring System

A. Kourou, A. Ioakeimidou, V. Avramea

**Abstract**—Planning for natural disasters and emergencies is something every school or educational institution must consider, regardless of its size or location. Preparedness is the key to save lives if a disaster strikes. School disaster management mirrors individual and family disaster prevention, and wider community disaster prevention efforts. This paper presents the usage of E-PreS System as a helpful, managerial tool during the school earthquake drill, in order to support schools in developing effective disaster and emergency plans specific to their local needs. The project comes up with a holistic methodology using real-time evaluation involving different categories of actors, districts, steps and metrics. The main outcomes of E-PreS project are the development of E-PreS web platform that host the needed data of school emergency planning; the development of E-PreS System; the implementation of disaster drills using E-PreS System in educational premises and local schools; and the evaluation of E-PreS System. Taking into consideration that every disaster drill aims to test and valid school plan and procedures; clarify and train personnel in roles and responsibilities; improve interagency coordination; identify gaps in resources; improve individual performance; and identify opportunities for improvement, E-PreS Project was submitted and approved by the European Commission (EC).

**Keywords**—Disaster drills, earthquake preparedness, E-PreS system, school emergency plans.

## I. INTRODUCTION

SCHOOL safety and educational continuity require a dynamic, continuous process initiated by management and involving teachers, students, parents, and the local community. School emergency management includes: Assessment of hazards, identification of vulnerabilities, ensurement of capacities and resources; maintenance of safe facilities, test of emergency plans with realistic simulation drills; and revision of school emergency plan based on the gained experience [1].

The recent experiences with natural disasters demonstrate the need for schools to be prepared for all-hazard crisis possibilities. Children spend a large part of their time in school, so whether a disaster occurs during school hours, before or after school, the school district plays an important role in the disaster management. Also, it is generally accepted that schools provide an important link between children, families and the wider community in preparing and dealing to hazardous events. Educating children about hazards is seen as an effective way to encourage their family members to improve home-based preparedness [2].

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Disasters occur regularly and affect regions in Europe and in Greece as well. Earthquake Planning and Protection Organization (E.P.P.O.) is the National Greek Authority responsible to implement the national policy on earthquake protection issues [3], [4]. E.P.P.O. contributes in the development of school community seismic safety culture and resilience through awareness initiatives addressed to teachers, students, parents, people with disabilities etc. [5]. These initiatives aim to improve the level of preparedness in the school environment planning, so as to reduce the impact of seismic risk. One of these initiatives is the E-PreS project [6] (Fig. 1).

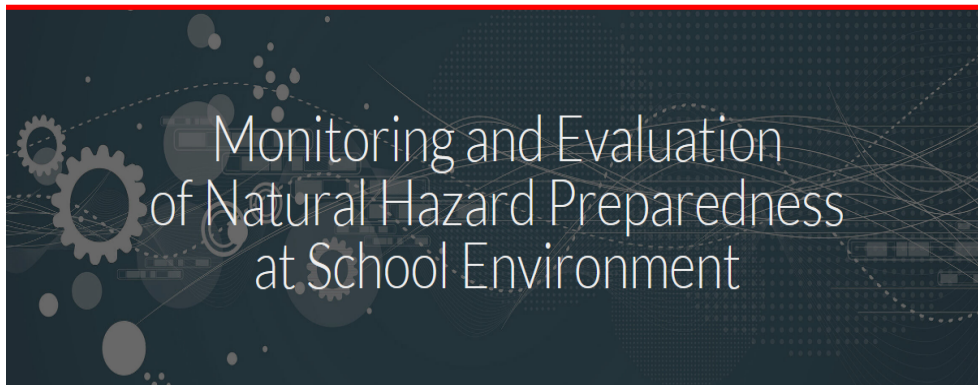
## II. OBJECTIVE-METHODOLOGY

### A. Aim of E-PreS Project and the Partnership

The purpose of this study is to present the usage of E-PreS System that is a managerial tool which supports schools in developing emergency plans specific to their local needs. E-PreS is the acronym of the project entitled: “Monitoring and Evaluation of Natural Hazard Preparedness at School Environments” which is co-funded by the Civil Protection Financial Instrument of the EC, with duration of two years.

Coordinator is the Kapodistrian University of Athens and partners are from four countries; Greece (E.P.P.O. and Natural History Museum of Crete-University of Crete), Italy (Vesuvius Observatory), Romania (National Institute for Research and Development in Construction, Urban Planning and Sustainable Spatial Development) and Bulgaria (Centre for Educational Initiatives). The abovementioned partners are experts on civil protection and share their experience and knowledge in the realization of this project.

E.P.P.O. and the other partners participate in E-PreS Project in order to improve the action-planning for ongoing school disaster risk reduction; the implementation of earthquake drills; the involvement of students with disabilities; and the evaluation of school emergency plans etc. The main objective of E-PreS Project is to create smart tools which define, simulate and evaluate in real time all hazards emergency steps customized to the unique district and school. By providing a clear architecture, defining the roles of actors and a common multi-language portal, E-PreS System allows school staff to: insert the necessary spatial data; make an in-field dynamic drill assessment; extract useful conclusions of the evacuation procedure [6].



Earthquakes in Greece and Turkey, floods in central/eastern Europe and volcano eruptions in Iceland and Italy have proven how vulnerable, in such disasters, the modern cities are and have affected many human lives and resources. Disasters like earthquakes, volcanic eruptions and floods occur with no warning and life-protecting actions must be taken immediately. In EU, a huge amount of resources, efforts and actions have been dedicated to the prevention and raising of awareness in the field of civil protection.

Fig. 1 E-PreS Project website

### B. Main Outcomes of E-PreS Project

The main outcomes of E-PreS Project are:

- a. Development of E-PreS web platform; testing the principals' features of the web platform; and relevant evaluation. Two target groups evaluate the platform (partners' staff through tabletop exercises and questionnaires; School Principals through close-form questionnaire);
- b. Development of an in-field dynamic assessment module (E-PreS System). The System tools (e.g., sensing infrastructure, communication, back-end system) facilitate the setup, monitoring and assessment of hazard-related drills in buildings and open, confined areas;
- c. Implementation of earthquake, flood or volcanic drills using E-PreS System in educational premises and local schools in Greece, Romania, Bulgaria and Italy;
- d. Evaluation and update of E-PreS System. Two target groups evaluate the System (partners' staff through tabletop exercises and questionnaires; School Principals through close-form questionnaire).

## III. RESULTS

### A. Needs Analysis and User Requirements

The needs analysis and end-users' requirements are essential to project success. These end-users have been polled about their awareness on emergency planning issues at their educational places and their particular interest in the E-PreS results. The involvement of experts' end users at the first phase of the project was vital to understand what they can expect

from the project's outcome and how they intend to use it to their advantage.

A specific questionnaire of 9 questions was developed and was administered to E-PreS users to assess levels of their preparedness on disaster management, their interest on E-PreS Project issues and also to identify ways of dissemination of the project outcomes. Questionnaires answered by 69 experts were gathered and analyzed. The questionnaires addressed to School Principals, teachers of primary and secondary schools, special needs educators, representatives of local municipality etc.

The 100% of the experts from Greece reported having an emergency school plan and holding earthquake drills every year. Concerning the number of executed annual drills at school, most of responders (42%) declared that they hold 3 drills every year, as defined by the Hellenic legal framework.

The responders' personal perception of drills' efficiency, is in general terms sufficient enough (69%). Concerning the existence of evaluation of executed drills, the large majority of the responders (75%) stated that after each drill an evaluation is followed (what went wrong, what more needs to be done).

The experts' opinion about the usefulness of E-PreS project is very promising. Results revealed that the majority of the responders think that E-PreS outcomes will be very useful (58%).

According to the results of the above mentioned survey, the majority of the responders do hold drills but they claim that the efficiency of these drills is not good enough. It is worth mentioning that even though in Greece many efforts have been done to establish a preparedness status for prospective earthquakes within the school community [7], there are still actions to be taken, and E-PreS comes to fill this gap.

### B. Disaster Drills at Schools

During an emergency situation, life protecting actions must be taken immediately. There will be no time to decide what to do next; everyone must already know how to react appropriately. After a natural disaster, further life protecting actions such as emergency evacuation should be necessary; well trained staff and students will guarantee that these crucial steps are taken as quickly and effectively as possible.

A School Disaster Plan is always a work in process document. It is an indispensable tool for recording and visualizing risks and school resources which help school staff to resolve how to fill the gaps between vulnerabilities and capacities [8].

Earthquake drills are an extremely important part of School Emergency Plan because they improve the skills of school community to respond efficiently in case of an earthquake; help School Principal and staff to evaluate how well all parts of the emergency plan work together and how well the staff and students are trained; offer an opportunity to identify training needs, gaps and vulnerabilities, establish new reflexes; and teach through action and repetition.

All in all, drill is an important component of the continuous “preparedness cycle” to ensure effective coordination during incident response. So, it is obvious that the importance of integrating drills using the E-PreS System into this broader effort of improving preparedness is crucial (Fig. 2).

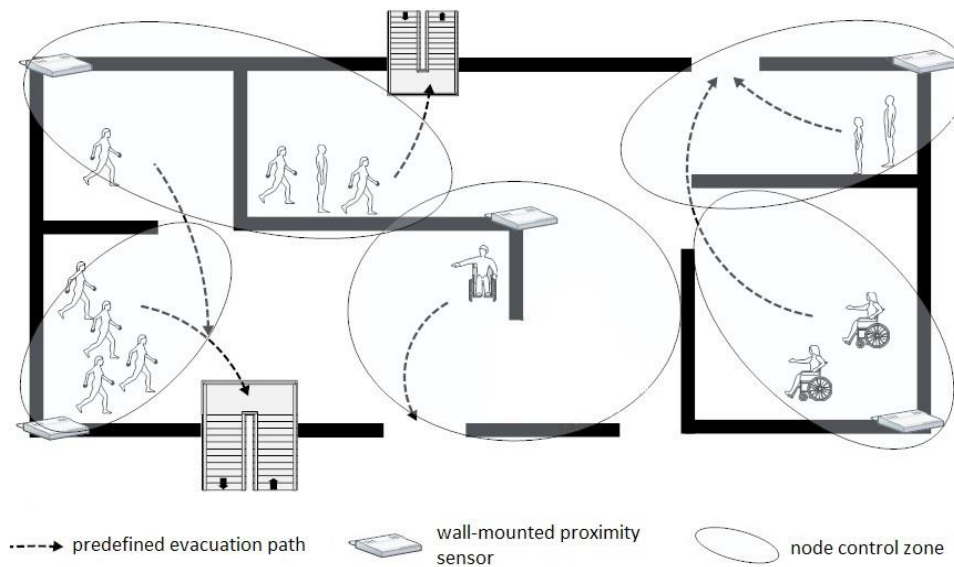


Fig. 2 E-PreS in field dynamic assessment concept

Greek schools and other educational structures, according to the relevant legislation, are required to have earthquake preparedness plans in place. A legal requirement of all Greek schools is at least three emergency drills; one at the beginning of each school year and two more trials during the school year. Drills should be carried out “in accordance with the school’s evacuation plan” [9].

In the framework of E-PreS project, earthquake drills take place in educational premises and local schools in Greece and Romania; flood drills in Bulgaria; and volcanic drills in Italy. These field trials involve the monitoring and evaluation of the E-PreS System during the evacuation process in building facilities. In order to perform the respective trials, the deployment and configuration of E-PreS infrastructure/system in schools and other educational environments is necessary.

It is worth mentioned that one of the most important parameter of a successful school evacuation arrangement is students’ flows. These flows are formed during an evacuation because large numbers of people move simultaneously along common circulation routes in the same direction. During the last decades, researchers have conducted quite thorough studies of the movement parameters of adults and people with

mobility impairments in buildings of various types under normal and emergency conditions [10], [11]. Also, students’ flow movement is defined by kinematic and psycho-physiological relationships, which differ among various route types and is also age determined. From that point of view, it is generally accepted that the standardization of the evacuation process at schools is vital. E-PreS System contributes to the standardization of the evacuation procedure through definition of drill metrics and baseline figures (e.g. the students flux through each emergency exit). After the drill execution, an assessment takes place in order to allow the School staff to pinpoint drill weaknesses, gaps and problems, and take remedy actions to improve the emergency planning [6]. Briefly, an overall view of E-PreS System during the drill is:

- a. E-PreS System takes into account the School Emergency Plan (buildings blueprints, entrances and emergency exits, building evacuation routes, hazardous materials locations, fire suppression equipment locations, etc.). The user (e.g. the School Principal) inserts the needed data (building floor plans, number and position of check points, estimated duration of the drill, flux etc.) to the E-PreS web platform before the drill.

- b. The involved users (teachers and school staff) are familiarized with the System, because they establish it to the school building before the drill.
- c. The actors (students, teachers and other school staff) participate to the drills and the System is monitoring the procedure. More specifically:
  - Floor mounted sensors (RFID readers) are placed indoors (Fig 3). These sensors are deployed in the respective monitored area of interest;
  - The participants carry lightweight wearable sensors that allow interaction between the user and the system. Sensors are easily wearable without any user disruption;
  - Floor sensors allow counting of the flux as the students pass through the checkpoints;
  - The readers sent the information to gateways that collect information and push it back to system (Fig. 4). So, when the drill is kick-started, the system monitors the exact location of involved persons and keeps detailed logs on the training activity (profiler module).



Fig. 3 E-PreS floor mounted sensors



Fig. 4 E-PreS node

### C. Evaluation of E-PreS

E.P.P.O. has defined a four steps evaluation procedure of E-PreS System.

First of all, partners' staff evaluates the functionality, usefulness and ease of use of E-PreS web platform during tabletop exercises. During these meetings, the staff discusses a simulated emergency situation; review problems and gaps; and tests the web platform in an informal, low-stress environment.

Secondly, School Principals evaluate the E-PreS web platform. They insert the needed data of the school in the platform before the drill; and identify strengths and areas of

improvement. It is necessary to take into account their opinion because they are the end users of the System.

Thirdly, after the implementation of the drill, teachers and administrative staff participated in it, evaluate the usefulness and ease of use of E-PreS System.

Finally, School Principals and E-PreS Evaluators evaluate the functionality, adaptability, usefulness and ease of learn or use of E-PreS System. This procedure should result in action plans for continued improvement of the school emergency plan.

### D. Testing and Evaluation of E-PreS Web Platform through Internal Users' Responses

The testing and the first internal evaluation of E-PreS web platform was a necessary step to identify if the System meets, or fails to meet its aim.

A good starting point for the first evaluation of the E-PreS web platform by the project partners was a look at the various principal motives, such as: functionality, system reliability, operation and maintenance ease, measurement accuracy, technology maturity, portability, installation ease, usability and adaptability. The outcome of this evaluation helped the consortium to identify any limitations or problems of this new system. It was essential to get feedback from the users of the E-PreS web platform. E-PreS partners got this feedback about the web platform by tabletop exercises. These tabletop exercises involved key personnel discussing simulated earthquake/volcanic scenarios in an informal setting. The testing of E-PreS web platform through these tabletop exercises aimed to evaluate E-PreS Web Platform; identify weaknesses and determine paths of improvement to become more realistic and complete; obtain participant feedback and recommendations for web platform improvement; increase awareness and understanding of hazards and their potential impacts; adopt E-PreS platform in the emergency plan procedure according to school preparedness needs.

The duration of tabletop exercises depended on the audience, the topic being exercised and the exercise objectives. In our case, the tabletop exercises were conducted in a few hours, so it was a cost-effective tool to validate the E-PreS web platform. More specifically, after the end of tabletop exercises, partners' staff had the opportunity to test the E-PreS web platform alone. Then, each one of the participants filled the specific questionnaire (A). This questionnaire is a short close-form one developed by E.P.P.O. in order to evaluate the various principals' motives of E-PreS web platform, such as: usefulness, ease of use, ease of learning etc. Besides the partners' staff, School Principals and teachers involved with school emergency planning had the opportunity to test the E-PreS web platform and filled the above mentioned questionnaire during the preparation of school drills.

### E. Evaluation of Earthquake Drill Procedure Using E-PreS System

The evaluation of E-PreS System during the drill is very important (Fig. 5). In that framework two closed form questionnaires (B and C) have been developed from E.P.P.O.



in order to evaluate the earthquake drill procedure using E-PreS System. The first one addressed to teachers, administrative school staff etc. that participate to the drills. The second one addressed to whoever is the user of E-PreS System during the drills (School Principals or the teachers responsible for the school emergency planning and the Drill Evaluators), in order to evaluate the E-PreS System.



Fig. 5 School drill using E-PreS System

#### IV. CONCLUSIONS

Emergency planning to be efficient and effective should have a multi-hazard approach and a multi scenarios perspective.

Disaster risk reduction is achieved through public awareness; development of prevention and resilience culture; improvement of population skills and change of behaviors. Effective training methods and proper educational material are necessary components in order to encourage the school community to engage actively in the abovementioned initiatives.

In Greece, E.P.P.O. has stepped up its efforts to build up awareness, increase preparedness, and ensure emergency response of schools and other educational environments, towards the safety and welfare of all.

E-PreS Project provides a framework that enables school personnel to respond effectively to a wide range of incidents. A key challenge that school faces during preparation is the definition of the evacuation procedure that ensures children are kept safe to various disaster scenarios. In that point, E-PreS System is a valuable, managerial tool that contributes to the improvement of school emergency planning taking into account the specific needs of each school.

E-PreS outcomes are: A web platform that gives the opportunity to end users to insert the needed data concerning the school emergency planning (such as: Buildings blueprints, building floor plans, number and position of check points, estimated duration of the drill, flux etc.) before the drill; an in-field dynamic assessment module (E-PreS System) that facilitates the setup, monitoring and assessment of hazard-related drills in buildings and open, confined areas; several earthquake, flood or volcanic drills using E-PreS System in educational premises and local schools in Greece, Romania,

Bulgaria and Italy; and evaluation and update of E-PreS System.

Jumping directly from hazard awareness to response-preparedness skills can reinforce the view that a motivated, well prepared and influential school community is a key to a "culture of safety". It is hoped that the development of the E-PreS System can contribute to the reduction of the disastrous consequences of future earthquakes and/or disaster events at schools.

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