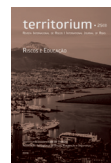




RISCOS



RISK REDUCTION EDUCATION IN PORTUGUESE SCHOOLS: THE EXAMPLE OF WILDFIRES*

EDUCAÇÃO PARA A REDUÇÃO DOS RISCOS NAS ESCOLAS PORTUGUESAS: O EXEMPLO DOS INCÊNDIOS FLORESTAIS

41

Adélia N. Nunes

Departamento Geografia e Turismo, CEGOT e RISCOS, Universidade de Coimbra (Portugal)

ORCID 0000-0001-8665-4459 adelia.nunes@fl.uc.pt

Bruno Martins

Departamento de Geografia e Turismo, CEGOT, NICIF, Universidade de Coimbra (Portugal)

ORCID 0000-0001-8681-2349 bruno.martins@fl.uc.pt

ABSTRACT

In Portugal, wildfires cause huge socioeconomic and environmental impacts. This study aims to understand the contribution of the school to wildfire risk education and to explore how 9th year students rank the risks that affect our country and the municipalities in which they live. The results show that students ranked wildfires risk as the most important risk at national scale and in the area where they live. When asked about the causes, consequences and mitigation measures, most of them found it difficult to identify them. The formal geography curriculum only contained material related to risk reduction education in 2015. However, a non-formal project (PROSEPE - Education and Awareness-Raising Project for School Population), adopted reducing the risk of wildfires as one of its main goals, when it was first established in the 1990s.

Keywords: School Education, wildfires risk reduction, student's risk perception, geography curriculum, PROSEPE, Portugal.

RESUMO

Em Portugal, os incêndios florestais causam enormes impactes socioeconómicos e ambientais. O presente estudo tem como objetivo compreender o contributo da escola na educação para o risco de incêndio florestal e explorar como os alunos do 9º ano de escolaridade classificam os riscos que afetam o nosso país e seus municípios de residência. Os resultados mostram que os estudantes classificam o risco de incêndio como a manifestação mais importante à escala nacional e na sua área de residência. Quando questionados sobre as causas, consequências e medidas de mitigação, a maioria demonstrou dificuldades na sua identificação. Com efeito, o currículo formal de Geografia apenas integrou questões relacionadas com a educação para a redução de riscos em 2015. Em contrapartida, o PROSEPE, um projeto não formal, desde o seu início, na década de 90, adotou como objetivos principais a redução do risco de incêndio florestal.

Palavras-chave: Educação escolar, redução do risco de incêndio florestal, perceção do risco por alunos, curriculum de geografia, PROSEPE, Portugal.

* O texto deste artigo corresponde a uma comunicação apresentada no IV Congresso Internacional de Riscos, tendo sido submetido em 18-04-2018, sujeito a revisão por pares a 18-04-2018 e aceite para publicação em 13-06-2018. Este artigo é parte integrante da Revista *Territorium*, n.º 25 (II), 2018, © Riscos, ISSN: 0872-8941.

Introduction

Several risks have affected the Mediterranean countries of Europe, with significant consequences on the economy and the environment of large areas. Droughts, floods and flash floods (Gaume *et al.*, 2016), heatwaves (Fischer & Schär, 2010) landslides, degradation and desertification (Geist & Lambin, 2004; Evans and Geerken, 2004) and forest fires (Pausas, 2004; Flannigan and Harrington, 1988), are some of the most important hazards that repeatedly affected European Mediterranean countries. Although fire has been an important element in ecosystem dynamics (Pausas and Vallejo, 1999; San-Miguel-Ayán *et al.*, 2012; Nunes *et al.*, 2014; Nunes *et al.*, 2016) and a tool used by humans for thousands of years, nowadays wildfires rank top of all European forest problems, affecting landscape, wildlife, vegetation, soils, water and air quality (DeBano *et al.*, 1998; Certini, 2005; Cerdà and Lasanta, 2005; Miranda *et al.*, 2008; Catry *et al.*, 2010; Malkinson *et al.*, 2011; Silva *et al.*, 2011; Novara *et al.*, 2013; Bodí *et al.*, 2014).

According to the Joint Research Centre (2016), Portugal has the highest relative burnt area of all southern European countries, between 1980 and 2015. Consequently, numerous studies have been addressed to the drivers behind wildfires in Portuguese territory, linking them mostly with climate/weather conditions (Lourenço and Gonçalves, 1990; Pereira *et al.* 2005; Carvalho *et al.*, 2008; Ferreira-Leite *et al.*, 2017) and changes in the landscape mosaic, as a consequence of agricultural abandonment and a marked increase in land covered by shrubs, grass and other light vegetation that is very prone to fire (Bajocco and Ricotta, 2008; Nunes, 2012; Moreira *et al.*, 2011; Oliveira *et al.*, 2012; Oliveira, 2014; Nunes *et al.*, 2016).

The importance of education in promoting and enabling Disaster Risk Reduction has already been identified by researchers and policy makers, and the World Disaster Reduction Campaign for 2006-2007 “Disaster Risk Reduction Begins at School” has resulted in various initiatives worldwide to make school buildings safer and have disaster risk reduction taught in school (International Strategy for Disaster Reduction, ISDR, 2007). The Hyogo Framework for Action (HFA) 2005-2015: Building the Resilience of Nations and Communities to Disasters adopted by 168 Member States of the United Nations at the January 2005 World Conference on Disaster Reduction resolved to ‘use knowledge, innovation and education to build a culture of safety at all levels’ as an action priority.

In Portugal, the National Education Council, via Recommendation no. 5/2011 of 20 October, would recognize that the national approach to risk reduction

and that the assumptions of the Hyogo 2005-2015 are not being respected and implemented. By this Recommendation has the acknowledged schooling through formal education to be an important vehicle for the promotion of risk education. They considered it important enough to introduce subjects relating to the different concepts of risk into the curricula, and are using them not only to communicate information and knowledge, but to also promote action to handle specific types of risk in practice. The final document, denominated Risk Education Framework (RERisco), was only approved in 2015, and includes the most important natural, technological and mixed risks and highlights the importance to “know the concept and the causes”, to “know the main effects”, to “know prevention behaviors and self-protection measures”, from the first year of school to secondary.

In fact, disaster risk reduction education into school curricula aims to raise awareness and provide a better understanding of disaster management for children, teachers and communities (Tuladhar *et al.*, 2014). Mainstreaming Disaster Risk Reduction is about building students’ understanding of the causes, nature and effects of hazards while also fostering a range of competencies and skills to enable them to contribute proactively to the prevention and mitigation of disaster. Morrissey (2007) emphasized the need to increase awareness about disasters among the school population, and the necessity to adjust the contents of plans and programs according to the types of hazards that occur in the region and at the national level.

The main aim of this study is to understand the contribution of school for risk education, particularly the wildfires risk education. To achieve this aim, specific objectives were identified: (i) to context, briefly, the problem of wildfires in Portugal in the European context; (ii) to explore how students of the ninth school year perceive and ranking the spatial variation of some risks that affect our country, on national level and into two municipalities, respectively located in central and northern Portugal, (iii) to assess if the students identify wildfires as the main risk in their municipality of residence, their causes, impacts and mitigation measures; (iv) to discuss the contribution of formal and non-formal education, specifically concerning wildfires.

Material and methods

Wildfires databases

The burnt area recorded yearly for the five European countries were obtained from the European Forest Fire Information System (EFFIS, San-Miguel-Ayán *et al.*, 2012) established by the Joint Research Centre and the

Directorate General for the Environment of the European Commission, the main source of harmonized data on forest fires in Europe. In order to compare burnt areas between the countries, a percentage of burnt area (the proportion of burnt area in relation to the total municipal area) were established to reduce the bias involved in comparing the absolute burnt area per country, since the size of the latter varies widely. Portugal is the smallest with 99 200km² and France the largest 634 801km².

Student Surveys: getting student feedback about risks and wildfires in Portugal

Survey was designed to investigate the perception of natural and environmental risks among students of the ninth school year, residents into two municipalities, Coimbra and Vila Nova de Gaia, respectively located in central and northern Portugal. A total of two hundred students, with an age ranging from 14 to 16 years were inquired, during April of 2017. A final list of 15 risks that ranged in Portugal was identified: Geophysical (earthquakes, volcanoes and tsunamis), climatological (hurricanes, tornados, drought, heat and cold waves), hydrogeomorphological (floods and costal erosion) and environmental risks (air and water pollution, soil degradation, desertification and wildfires).

The applied questionnaire was divided in two main parts. In the first part, the respondents were asked to provide their response about the spatial incidence for each risk at national scale, based on a five point ordinal Likert scale: almost no risk (d1 = 1), slight risk (d2 = 2), moderate risk (d3 = 3), and high risk (d4 = 4) and extreme risk (d5 = 5). In the second part of the questionnaire, the respondents were asked to indicate the main risk that affect their municipality of residence, and to identify the two main causes, consequences and mitigation measures in order to minimise its occurrence. Coimbra and Vila Nova de Gaia, located respectively in the central and northern part of the country, were the selected municipalities. For both municipalities, the mean annual burnt area for the period 1980-2015 was around 1% of the total municipality surface. In absolute values, the differences are, however, significant; for the period of 1980-2015, the burnt areas were, respectively, 11 300 e 6370 hectares for Coimbra and Gaia, whilst for 2005-15 the totals were 5 170 and 1 479 hectares for Coimbra and Gaia, respectively.

Descriptive statistics were used to illustrate the levels of perceived risk according to the percent of responses included in each class of risk. The data was analyzed with aid of SPSS Version 18.0 (IBM Corporation, Somers, NY, USA) for both descriptive statistics and correlation analysis. The differences in risk perception will be shown through a comparison of the different geographic differences.

Formal and non-formal education: wildfires in portuguese schools

A formal education is what students learn in a traditional classroom. It's the organized method of learning being administered by a government body. This formal education must be an institution that's accredited where the curriculum needs to follow the customary standards of academia. The formal geography and natural sciences curriculum guidelines for the third year basic education were analysed since 2001, and are collected from the Directorate-General for Education (Direção-Geral da Educação) of the Portuguese Ministry of Education and Science. The 'official curriculum' is the planned programme of objectives, content, learning experiences, resources and assessment offered by a school.

Although there is no consensus on the concept of non-formal teaching in the literature, it refers to all educational activity organised outside the formal education system, established and designed to serve citizens and achieve identifiable teaching objectives (community groups and other organisations) (Coombs, 1973; Hamadache, 1991; Hoppers, 2006). Using Eshach's (2007) concept as a reference, we can consider the clubs as non-formal educational spaces, as they demonstrate the following characteristics: typically non-sequential content; prearranged experimental activities, despite being flexible, and absence of evaluative tools. Thus, non-formal education practices, which consists in a gathering of educational practices that are not included in the formal system of education were evaluated, particularly related with a national project, adjusted to the students and teachers and structured to preserve the forest and prevent wildfires, carried out since 1993.

Results and discussion

Why wildfires Prevention Education in Portugal?

Over the last three decades, the number of forest fires exceeded half a million ignitions and the total burnt area exceeded the 3 400 000 ha, representing more than a third of the surface area of mainland Portugal. For the period of 1980-2015, Portugal has been the most affected Mediterranean country by fires, with an annual average of 20 ignitions/100 km² and around 1.15% of the total surface burnt. These values showed that Portugal registers 6 times more ignitions when compared with Spain and Italy and 17 and 26 times more than Greece and France, respectively (fig. 1a). Concerning burnt area, the results for the same period demonstrated that the relative area affected by wildfires were 3 times higher if compared with Spain, Italy and Greece and 30 times greater by comparison with France (fig. 1b).

In addition to the recorded values, 2017 was a very catastrophic year for Portuguese territory, with around 500 000 hectares burnt resulting in more than 100 deaths and thousands of injured people.

Student's risk perception: risk rankings by the students

44

The perceived natural and environmental risks to students in Portugal for the 15 hazards considered in this study are shown in the fig. 2, with the hazards ranked according to the percentage of the respondents who indicated that they classification in each risk class. For the students of both municipalities wildfires were ranked as the top of the risks at national-scale. In fact, forest fires registered at the national level a recurrent manifestation especially in the North and centre of Portugal (Ferreira-Leite *et al.*, 2011; Nunes, 2012; Nunes *et al.*, 2016), widely published by the media, making them a high perceived risk. Although the sequence of listed risk are slightly different for both municipalities, the results of the survey yielded strong correlations ($r: 0.946$) between the perceived risk by the students for the national scale.

The fig. 2 synthetizes the results obtained in the second part of the questionnaire, where the students indicate the main risk that affect their municipality of residence, and identify the main causes, consequences and mitigation measures in order to minimize its occurrence. As we can see in the fig. 3a, more than a half of the students consider wildfires as the most important hazard in its municipality. In Coimbra the results are slightly higher when compared with Gaia, which can be explained by the largest burned area, in absolute values, recorded in the last decade. In fact, as Dosman *et al.* (2002) refer regional differences in risk perception may be resulted by a number of factors, such as proximity to the hazard, the nature and type of information sources available. Regarding to the causes and consequences of wildfires (fig. 3 b and c), the respondents also show significant differences between municipalities, with the largest number of students in Coimbra to be able to identify the motivations and the impacts of the fires. Nevertheless, this value is below 50%, revealing the lack of knowledge about how to prevent fires. As regards the identification of mitigation measures, the results are close, and also show the lack of education concerning wildfires risk reduction in Portugal.

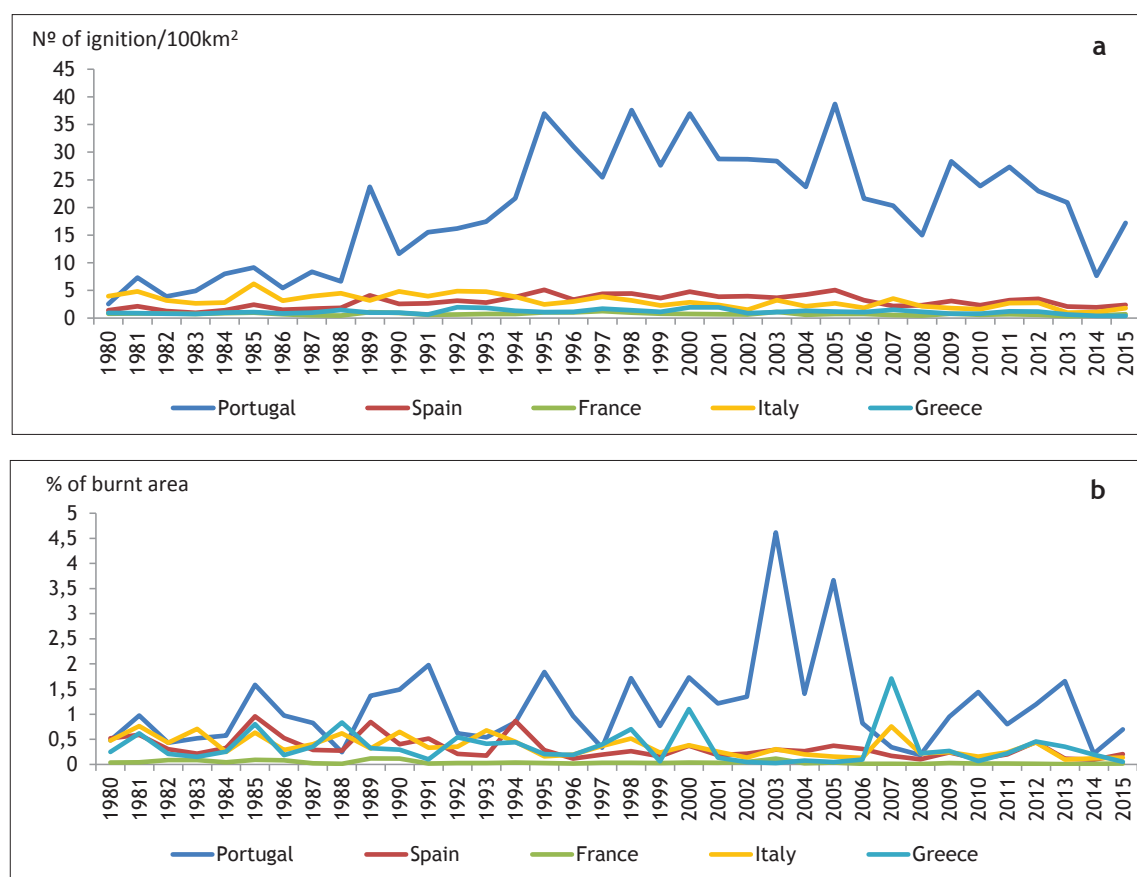


Fig. 1 - Evolução temporal da densidade de ignições (n.º de ignição/100km²) (a) e da área ardida (em %) (b) nos países mais afetados da Europa Mediterrânea (Fonte: <http://effis.jrc.ec.europa.eu/>).

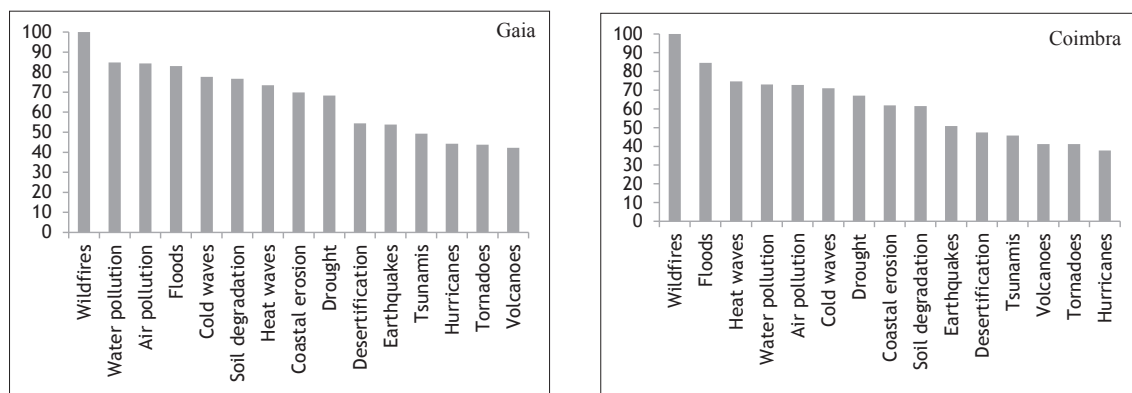


Fig. 2 - Ranking of risks at national level, according to the risks perceived by 9th year students (values normalized to 0-100).

Fig. 2 - Classificação dos riscos a nível nacional, de acordo com os riscos percebidos pelos alunos do 9.º ano de escolaridade (valores normalizados de 0-100).

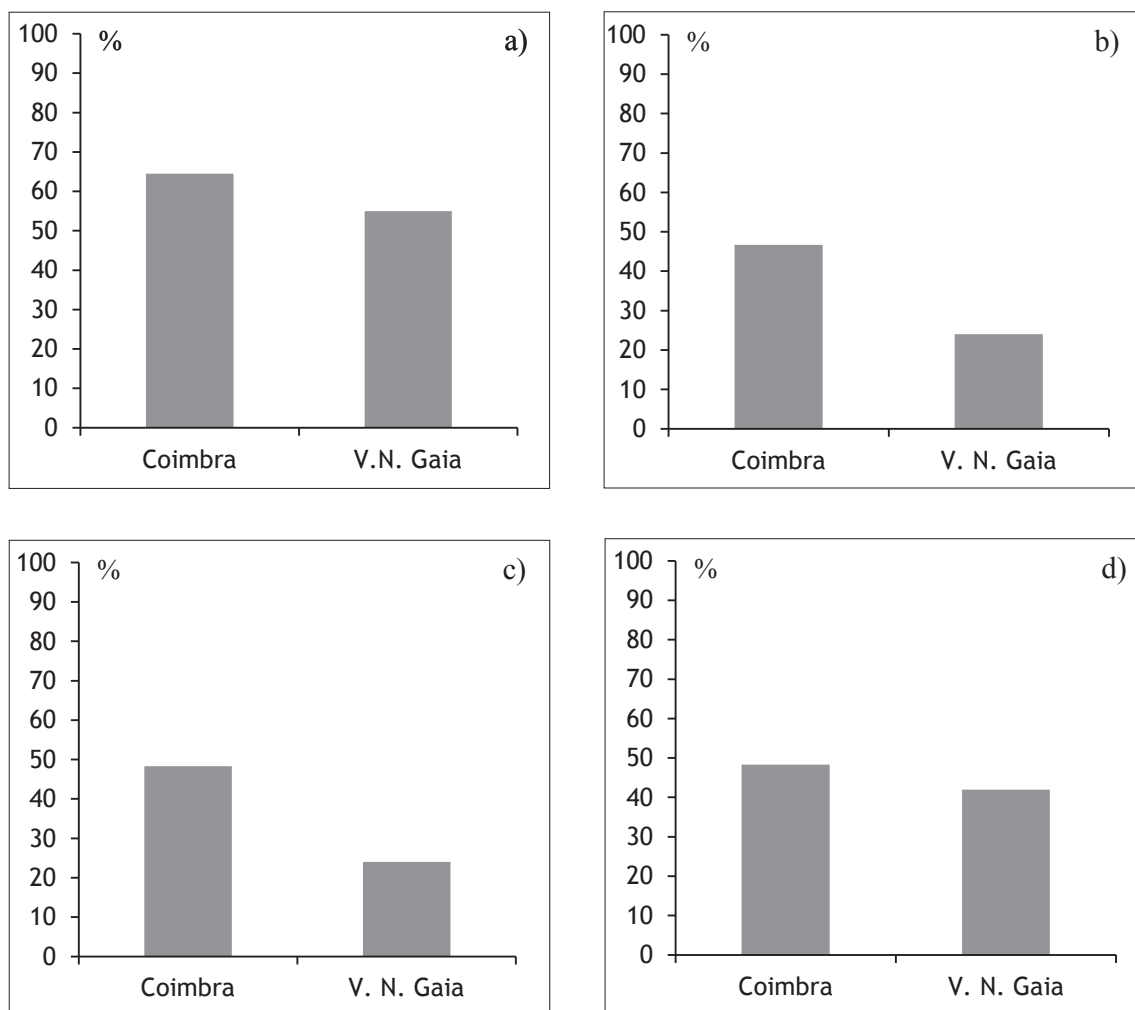


Fig. 3 - How students perceive fires: a) Identify wildfires as the most important risk in its municipality; b) Indicate, at least one, cause of wildfires; c) Identify, at least one impact of a wildfire event; d) Indicate at least one wildfire mitigation measure.

Fig. 3 - Como os estudantes percecionam os incêndios: a) Identificam os incêndios florestais como o risco mais importante no seu município; b) Indicam, pelo menos uma, causa responsável pela ocorrência de incêndios florestais; c) Identificam, pelo menos um, impacte da sua manifestação; d) Indicam, pelo menos uma, medida de mitigação de incêndios florestais.

*Wildfires in school education in Portugal**Formal education*

Several authors consider that geography has a long tradition in the study of natural hazards / natural disasters and vulnerability (Fucsh, Kuhlicke & Meyer, 2011; Montz & Tobin), but more importantly, that geography can respond to the requirements for the prevention and management of natural disasters, it studies space, time, environment, society, relationships and correlations (Hualou, 2011).

The Portuguese geography curriculum guidelines of third year basic education (Câmara *et al.*, 2001), in force during the period 2001 to 2015, do not refer to the problem of forest fires. Cunha (2008) states that, on analysing the contribution of formal education in geography in the prevention of forest fires, that fires in Portugal are not given importance. Tedim *et al.* (2010) has verified, however, after analysing more than a dozen textbooks, that the subject constitutes a topic for analysis in around half of them.

In practice, the suggestions provided by the Geography Curriculum Guidelines (2001) seem visibly insufficient, as they are only directed towards covering the causes and effects of catastrophes, without any reference to illustrating the basic concepts, such as those relating to risk and catastrophe, or the definition of the types of risk (Tedim *et al.*, 2010). The physical and natural sciences curriculum guidelines (Galvão *et al.*, 2001) do not refer to forest fires either, although some textbooks mention them without going into depth (Tedim *et al.*, 2010).

Facing these circumstances, the need to reinforce the less clear aspects of the curriculum guidelines seemed evident, as did the need to adjust and broaden the programme contents and educational experiences in the context of the problem of risks, in this case in particular the risk of forest fire and the protection of the forests. The process would concentrate equally on the prevention of risks and in mitigating the consequences of catastrophes. This content is fundamental to creating a culture of prevention and protection, which could lead to a significant reduction in the negative consequences of manifested natural risks. We should also add that the United Nations dedicated the decade of the 1990s to the reduction of natural catastrophes, emphasising the importance of strengthening risk prevention, mitigation and preparation in order to minimise the consequences of manifested natural risks.

In the geography curriculum targets proposed for year 9 of school, which are being implemented in the 2015/16 academic year, the importance of the forests and the problem of forest fires in Portugal emerge via two general objectives (Nunes *et al.*, 2013):

(i) To understand the importance of the forest on a planetary scale and in Portugal and (ii) To understand the influence of forest fires in the environment and in society. These objectives can be broken down into specific descriptions or objectives, which respectively aim to:

- (i) Explain the principal functions of the forest; Locate the main forest areas on a planetary scale and in Portugal; Characterise the current forest composition in Portugal; Explain the main causes of the destruction of the forest on a planetary scale and in Portugal; Infer the consequences of the destruction of the forest on a planetary scale and in Portugal; Identify measures for the preservation of the forests;
- (ii) Distinguish forest fire from other fires; Identify the natural and human causes responsible for the occurrence of forest fires; Explain the areas most susceptible to the occurrence of forest fires, on a planetary scale and in Portugal; Infer the impacts of forest fires on the land; Recognise forest fire prevention measures.

By establishing a set of fundamental lessons, it enables the students to learn to respond to a range of structural questions on geographical science: Where is it located? Why is it located there? When does it happen? How is it distributed? What are the characteristics? What are the impacts? How is it managed? The search for answers to these geographical questions leads to the need to investigate spatial distribution and the inter-relation of phenomena on the Earth's surface. In practical terms, to live in a 'Risk Society' (Beck, 1992) requires the school to exercise new capabilities that could make a proactive, informed and resilient society possible. The aim, therefore, is for contemporary school geography, alongside the other sciences, to enable students to think critically, so they are able to know, recognise, evaluate and prevent risk, as well as adopt protective measures when risk is presented.

*Non-formal education**PROSEPE: a 20 years project of education towards preserving the forest and reducing the wildfire risk*

The PROSEPE (Project for the Awareness and Education of the School Population), since its beginnings in 1993, has always sought to impart values and educate the population, especially the youngest, in the preservation of the environment, with particular emphasis on the promotion and preservation of the forest (Lourenço *et al.*, 2012; Nunes *et al.*, 2014). It has adopted as its principal objectives the defence of the forest and reducing the risk of forest fires. The development of this project within the school setting, albeit in non-formal learning contexts, was accomplished through the creation of "forest clubs", incorporating primary to

secondary schools, going beyond basic education where it proved dominant, to technical professional education and even special education.

Over the more than two decades that PROSEPE has been active (1993/94-2015/16), more than 700 forest clubs were founded on a national level (fig. 4a), among which the districts of Braga, Leiria, Aveiro, Porto and Coimbra stand out with the highest numbers (fig. 4b). This higher number of clubs in the districts/municipalities located north of the River Tagus and in the Algarve is due to the greater incidence of forest fires in these territories and the need felt there to promote measures to bring awareness to the school population.

However, the number of clubs active during this period was very unequal, reflecting the greater support given to the project by the central political power, that is the Ministries for Education, Internal Administration, Agriculture and Environment, in the first phase, that is until the 2001/02 year. From this point on, the support became less and was not delivered on time, and in recent years has become inexistent, null, which, together with changes to the teaching profession, explains the development there.

The academic years between 1999/00 and 2002/2003, with more than 300 participating schools (fig. 4), stand out as being those which truly corresponded to the project's objectives, as in each of these years, close to 15 thousand students worked weekly in the project and indirectly in the respective schools, bringing awareness to more than a million youngsters. Structured in triennial cycles, each one has an overarching theme and specific subtopics for each academic year (fig. 5), which were developed by teachers and students according to an annually approved plan of activities.

As well as the activities that take place weekly in the context of the relevant subtopic for each academic year, the forest clubs also participate in traditional PROSEPE activities, such as the commemoration of "Native Forest Day", "PROSEPE Day", "World Forest Day" or "World Environment Day", or holding the "Forest Olympics", with a "Schools" phase and then a "National Final", alongside other varied activities. For example, collecting and then sowing seeds, maintaining a greenhouse and existing plots within the school space and the Forest Park, outside this space, the practice of the three Rs, etc., are also promoted in a non-formal school environment.

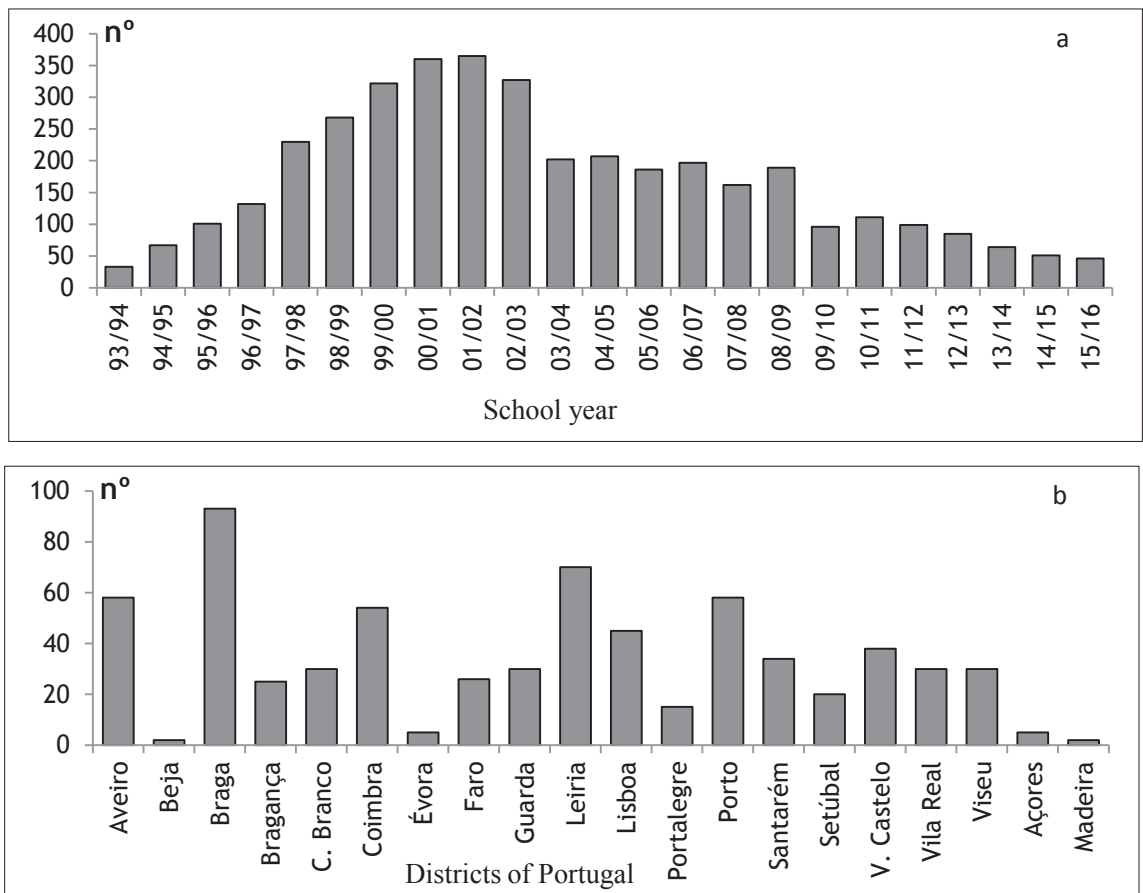


Fig. 4 - Annual trend of the number of Clubes da Floresta (Forest Clubs) in the period 1993/94 to 2015/16 (a) and their distribution by district (b).

Fig. 4 - Evolução anual do número de clubes da floresta, entre 1993/94 a 2015/16 (a) e sua distribuição por distrito (b).

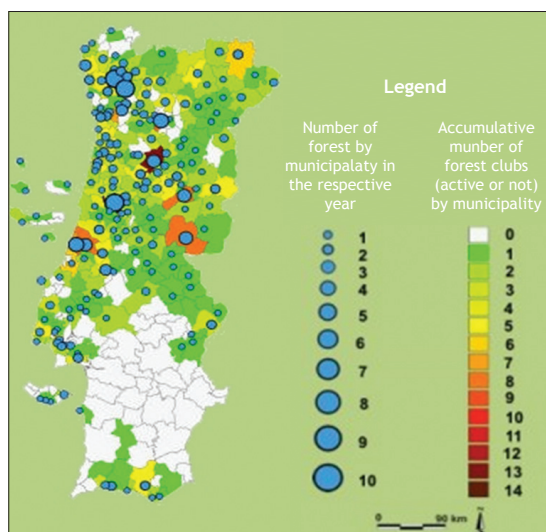


Fig. 5 - Spatial distribution of the schools associated with PROSEPE, in the 2002/03 academic year.

Fig. 5 - Distribuição espacial das escolas associadas ao PROSEPE, no ano de 2002/03.

As it concerns an educational project, training teachers was, equally, acknowledged as one of the essential pillars for sustained teaching of forestry education to the school population, as over the years, different training activities had been developed, in which geography teachers were dominant.

As an example, between 1993 and 1996, six “Pedagogical Meetings on the Risk of Forest Fires (EPRIFs)” took place in different cities across the country, which 1900 teachers attended. In the 1996/97 academic year, the second set of educational activities took place in different regions, called “Prevention of Forest Fire Days (JOPREFFs)”. Around 1000 teachers participated in a total of 16 events. The following decade the “National PROSEPE Days” took place, which attracted the participation of around 4000 teachers.

All these activities took on a markedly pedagogical character, covering geographical topics, specifically about the forest and environment, in a technical-scientific perspective directed towards education. The emphasis returned systematically to the contribution of forest fires, as obstacles to the development and preservation of the forest. Geography was always present, through the analysis of the different aspects of the territories, associated with the whole process of ignition and development of fires. The sessions were dedicated as much to the risk of forest fire, specifically towards their reduction through preventative measures and defending the forest against fires, as to geographical information systems applied to the cartography of fires or to the management of the forest space, or even through

analysing their effects and, naturally, to the contribution that PROSEPE could make towards the reduction of the risk of forest fire.

In addition to the activities above, the PROSEPE team created and made available a set of didactic, pedagogical, promotional and scientific publications, with the intention of serving as a link between the forest clubs, but also to contribute both to the training of teachers, as well as encouraging students to take responsibility, and even to improve awareness in the community in general. As an example, the magazine “Folha Viva (live sheet)”, a publication mainly aimed at club members, also acts as a means of reaching the community. As a channel to promote the PROSEPE activities taking place, but also takes on a sense of exchange, in which each club can divulge its activities by participating in the different categories of the magazine.

Conclusion

Nowadays, wildfires constitute the major and the most serious environmental problem in Portugal. Although students of both municipalities perceived and ranked wildfires as the top of the risks at national-scale and in their residence area, when asked about the respective causes, consequences and mitigation measures, the vast majority demonstrated difficulties in its identification. Although the integration of disaster risk management in the education sector has been recognized as crucial (ISDR, 2007; UNESCO/ UNICEF, 2012), in order to increase awareness of the effects and causes of disasters, in Portugal little attention had been given to risk education, in the school curriculum. Only in 2015 the formal curriculum incorporated issues related with risk education, through specific disciplines, such geography, or by the implementation of the Risk Education Framework, under a citizenship education context.

The reorganisation of basic education, through the Curricular targets, in the topics associated with “Risk, Environment and Society” that will be implemented in year 9 geography will enable, without doubt, more in depth treatment of the problem of risk, including the risk of forest fires. This will enable students to acquire new knowledge, making a more active, participative and informed citizenship possible. In practice, contemporary school geography has demonstrated significant gaps over the last decades in the integrated coverage of risks, in particular the risk of forest fire, paving the way for constructed knowledge and actions within the “*risk society*” paradigm.

In contrast, PROSEPE, promoted in non-formal education settings, through its pioneering work and longstanding presence over more than two decades,

and through its involvement with schools, teachers and students, has acquired the privileged position of being able to intervene in the mobilisation of the school community, providing and promoting dynamics and educational practices that aim for, in the widest sense of citizenship teaching, the adoption of attitudes and behaviours directed towards valuing the forests, and preventing and managing the risk of forest fire. In practical terms, through the many educational activities directed both at teachers and students, by teaching content with technical and scientific precision, and by promoting a range of diverse activities, PROSEPE has acquired a specific role in the school community, which is seen as informed and participative, not only with regards to the protection of forest values in particular, but also to environmental values in general.

This study is, however, largely exploratory in nature and further empirical studies are needed to assess how the integration of risk issues in the formal education contribute to the integration of risk management and increase the awareness of the causes, effects and mitigation measure of the type of disasters that currently affect our territory. There is, of course, the challenge of actually measuring the improvement of risk education, after the introduction in the formal curriculum the objectives, content, learning experiences in order to assess if students are, now, better prepared to take the appropriate measures in order to avoid and deal with the risk, especially with wildfire risk.

Acknowledgements

This paper was supported by NICIF (Centre for Scientific Research of Forest Fires) at the University of Coimbra and by the CEGOT (Centre for Studies in Geography and Spatial Planning), which is financed by national funds via the Foundation for Science and Technology (FCT) under the COMPETE project, reference POCI-01-0145-FEDER-006891 (FCT project: UID/ GEO/04084/2013).

References

Bajocco S., Ricotta C. (2008). Evidence of selective burning in Sardinia (Italy): which land-cover classes do wildfires prefer? *Landscape Ecology*, 23, 241-248.

Beck, U. (1992). *Risk Society: Towards a New Modernity*. New Delhi: Sage (Translated from the German Risikogesellschaft, published in 1986).

Bodí, M. B., Martin, D. A., Balfour, V. N., Santín, C., Doerr, S. H., Pereira, P., Cerdà, A., Mataix-Solera J. (2014). Wildland fire ash: production, composition and eco-hydro-geomorphic effects. *Earth-Science Reviews*, 130,103-127.

Câmara, A., Ferreira, C., Silva, L., Alves, M., Brazão, M. (2001). *Geografia. Orientações Curriculares 3º Ciclo*. Departamento de Educação Básica. Direção geral de Educação, Ministério da Educação.

Carmo M, Moreira F, Casimiro P, Vaz P. (2011). Land use and topography influences on wildfire occurrence in northern Portugal. *Landscape Urban Plan*, 100, 169-76.

Carvalho, A., Flannigan, M. D., Logan, K., Miranda, A. I., Borrego, C. (2008). Fire activity in Portugal and its relationship to weather and the Canadian Fire Weather Index System. *International Journal of Wildland Fire*, 17, 328-338.

Catry, F. X., Rego, F., Moreira, F., Fernandes, P. M., Pausas, J. G. (2010). Post-fire tree mortality in mixed forests of central Portugal. *Forest Ecol. Manage.*, 260, 1184-1192.

Cerdà, A. & Lasanta, T. (2005). Long-term erosional responses after fire in the Central Spanish Pyrenees: 1. Water and sediment yield. *Catena*, 60 (1), 59-80.

Cerdà, A. (1998). Changes in overland flow and infiltration after a rangeland fire in a Mediterranean scrubland. *Hydrological processes*, 12 (7), 1031-1042.

Certini G. (2005). Effects of fire on properties of forest soils: a review. *Oecologia*, 143, 1-10.

Coombs, P.H. (1976). Nonformal education: Myths, realities, and opportunities. *Comparative Education Review*, 20 (3), 281-93.

Cunha, M. (2008). *O contributo da educação formal em Geografia na prevenção dos incêndios florestais*. Dissertação de Mestrado, Universidade do Porto, Porto.

DeBano, L. F., Neary, D. G., Folliott, P F. (1998). *Fire's Effects on Ecosystems*. John Wiley and Sons, New York, 333 pp.

Dosman, D. M., Adamowicz, W .L., Hruday, S.E. (2002). Socioeconomic determinants of health and food safety related risk perceptions. *Risk Anal.* 21, 307-318.

Eshach, H. (2007). Bridging In-school and Out-of-school Learning: Formal, Non-Formal, and Informal Education. *Journal of Science Education and Technology*, 16 (2), 171-190.

Evans, J. & Geerken, R. (2004). Discrimination between climate and human-induced dryland degradation. *Journal of Arid Environments*, 57, 535-554.

Ferreira-Leite, F., Ganho, N., Bento-Gonçalves, A., Botelho, F. (2017). Iberian atmospheric dynamics and large forest fires in mainland Portugal. *Agricultural and Forest Meteorology*, 247, 551-559.

- Ferreira-Leite, F., Gonçalves, A. B., Vieira, A. (2011). The recurrence interval of forest fires in Cabeço da Vaca (Cabeira Mountain—northwest of Portugal). *Environmental Research*, 111, 215-221.
- Fischer, E. M. and Schär C. (2010) Consistent geographical patterns of changes in high-impact European heatwaves. *Nature Geoscience*.
DOI: <https://doi.org/10.1038/ngeo866>
- Flannigan, M.D., and Harrington, J.B. (1988). A Study of the Relation of Meteorological Variables to Monthly Provincial Area Burned by Wildfire in Canada (1953-80). *J. Appl. Meteorol.* 27:441-452.
- Fuchs, S., Kuhlicke, C., & Meyer, V. (2011). Editorial for the special issue: vulnerability to natural hazards—the challenge of integration. *Natural Hazards*, 58 (2), 609 - 619.
- Galvão, C., Neves, A., Freire, A. M., Lopes, A. M., Santos, M. C., Vilela, M. C., et al. (2001). *Ciências físicas e naturais. Orientações curriculares para o 3º ciclo do ensino básico*. Lisboa: DEB, Ministério da educação.
- Gaume, E., Borga, M., Llassat, M. C., Maouche, S., Lang, M., & Diakakis, M. (2016). *Mediterranean extreme floods and flash floods. The Mediterranean Region under Climate Change*. A Scientific Update, IRD Editions, pp.133-144, 2016, *Coll. Synthésés*, 978-2-7099-2219-7.
- Geist, H. J. Lambin, E. F. (2004). Dynamic Causal Patterns of Desertification. *BioScience*, 54 (9), 817-829.
- Hamadache, A. (1991). Nonformal education: A definition of the concepts and some examples. *Prospects*, 21(1), 111-124.
- Hoppers, W. (2006). *Non-formal education and basic education reform: a conceptual review*. International Institute for Educational Planning, UNESCO, Paris.
- Hualou, L. (2011). Disaster Prevention and Management A Geographical Perspective. *Disaster Advances*, 4 (1), 3-5.
- ISDR - INTERNATIONAL STRATEGY FOR DISASTER REDUCTION (2007). *Towards a Culture of Prevention: Disaster Risk Reduction Begins at School- Good Practices and Lessons Learned*. United Nations, UNESCO, 153p.
- JRC, JOINT RESEARCH CENTRE. FOREST FIRES IN EUROPE, MIDDLE EAST AND NORTH AFRICA (2015). Technical Report n.15, EUR 28148 EN, 2016.
- Long, H. (2011). Disaster Prevention and Management: A Geographical Perspective. *Disaster Advances* 4(1):5 p.
- Lourenço, L. & Gonçalves, A. B. (1990). As situações meteorológicas e a eclosão-propagação dos grandes incêndios florestais registados durante 1989 no Centro de Portugal. In *II Congresso Florestal Nacional*. Porto, Portugal, 755-763. Available from: https://www.uc.pt/fluc/nicif/Publicacoes/Estudos_de_Colaboradores/PDF/Comunicacoes_congressos/IICongresso_Florestal_Nacional_1990
- Lourenço, L., Bernardino, S., Fernandes, S., Félix, F. (2012). A Geografia como suporte de um Projeto de Sensibilização e Educação da População Escolar, o PROSEPE - Geography in support of a Project to Raise School Population Awareness and Education: PROSEPE". *Ciência Geográfica, Revista da Associação dos Geógrafos Brasileiros*, Barau/São Paulo, XVI (2), 217-229. Available from: http://www.uc.pt/fluc/nicif/Publicacoes/Estudos_de_Colaboradores/PDF/Publicacoes_periodicas/Revista_AGB_vol_2_2012_artigoprosepe.pdf
- Malkinson, D., Wittenberg, L., Beeri, O., Barzilai, R. (2011). Effects of repeated fires on the structure, composition, and dynamics of Mediterranean maquis: Short- and long-term perspectives. *Ecosystems*, 14, 478-488.
- Martin, W. E., Martin, I. M., Kent, B. (2009). The role of risk perceptions in the risk mitigation process: the case of wildfire in high risk communities. *J Environ Manage.* 91(2):489-98.
- Miranda, A .I., Monteiro, A., Martins, V., Carvalho, A., Schaap, M., Builtjes, P., Borrego, C. (2008). Forest Fires Impact on Air Quality over Portugal. *Air Pollution Modeling and Its Application XIX. Part of the series NATO Science for Peace and Security Series Series C: Environmental Security*, 190-198.
- Montz, B.E & Tobin, G.A. (2011). Natural hazards: An evolving tradition in applied geography. *Applied Geography* 31 (1), 1-4.
- Moreira, F., Viedma, O., Arianoutsou, M., Curt, T., Koutsias, N., Rigolot, E., Barbati, A., Corona, P., Vaz, P., Xanthopoulos, G., Mouillot, F., Bilgili, E. (2011). Landscape - wildfire interactions in southern Europe: Implications for landscape Management. *Journal of Environmental Management*, 92, 2389-2402.
- Nelson, K .J., Connot, J., Peterson, B., Picotte, J. J. (2013). LANDFIRE 2010 - Updated Data to Support Wildfire and Ecological Management. *Earthzine* (accessed in: <http://www.earthzine.org/2013/09/15/landfire-2010-updated-data-to-support-wildfire-and-ecological-management/>, 25.05.2014).
- Novara, A., Gristina, L., Rühl, J., Pasta, S., D'Angelo, G., La Mantia, T., Pereira, P. (2013). Grassland fire effect on soil organic carbon reservoirs in a semiarid environment. *Solid Earth*, 4 (2), 381.

- Nunes, A. N. (2012). Regional variability and driving forces behind forest fires in Portugal, an overview of the last three decades (1980-2009). *Applied Geography*, 34, 576-586.
DOI: <https://doi.org/10.1016/j.apgeog.2012.03.002>
- Nunes, A., Almeida, A. C., Nolasco, C. (2013). Metas Curriculares de Geografia- 3º Ciclo do Ensino Básico, Ministério da Educação e Ciência, 19 p. Available from: <http://www.dge.mec.pt/index.php?s=noticias¬icia=396>
- Nunes, A., Lourenço, L., Félix, F., Oliveira, S. (2014), *PROSEPE: duas décadas a educar para a preservação da floresta*. In CORDEIRO, A. M. Rochette; ALCOFORADO, Luís; FERREIRA, A. Gomes (Coords.) *Territórios, Comunidades Educadoras e Desenvolvimento Sustentável*, Coimbra: DG-FLUC., 157-167. Available from: http://www.uc.pt/fluc/nicif/Publicacoes/Estudos_de_Colaboradores/PDF/Comunicacoes_congressos/2014_Atas_Territorios_Comunidades_Educadoras_LL1.pdf/
- Nunes, A., Lourenço, L., Meira, A. C. (2016). Exploring spatial patterns and drivers of forest fires in Portugal (1980-2014). *Science of the Total Environment*, 573, 1190-1202.
DOI: <https://doi.org/10.1016/j.scitotenv.2016.03.121>
- Oliveira, S., Oehler, F., San-Miguel-Ayanz J., Camia, A., Pereira, J.M.C. (2012). Modelling spatial patterns of fire occurrence in Mediterranean Europe using Multiple Regression and Random Forest. *Forest Ecol Manag.*, 275, 117-129
- Oliveira, S., Pereira, J.M.C., San-Miguel-Ayanz, J., Lourenço, L. (2014) Exploring the spatial patterns of fire density in Southern Europe using Geographically Weighted Regression. *Appl Geogr*, 51, 143-157.
DOI: <https://doi.org/10.1016/j.apgeog.2014.04.002>
- Pausas J. G., Vallejo, V. R. (1999). The role of fire in European Mediterranean ecosystems. In: Chuvieco E (ed.). *Remote sensing of large wildfires in the European Mediterranean basin*. pp. 3-16. Springer, Berlin
- Pausas, J. G. (2004). Changes in Fire and Climate in the Eastern Iberian Peninsula (Mediterranean Basin). *Climatic Change*, 63, 337-350.
- Pereira, M. G., Trigo, R. M., Da Câmara, C. C., Pereira, J. C., Leite, S. M. (2005). Synoptic patterns associated with large summer forest fires in Portugal. *Agricultural and Forest Meteorology*, 129, 11-25.
- Rebello, F. (1980). Condições de tempo favoráveis à ocorrência de incêndios florestais. Análise dos dados referentes a Julho e Agosto de 1975 na área de Coimbra. *Biblos*, 56, 653-673.
- San-Miguel-Ayanz, J., de Rigo, D., Caudullo, G., Houston Durrant, T., Mauri, A. (2016). *European Atlas of Forest Tree Species*. European Commission.
- San-Miguel-Ayanz, J., Schulte, E., Schmuck, G., Camia, A., Strobl, P., Liberta, G., et al. (2012). Comprehensive Monitoring of Wildfires in Europe: The European Forest Fire Information System (EFFIS). In: Tiefenbacher J, editor. *Approaches to Managing Disaster - Assessing Hazards, Emergencies and Disaster Impacts*. *InTech*. Available from: <http://dx.doi.org/10.5772/28441>
- Silva, J. S., Vaz, P., Moreira, F., Catry, F., Rego, F. C. (2011). Wildfires as a major driver of landscape dynamics in three fire-prone areas of Portugal. *Landscape and Urban Planning*, 101, 349-358.
- Tedim, F., Ferreira, M., Cunha, M. A., Sousa, C.G. (2010). Risco de Incêndio Florestal no Ensino da Geografia no 3º Ciclo do Ensino Básico. Ensino da Geografia e Processo de Bolonha. *Actas do XII Colóquio Ibérico de Geografia*, Porto: Faculdade de Letras, Universidade do Porto.
- Tuladhar, G., Yatabe, R., Ranjan, K. D. & Netra, P. B. (2014). Knowledge of disaster risk reduction among school students in Nepal. *Geomatics, Natural Hazards and Risk*, 5:3, 190-207.
- UNESCO/ UNICEF (2012). *Disaster Risk Reduction in School Curricula: Case Studies from Thirty Countries*. Available from: <http://unesdoc.unesco.org/images/0021/002170/217036e.pdf>