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Water and flood adaptation education: from theory to practice

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Abstract

The risk of flooding is the main natural hazard that affects the European region. This hazard has worsened in the recent decades due to the urban occupation of flood areas and the effects of climate change. Therefore, in Spain, interest in this subject is accentuated in the case of future teachers because this issue is mandatory to teach in primary education (grades 1–6; social sciences subject). The aims of this research are to explore the instruction about flooding received by future teachers during their school and university period and propose the instruction curricular activities to do in classroom (primary education). Methodologically, a questionnaire was distributed among future teachers of primary education (Faculty of Teaching Training of the University of Valencia, Spain) during three academic courses (2018-19, 2019-20 and 2020-21). Also, the current curriculum was analysed (Royal Decree 126/2014, of February 28, which establishes the basic curriculum for primary education). Some results regarding the respondents' perception show that most of the respondent did not receive such training (68.3%) during their school period. And regard with the information received about floods during the university stage (primary education teacher degree), the majority of the respondents did not receive any formation (89.1%). With reference to the curricular proposal activities, they are characterized by the problematization (critical methodology; activities that student should resolve problems).

Keywords: Flood Adaptation; Flood Management; Flood Risk; Socio-Hydrological; Water Education

INTRODUCTION

Natural hazards, specifically those of an atmospheric nature, are generating an increasing volume of economic and human losses (Pérez *et al*., 2015). In the world, according to the report published by the Center for Research on the Epidemiology of Disasters (CRED, 2019), floods are the most frequent natural hazard (with a percentage of 43% of the total) and affected majority of people (two billion inhabitants) between 1998 and 2017. In relation to the flood deaths, these amounted to 142,088 (11% of the total victims of natural disasters) around the world. In Europe, the report published by the European Environmental Agency (EEA, 2017) highlighted that between 2000 and 2014, there were approximately 2,000 deaths and almost 8.7 million people affected by floods. According to Morote and Hernández (2020) it is also important to consider the effects of climate change, such as heavy rainfall. As indicate in different international reports (Intergovernmental Panel on Climate Change, IPCC, 2018) and Spanish (Center for Studies and Experimentation of Public Works, CEDEX 2017) reports, rainfalls are predicted to become more frequent and heavier.

Spain is one of the European countries with the highest levels of flood risk (European Observation Network for

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Territorial Development and Cohesion, ESPON 2008). In words of Olcina (2018), in this country, two million people live in areas at high risk of flooding, and during the period of 1995-2015, a total of 526 deaths were recorded due to this phenomenon. The areas with the highest risk are coastal, generally the Mediterranean coast. In the Region of Valencia (study area), according to the Action Plan of the Territorial Action for Flood Risk Prevention (PATRICOVA), approximately 600,000 inhabitants (12% of the population) live in flooded areas and more than 300 educational centers are in these locations (PATRICOVA, 2015).

Currently, the main lines of action to reduce risk are environmental issues and a more effective land management (Olcina *et al*., 2020; Gaaloul *et al*., 2020). In previous decades, the main measure to reduce flood risk was the construction of hydraulic structures to guarantee the necessary level of security in the affected areas (Parker, 1995). These actions led to overconfidence in the engineering works and the maintenance and development of inappropriate actions were increased exposure and vulnerability. Since 2000, actions designed to decrease hazards have given way to measures to reduce the vulnerability and exposure (Morote and Hernández, 2020). These are based on land management uses, risk mapping, and the construction of "soft" infrastructures that are more respectful with the environment (Perles *et al*., 2017). However, as indicated by Morote and Hernández (2020), instruction from educational centers (a non-structural action) is largely overlooked. In developed countries, it is considered essential to train future citizens in issues related to science. To do this, teaching is probably the most effective tool to improve their knowledge, not only in the scientific field, but also with respect to everyday life (Morote and Souto, 2020).

Different studies in the last decade highlighted the importance given to the study of flooding at all educational levels; for example, in the United States (McWhirter and Shealy, 2018), United Kingdom (McEwen *et al*., 2014) or Asia (Ahmad and Numan, 2015). Most of the scientific studies on flooding from an educational perspective have been carried out through the natural sciences (Garzón *et al*., 2009). In Spain, these types of research related to teaching of geography and/or social sciences are uncommon (Cuello, 2018; Ollero, 1997). In the Region of Valencia, except for a few recent studies (Morote, 2017; Morote, 2019a; Morote and Pérez, 2019; Morote and Hernández, 2020; Morote and Souto, 2020), works on this issue are scarce.

The problem addressed in this research is that the risk of flooding is a relevant topic on a social, economic, and territorial level, in Spain. Besides, it should be studied in primary education to contribute to the understanding of this phenomenon as established in the current educational curriculum for the Region of Valencia (Decree 108/2014 of 4 July) and on a national level (Royal Decree 126/2014 of 28 February). According to the Royal Decree 126/2014, in the field of social sciences, different disciplines are integrated that study the people as the social beings and their reality in their geographical, sociological, economic and historical aspects. The purpose of social sciences in primary education is to learn to live in society, knowing the fundamental mechanisms of democracy and respecting the rules of collective life. Regarding the issue of water and flood risk, this is in Block 2 "The world we live in". This block includes the contents related to the universe, the representation of the Earth and orientation in space, water and responsible consumption, the climate and climate change, and landscape and human intervention in the environment. It is in these last contents where the question of water can be located (Table 1).

Table 1. Curricular contents about water and floods of the Royal Decree 126/2014, of February 28, which establishes the basic curriculum for primary education (Spain). (Ministry of Education, Culture and Sports, 2020). Own elaboration

Contents	Evaluation criteria	Learnings standards
- The atmosphere. Atmospheric phenomena.	- Identifying the atmosphere as the scene of meteorological phenomena and explaining the importance of its care.	- Identify and name atmospheric phenomena and describe the causes that produce the formation of clouds and rain. - Explain the importance of taking care of the atmosphere and the consequences of not doing it.
- The Weather. Measurement and prediction.	- Explaining the difference between the climate and atmospheric weather and interpret the weather maps.	- Explain what the difference is between the atmospheric weather and climate. - Identifies the different measuring devices used to collect atmospheric data, classifying them according to the information they provide. - Describe a weather station, explain its function and make and interpret simple graphs of temperatures and precipitation. - Interpret the simple weather maps distinguishing their main elements.
- Weather maps. Conventional symbols. - Climate and climatic factors.	- Identifying the elements that influence the climate, explaining how they act in it and acquiring a basic idea of climate and the factors that determine it.	- Define climate, name its elements and identify the factors that determine it.
- The great climatic zones of the planet. - The types of climates in Spain and their areas of influence.	- Recognizing the climatic zones of the world, the types of the climates of Spain and identifying some of their basic characteristics	- Explain what a climatic zone is, naming the three climatic zones of the planet and describing their main characteristics. -Define and indicate on a map the types of climates in Spain and the areas affected by each one, interpreting and analysing climates of different territories in Spain relating them to the climate to which it belongs.
- The hydrosphere. Distribution of the water on the planet. - The water cycle.	- Explaining the hydrosphere, identify and name bodies and water courses, differentiating surface waters and groundwater, basins and watersheds, describing the water cycle.	- Define hydrosphere, and identify and name bodies and water courses, explaining how groundwater is formed, how it emerges and how it is accessed. - Describe in an orderly fashion the phases in which the water cycle occurs. - Difference basins and watersheds. - Identify and name the sections of a river and the characteristics of each one of them.
- The geographical diversity of the landscapes of Spain: relief and hydrography. - The geographical diversity of the landscapes of Europe: relief, climates, and hydrography.	- Explaining what a landscape is and identify the main elements that compose it. - Describing the characteristics of the relief of Spain and its hydrographic network, locating them on a map. -Identifying the main relief units in Europe, their climates and their hydrographic network, locating them on a map.	- Define landscape, identify its elements, and explain the characteristics of the main landscapes of Spain and Europe, valuing their diversity. -Locate on a map the main units of the relief of Spain and its hydrographic slopes. - Locate the seas, oceans, and the great rivers of Spain on a map. - Locate on a map the relief of Europe, its hydrographic slopes and its climates. - Recognize the main features of the relief, rivers, and climate of Europe.
- Human intervention in the environment.	- Explaining the influence of human behaviour in the natural environment, identifying the sustainable use of natural resources, proposing a series of measures necessary for the sustainable development of humanity, specifying its positive effects.	- Explains the sustainable use of natural resources proposing and adopting a series of measures and actions that lead to the improvement of the environmental conditions of our planet.
- Climate change: causes and consequences Responsible consumption.	- Explaining the consequences of our actions on the climate and climate change.	- Explain the causes and consequences of climate change and responsible actions to stop it.

It should be noted that the word "flood" or "risk" is never found. Therefore, it is understood that it is an element derived from the climate (consequence or feature of the Mediterranean climate). But, it is also positive to incorporate content on "the intervention of the human being" since in this way it can be interpreted that these phenomena related to water can be the sum of the "vulnerability" component (human factor) and the "dangerousness" (climatic features) (Ward *et al*., 2020). However, the primary education curriculum is remarkably simple and it is each teacher's job and even the publishers of school textbooks, who must adapt and propose more specific content and activities.

With the implementation and possible adaptation of the contents and activities that are proposed, the explanation of climate risks in classroom would be improved, as a matter of interest in primary education. And this is due to various issues related to the treatment of these phenomena in social sciences and school geography: 1) Insufficient scientific rigor, information, and excessive catastrophizing of school textbooks (Morote and Olcina, 2020). Regarding these resources, although the fact that their use has decreased in recent years, they continue to present a key role and it is something that has not been changed with the introduction of new digital media (Bel and Colomer, 2018), 2) Insufficient training of current teachers on this subject (Morote and Hernández, 2020; Morote and Souto, 2020) that would require the development of specific courses through teacher training centers, 3) Influence of the media on these phenomena in the social representations of teachers (Morote, 2019a) and in textbooks (Morote and Olcina, 2020), and 4) Few times that teachers have at these educational levels, when proposing problematic activities and exercises different from those that are inserted in textbooks (Souto *et al*., 2019).

The aims of this research are to explore the instruction about flooding received by future teachers during their school and university period and propose instruction curricular activities to do in classroom (primary education). In relation with these proposals is interesting to analyse their problematization (critical methodology; activities that student should resolve problems).

MATERIALS AND METHODS

Design of the research

This research is based on a mixed correlational and exploratory study (non-experimental) and applied the same procedure and methodology as other works conducted about the instruction of climate change and natural hazards from the social sciences (Morote and Hernández, 2020). It adopts a transversal design as the information analysed has been gathered at a specific moment (academics years of 2018-19, 2019-20 and 2020-21) and as a case study (Faculty of Teaching Training of the University of Valencia, Spain) (Fig. 1).

Fig. 1. Region of Valencia, Spain. Own elaboration

Context and respondents

In relation to the context and the respondents, the selection procedure has been conducted through non-probability sampling (available or convenience sampling). Two groups from the 4th year of the primary education teacher degree from the Faculty of Teaching Training (University of Valencia) were selected during three courses (2018-19, 2019-20 and 2020-21). All participants attend the subject of "Instruction of social sciences. Applied aspects" (code 33651). It is a theoretical-practical subject that analyses geographic content. In fact, it is the only subject where geographic content is taught in this degree. With reference to the representativeness of the sample, considering the total number of students enrolled (275 students), to achieve a confidence interval of 95% and a margin of error of 5%, a minimum of 161 students would be required to be a representative sample. The final total number of respondents was 240, so a representative number was achieved.

With respect to the socio-cultural characteristics, it should be noted that most of the respondents were women (71.3%). These data are within the normal ranges of the type of student of the Faculty of the Teaching Training, as the percentage of women in the final year is 70.2% (University of Valencia 2020). Regarding age, the range of the sample is mainly between 21 and 25 years (average age of 21.6).

Questionnaire, data analysis and procedure

The instrument designed to carry out the research is a questionnaire to obtain the information necessary to meet the aims proposed. The questionnaire was divided into five sections with a total of 28 items. Taking into account the aims in this research, the data obtained from: Section 1 (social characteristics: items 1 and 2); Section 4 (training about floods during the school stage: items 15, 16 and 17); and Section 6 (teacher training about floods: items 22, 24 and 26) were analysed (Table 2).

The questionnaire was conducted in an intermediate session (first four-month period) during the last week of November (years of 2018, 2019 and 2020) and with a response time of 20 minutes. The questionnaire was also validated by two researchers from the Department of Experimental and Social Sciences

Table 2. Items of the questionnaire examined in this research. Own elaboration

Section 1. Social characteristics	
-Item 1. Age	**Response type/Variables** Ended answer question/number.
-Item 2. Gender	**Response type/Variables** Ended answer question: Male/ Female/ I prefer not to say/ Other.
Section 4. Training about floods during the school stage	
-Item 15. Did you receive any kind of information about floods, during your school stage?	**Response type/Variables** Ended answer question: Yes/ No/ I do not remember.
-Item 16. Could you quote what information you received?	**Response type/Variables** Open answer question.
-Item 17. If the previous answer has been affirmative, in what educational stages do you remember having received this content?	**Response type/Variables** Ended answer question: Primary Education/ Secondary Education/ Baccalaureate.
Section 6. Teacher training about floods	
-Item 22. Are you qualified as a future teacher to be able to teach these contents?	**Response type/Variables** Likert scale (value: 1 to 5. 1 being the lowest value and 5 the highest).
-Item 24. Is it worth working on these contents at school?	**Response type/Variables** Likert scale (value: 1 to 5. 1 being the lowest value and 5 the highest).
-Item 26. Have you previously received any training on these contents in your university education?	**Response type/Variables** Ended answer question: Yes/ No/ I do not remember.

Education at the University of Valencia (Spain), and a researcher from the Department of Regional Geographic Analysis and Physical Geography of the University of Alicante (Spain). All the respondents answered all the questions and the respondents' anonymity was preserved during the entire procedure and confidentiality was guaranteed in writing.

RESULTS AND DISCUSSION

Teacher training about floods

With reference to the school training about floods (Section 4), in the item 15, the students should answer if they had received training on this topic at the school stage. The answer states that most of the respondent did not receive such training (68.3%; n= 164) (Table 3). This received training (item 16) was acquired mainly during the secondary (46.3%; n= 111) and primary stages (34.3%; n=82) (Table 3). Data on baccalaureate is low (19.3%; n= 46), because the part of the students who study this degree before going to the university attended an Educational Module and, therefore, without the necessity to attend to the High School (baccalaureate stage).

Table 3. Training on floods during the school stage. Source: Results of the survey. Own elaboration

Item 15	Yes: (20.4%; n= 49) No: (68.3%; n= 164) I do not remember: (11.3%; n= 17)
Item 16	Primary education: (34.3%; n= 23) Secondary education: (46.3%; n=31) Baccalaureate: (19.4%; n= 13)

In relation to the information pointed by those who answered affirmatively (item 17), responses are obtained that explained the concept of flooding as something abstract and decontextualized of the risk phenomenon (danger plus vulnerability). For example, student 1 (2020) "floods as a phenomenon and concept, not about risks" or student 2 (2020) "we simply analysed what the floods were, but nothing related to the risks". The responses also highlight that the information received was characterized by its simplicity: student 3 (2020) "in the Geography subject (Baccalaureate) teachers told us a little about the floods and their consequences, but not giving it much importance" or student 4 (2020) "I remember slightly talking about floods that have been took place but it was not a subject in which much time was spent". Others, but at the same time interesting, are those related to the explanation of past events such as the 1957 flood that particularly affected the city of Valencia (Figure 2 and 3). Answers as: student 5 (2020) "information about the flood of 1957"; student 6 (2020) "teachers told me about the flood that took place in 1957 in the Turia river (Valencia)"; or student 7 (2020) "explanation of how the famous flood happened in Valencia" are common. Also, there are some answers are also related with instructions about how to act in the event of a flood: student 8 (2020) "teachers explained to me that on days of heavy rain we should avoid places near ravines or rivers because they can overflow".

The Section 6 examines how students value their ability to teach about floods. The item 22 is linked to the perception that the students have about their ability to explain this topic in the classroom ("Are you qualified as a future teacher to be able to teach these contents?"). The result obtained (likert scale) is 2.9 (out of 5) (Table 4). These data show an average training value. Regarding item 24 ("Is it worth working on these contents at school?"), the responses show that the majority of the future teachers state that floods are important to teach at the school (value of 4.4 in the likert scale). The next question (item 26: "Have you previously received any training on these contents in your university education?") is related to the information received about floods during the university stage (specifically during the Degree). The results highlight that most of the respondents did not received any formation about this subject during this stage (89.1%; n= 147). A 6.1% (n= 10) answered that they did received formation and the 4.8% (n= 8) did not remember.

Fig. 2. The Riuá flood in the city of Valencia (14th October 1957) (Turia river) (Diari La, 2016)

Fig. 3. The Riuá flood in the city of Valencia (14th October 1957) (Diari La Veu, 2016)

When analysing the social representation and proposal activities of the future teachers of primary education, it has been demonstrated their low level of capacitation and creativity to teach these contents. With reference to climate change and natural hazards teaching, Morote and Olcina (2020) explained that there are several problems that still persist because this topic is not dealt with the enough scientific rigor due to: 1) In geography classes, the textbook continues to be the main resource used. Moreover, they are characterized by their limited scientific rigor and being notably influenced by the media and by excessive catastrophism when analysing this topic, 2) Marked influence of the media in the teaching staff's conception of information on climate change, and 3) The limited training of teachers on this topic.

In the case of flooding and climate change, as point by Souto *et al*. (2019), school textbooks are not the best option due to the mistakes and stereotypes usually found in them (Morote, 2019b). The former pointed that to explain flooding, the classic Cycle of Erosion by Davis -dating to the nineteenth century- is still being used and it has become an obsolete explanation. The analysis of the textbook's highlights, on the one hand, that very few refer to the impact of human beings' action on the natural flow regime of rivers, and the information on the concept of hazards (both in contents and proposed activities)

is practically non-existent, on the other. Morote (2019b) and Morote and Olcina (2020) stated that in Spain, in terms of climate change, in the social sciences textbooks (primary education), the contents are full of mistakes. These mistakes are replicated in the media (internet, TV and social networks), giving rise a catastrophic image that is not justified by climate change, matched by images and photographs that are completely unrelated to this phenomenon. Moreover, these authors explain that human beings (the vulnerability factor) are practically inconspicuous due to their absence from school textbooks. These shortcomings were also noted by Abbot *et al*. (2019), who, after selecting 450 diagrams of the water cycle in textbooks, scientific publications, and the internet, reached the conclusion that around 85% do not refer to human interaction with the natural processes. This fact has also been highlighted in studies carried out in the United States by Lutz (2011). This author highlighted that the analysis of physical geology textbooks used in introductory courses showed that there is a systematic lack of clarity regarding flood risk. This fact was also observed in this research, which took the future teachers' opinions into account. In other words, as also Morote and Hernández (2020) pointed, there is a significant lack of any mention of human beings when explaining flooding events.

With reference to the social perception of the future teachers, authors as Morote and Hernández (2020) highlighted that only 21.3% of the future teachers had received training about floods during their school years. Morote and Souto (2020) achieved the similar results for the Mediterranean region, where only 12.1% of the future primary education teachers had received training about this topic. Regarding the factor perception that influence floods, mostly of the respondents believe that the main variables are climate change and the spatial land management (Morote and Hernández, 2020). Furthermore, 51.3% believe that this phenomenon has been increasing over the last few years, and 82.5% think that it rains heavier today. Other results from the research of Morote and Hernández (2020) were the rating of the weight of the factors that could influence the floods risk. For example, future teachers' responses, who confirmed having received training on flood risk during their school years, point the education as one the main factor. But only represents 11.2% of the responses. "These data show that this factor (training of young people) is not considered as a variable that can influence vulnerability to the risk of flooding. This result is most worrying, as the respondents of this research will be teachers in the future" (Morote and Hernández, 2020).

Regarding the emergency protocols, the results corroborate what Ramiro (1996) pointed in the 1990s: the need to address this problem with the assistance of experts, as the teachers' subjectivity could undermine the school's objective because they do not have precise knowledge of the hydrographic system. Similar finding was also obtained by Souto *et al*. (2019) for the Spanish Mediterranean region. That is, the lack of initiative and training of future teachers when addressing these issues in social science classes at the primary education stage.

Curricular proposals

When the curricular proposal, is to be made, the contents proposed of the Royal Decree 126/2014 and its limitations should be considered. One of the shortcomings, as already highlighted in the Introduction it is the simplicity of the content related to both climate change and flood risks in which they are practically unnoticed. The proposal presented here has the objective of: 1) Sensitizing students that this phenomenon can be influenced both by climatic factors (climate change) due to a greater intensity and frequency of these episodes, as well as 2) By the increase in

the vulnerability of the human being to occupation flooding areas, increased urbanization (increase of the impermeabilization), abandonment of the crops that traditionally laminated flooding water, a higher concentration of population in risk areas, perception of "risk 0" of the society, etc. (Table 5).

Taking into account this curricular proposal, the teacher is in charge of deciding and proposing different problematic activities (for example, in

Table 5. Curricular proposal (social sciences) for teaching flood risk in the Mediterranean region (primary education). Own elaboration

Contents	Evaluation criteria	Learnings standards
- Climate changes throughout terrestrial history: glaciations, small ice age and current warming.	- Knowing the evolution of the main planetary climatic oscillations on Earth and analyse how they affected the Spanish territory. - Analysing the evolution of the main anthropogenic greenhouse gases since the industrial revolution. - Recognizing the main consequences derived from these climate changes that are manifested or will manifest in the future in Spain.	- Understand climate change in the context of the evolution of the Earth's climate. - It understands the climate change as a problem aggravated by human pollution, but without losing perspective on the evolution of the climate throughout history due to natural causes. - Interprets the main effects that climate change can cause on society due to the increase in greenhouse gases due to anthropogenic causes. - Values that heavy hourly intensity rain episodes will be more intense and frequent in the future due to global warming.
- Main characteristics of the Mediterranean climate.	- Knowing the main features of the Mediterranean climate considering its atmospheric extremes (floods and droughts). - Interpreting that in the Mediterranean climate, the succession of episodes of intense rains is something structural.	- Understand the main characteristics of the Mediterranean climate taking into account that one of its peculiarities is the atmospheric extremes such as floods and droughts. - It understands that the Mediterranean climate is a climate of extremes and the episodes of precipitation of strong hourly intensity are normal.
- Human activity as a factor in increasing the risk of flooding (see Figure 4).	- Understanding that human beings have increased the risk of flooding in the Mediterranean region as a consequence of greater exposure and perception of "domination of nature".	- It interprets that in recent decades, human action has increased the risk of flooding due to increased vulnerability and exposure. -It understands that in the Mediterranean region vulnerability has increased as a consequence of: an increase in the population and its concentration in dangerous areas (ravines, rivers, marshes, etc.); increased runoff due to a larger urbanized area (greater impermeability); abandonment of agricultural uses that traditionally laminated floods; a greater sense of perception of "risk 0".

Fig. 4. Aerial view of the Vega Baja (low floodplain) (village of Dolores, Alicante, Region of Valencia) after the floods of 12-13 September 2019 (Diario Información, 2019)

order for the student to look for solutions). These activities can be carried out both individually or in group work and can be done in the classroom or as homework. Regarding the evaluation and qualification, it is the teacher who must decide, as well as the weight he gives to his qualification. It can even be a proposal for an examination, or a synthesis activity of the didactic unit dedicated to climatology where content on the climate change and natural risks is usually inserted. Also, it should be noted that the curricular proposal besought here has the aim of being a guide and model so that teachers can implement in other geographical areas where a series of data is accessible for at least 30 years to be able to carry out analysis of trends. Therefore, for the development of activities, it may be interesting to consult the climatic series of observatories, with the comparison between different statistical periods, which can also be obtained in Spain, for example, on the website of the State Meteorological Agency (AEMET). For a better understanding of the topic of climate risks and climate change as an incentive process for their intensity and frequency, it is necessary for teachers to consult reports on climate change and web portals (Adaptecca; AEMET; Catalan Climate Change Office; Mediterranean Environmental Studies Center [CEAM]) that have specialized in this matter. Likewise, these official meteorological or environmental bodies offer information on atmospheric phenomena and processes on their social networks (Twitter and Facebook, basically) of interest for use in the classroom. The National Geographic Institute (IGN, 2021) also has the interesting materials for the approach of classroom practices in matters of the Spanish physical environment that include aspects of natural hazards (Table 6).

Table 6. Online resources for teachers and students. Own elaboration

Centre for Mediterranean Environmental Studies (CEAM). Reports on evolution of marine temperature in the Mediterranean Sea:
- ✓ http://www.ceam.es/ceamet/SST/index.html

***Intergovernmental Panel on Climate Change (*IPCC).** Official reports on climate change. Monographic reports on specific aspects (oceans, ice):
- ✓ https://www.ipcc.ch

Meteorology State Agency (AEMET). Climate data from official observatories, reports on the state of the climate and climate modeling:
- ✓ http://www.aemet.es/es/serviciosclimaticos/datosclimatologicos
- ✓ http://www.aemet.es/es/conocermas/recursos_en_linea/publicaciones_y_estudios/estudios/detalles/informe_clima_2019
- ✓ http://www.aemet.es/es/serviciosclimaticos/datosclimatologicos

National Geographic Institute (IGN). Instruction resources, maps and graphs of interest for the explanation of this topic:
- ✓ https://www.ign.es/web/ign/portal/recursos-educativo

National Plan for Adaptation to Climate Change (AdapteCCa). Official website for modelling climate change in Spain:
- ✓ http://escenarios.adaptecca.es/#&model=multimodel&variable=tasmax&scenario=rcp85&temporalFilter=YEAR&layers=AREAS&period=MEDIUM_FUTURE&anomaly=RAW_VALUE

Notification System for Singular Atmospheric Observations (SINOBAS). Website of meteorological extreme events in Spain:
https://sinobas.aemet.es

Program of the United Nations of the Mediterranean. Reports on climate change and atmospheric extremes in the Mediterranean region:
- ✓ https://ufmsecretariat.org/wp-content/uploads/2019/10/MedECC-Booklet_EN_WEB.pdf

Territorial Action Plan on flood risk prevention in the Valencian Region (PATRICOVA). Showing areas at risk of flooding according to various parameters (viewer):
https://visor.gva.es/visor/

The Catalan Office for Climate Change. Report of the Catalonia Climate Change:
- ✓ http://cads.gencat.cat/web/.content/Documents/Publicacions/tercer-informe-sobre-canvi-climatic-catalunya/Sintesis/CC_Sintesi-CASTELLA_web.pdf

Websites of associations of Meteorology:
- ✓ https://www.meteoclimatic.net
- ✓ https://redmeteo.ametse.es
- ✓ https://www.avamet.org/

Addressing floods in primary education is the utmost importance, as how this phenomenon works must be taught to the youngest cohorts (Morote and Souto, 2020). Nevertheless, its explanation should be simple so that the students would be able to understand it easily (Olcina, 2017). As pointed Chevallard (1991), it should be carried out through instruction transposition or "transforming wisdom into learned knowledge", as knowledge undergoes transformations to be taught in classrooms. For this reason, Souto *et al.* (2019) proposed the activities based on: 1) How to act in a flood episode; 2) An analysis of past episodes; and 3) Field trips as a resource for analysing the risk in situ, and thereby achieving a better understanding of the territory. Morote and Pérez (2019), based on their experience with a field trip about flood risk, reveal that the benefits generated for the students are immediate and, in the long term, undeniable. This type of training activity creates awareness among the learners and fits them with the capacity to act in contingency situations that they did not have before due to a lack of perception (Morote and Hernández, 2020). Lutz (2011) proposed an alternative conception of risk based on the analogy between playing a game of chance and living in a hazardous situation. In this way, the statistical ensembles are introduced to characterize risk as a function of the exposure duration by flood risk management professionals in local governments. This author considered that roleplaying about processes and structures enables an evaluation to be made of participants' perceptions of their learning experiences.

As highlight by Morote and Hernández (2020) it is necessary to address the phenomenon of flood risk in the classroom (at all levels) together with the use of efficient teaching strategies. The task of selecting the resources and types of activities to carry out in the classroom, the commitment to a dynamic and experiential teaching strategy able to motivate children and teenagers, and making the contents to be taught interesting, attractive, and easy to understand should be a priority and should not depend on each teacher (Martínez and Olcina, 2019). According to Morote and Olcina (2020), how the issue of floods and climate change is taught should be chosen correctly, as using excessive extremism or catastrophism is not conducive to learning. In that vein Cuello (2018) added that it is necessary to use new resources in the classroom, going beyond the simplified models that are proposed in the textbooks. The huge quantity and diversity of information gathered, with its filters, biases, and conflicts of interest, offer great educational opportunities for teaching students about a more complex, integrated, and sustainable concept of rivers, their relationships with towns, and flooding events.

CONCLUSION

The analysis of the instruction about flooding received by future teachers during their school and university period highlights the need to improve the explanation of the phenomenon of flood risk, and more specifically, the concepts of danger and vulnerability. A factor that could explain this weakness is that in the current curriculum of degree in primary education (the case of the University of Valencia), there is no specific subject on natural hazards. It is, therefore, in the teacher opinion and always considering the Teaching Guide, the problems/questions to be dealt with and carried out to promote a critical methodology. It is, after all, one of the aims that we have as teachers to encourage critical thinking in students and that they know how to understand the territory (dynamics and processes) and the possible impacts and risk of its implementation.

The knowledge and training received about the factors and causes that generate the floods in all their school stages is clearly insufficient. The answer states that most of the respondent did not receive such

training I in the school period (68.3%; n= 164). To accentuate this weakness, those who responded that they had received training on this topic highlighted that the concept of flooding was something abstract and decontextualized of the risk phenomenon. This lack of training makes it difficult for the society to improve their knowledge, not only in the scientific field, but also with respect to everyday life. However, is even more serious because the respondent are future teachers (primary education). In addition, they will be the ones who will train the children in the future and the lack of training about floods will most likely be repeated.

The training deficit and the need to correct it is accentuated given the impacts of climate change forecasts in the study area. The forecasts point that extreme events will be accentuated. That is, the intensity and droughts periods and flood events will be increase. And this rise will have impacts on water resources namely a decrease in available water resources due to a decline in rainfall in the case of droughts and a decrease in available flows, due to the increase of heavy rain events. This state will accentuate water stress in a region where the shortage of water resources is a defining feature as a result of the aridity of the climate and the increase in demand since the 1960s.

Against this background, there has been a change in the paradigm of flows associated with heavy rainfall. These flows of being unknown and identified as a "risk" (due to the damage caused and the high levels of pollution) have begun to be considered as a resource. In the last decades, in urban areas Rainwater Harvesting (RWH) has emerged as a field of sustainable water management, which offers an alternative water supply for at least non drinking uses (Imteaz and Moniruzzaman, 2018) taking into account the fit for purpose concept. In other words, these flows stored and properly treated can be used for non-conventional uses (for example for watering garden or street washing) and reduce the pressure on drinking water considering to the quality required for each use. A use that has received increasing attention by managers and supplying companies because climate change forecasts since they increase the resilience of the territories.

Its use would allow, on the one hand, to take advantage of the flows generated by the floods (increasing available water resources) and reduce the damage related with these phenomena and to raise awareness among future generations (which was the objective of this research) about the characteristics of the territories in which they live, on the other. That is to say, that they be able to understand that the Mediterranean region is a risk region and in this area water resources are scarce. This gave rise to land management systems based on rainwater harvesting in the past. These systems were given up from the 1960s. Therefore, rainwater went from being a "resource" to a "risk". Since the beginning of the 21st century. These practices (or at least the concept on which they are inspired) are being added to the management of water resources. Therefore, rainwater is considered as a resource again.

Among the future proposals derived from this research, it is worth mentioning: 1) To go on implementing this questionnaire in subsequent academic years to check out if there are changes in the answers, 2) To develop other items of the questionnaire that have not been examined in this research and analyze the relationships established between them, and 3) To analyze what teaching methods are carried out in the classes. This would be required to conduct the interviews with teachers. In this way, the students and teachers' answers could be contrasted. This even becomes more important when considering the future scenarios of climate change in which episodes of heavy rainfall would be more intense and frequent (Eslamian *et al*., 2011). Therefore, to train the younger population in raising awareness and training about these

phenomena is necessary to achieve a society more resilient to climate change.

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AUTHOR CONTRIBUTIONS

All authors contributed to the study conception, design, methodology and the results.

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