Many thanks to the two referees and editor for their detailed and constructive reports.

We have made the changes in the original manuscript as reflected in the previous responses to the reviewers. In the revised version of the manuscript, all the changes in relation to the comments of the reviewers and editor are marked with active change control (the new text is marked in yellow). Additionally, a thorough revision of the language has been carried out by a professional translator native in English. All these changes are also reflected with active change control

In summary, all the recommendations made by you and the reviewers have been considered, making the changes in the manuscript in relation to these recommendations and suggestions. In this way, we attach the revised manuscript with control changes to reflect the changes in relation to the comments of the reviewers and editor.

Please, if you need any clarification, information or additional document, do not hesitate to contact us.

Below we reflect the specific changes in the original manuscript in relation to the suggestions of both reviewers:

Referee #1 responses:

Overall comment:

- **Reviewer general comment:** This is a very interesting paper, well-structured and written. The issues addressed are within the scope of NHESS. The construction of the SMC db is of high importance for the analysis of the spatial and temporal changes in the coastal areas vulnerability to floods. Conclusions can be very useful to decision-makers for adaptation planning. The methodology followed for the development of the SMC database is appropriate and well presented. Therefore, the article merits being published, with minor changes.
    - **Authors response:** Thank you for your flattering and constructive comments. We believe that the results of this work may represent an improvement in the knowledge of the spatio-temporal patterns of floods in the Spanish Mediterranean coast in the last 50 years. We have included all your suggestions in the new manuscript version, this will make the manuscript undoubtedly more robust.

Specific comments:

- **Reviewer comment:** 1. My only scientific concern is the use of 2 different averaged indices for the average impact severity. I mean, the intensity level is actually related to the impact magnitude: low damages / major / deaths and/or general destruction. Then the authors produce a damage severity index, which uses in the equation the intensity level as weight implemented on the various damages occurrence. I can understand that cases can be compared better based on the severity index. However, I am not convinced about the use of 2 ‘average’ values used to evaluate trends or vulnerability at aggregated areas. What is the point? Maybe this could be better explained.

- **Authors response:** We agree with you that the use of two different means can lead to confusion. However, we believe that the comparison between these two indices can help to have a better idea of the problems generated by floods in the study area. We consider that the average intensity is a robust measure, since it limits the accumulated bias of adding several quantitative magnitudes extracted from qualitative information. In addition, the average intensity is based on numerous works that use the three levels of intensity for the study of floods through historical and hemerographic documentation (Camuffo and Enzi, 1996; Barriendos et al., 2003; Llasat, et al., 2005; Barriendos et al., 2014). However, we believe that the severity index provides additional information, although it may be subject to greater subjectivity. As an example, a flood of intensity 2 could produce major damage, but with concentrated effects in agriculture (Intensity = 2, severity index = 2), while a flood of intensity 1, could have some weak damages, but extended to a large number of sectors (for example roads, tourism, commerce and agriculture) (Intensity = 1; severity index = 4 * 1 = 4). In other cases a flood could be very intense and also affect a large number of sectors, so its final impact is greater than if simply considering the intensity (For example, a flood of intensity 2, which affected roads, agriculture, tourism and trade would have a severity index of 8). Therefore, the severity index offers information that is complementary to the intensity level and the amount of damages.
- **Manuscript changes:** we have introduced part of the previous discussion in the new version of the manuscript (pages 8 and 9). Additionally, we have moved the part of section 4 (Results) where the calculation of additional variables was discussed, to section 3 (Methodology and sources).

- **Reviewer comment:** 2. In what concerns the structure of the paper, my only concern is the introduction. In page 4, paragraph 4 (lines 24-29) is too methodological to be included in the introduction. It confuses the reader who expects to read the objectives and research questions instead of fragmentary information about methods employed. I suggest this part to be transferred to the methods section.
  - **Authors response and Manuscript changes:** we agree with you that this part of the work is not appropriate for the introduction section and that it is more typical of the methodology section. However, in order to not repeat information in the methodology section, we have delete most of the text from lines 24 to 29 on page 4 in the new version of the manuscript.

- **Reviewer comment:** 3. Please consider for your references regarding the databases in other countries also the high-impact weather events database of the National Observatory of Athens, Greece, which is also active on-line, constantly updated and with weather and impact intensity classification (10.5194/nhess-13-727-2013). The NOA db has been also based on press articles.
  - **Authors response and Manuscript changes:** Thank you very much for your important suggestions. We have included the reference 10.5194 / nhess-13-727-2013 in the introduction section and we have pointed out the peculiarities of this database. Additionally, we have added its hemerographic characterization to the description of the NOA database (See lines 26 to 28 in page 2 in the new manuscript version).

Technical corrections:

- **Authors response:** Thank you very much for highlighting these important details and providing advice about the convenience of including some necessary clarifications. All these issues have been taken into account. Most of the corrections have been resolved thanks to a native English speaker who will be responsible for reviewing the text of the new version before being sent.
  Here is a more detailed description of the changes carried out:

- **Reviewer comment:**
  1. P3, l15: Please delete the ‘y’.

- **Manuscript changes:** Delete

2. P4, l10: Please delete ‘but’.

- **Manuscript changes:** Delete

3. P4, l14: It is ‘flood cases’, not ‘floods cases’. Please repeat correction throughout the article.

- **Manuscript changes:** this mistake has been corrected

4. P4, l15: Please correct as: In this regard it must be clarified the difference between flood cases and flood events

- **Manuscript changes:** this mistake has been corrected

5. P4, l24: Please add ‘digital’ before ‘archives’.

- **Manuscript changes:** word included

6. P4,l29: The sentence is too big. Please start a new one from ‘in general.

- **Manuscript changes:** we have corrected this sentence in the revised manuscript.

7. P4, l33: Please delete ‘This is’, otherwise the sentence does not make sense. In the same sentence, please use the same term throughout the paper regarding the flood ‘case’. You have explained very well in the document the difference between case and event. So, the words ‘episodes’ and ‘events’ in this sentence do not fit.

- **Manuscript changes:** Thank you very much for your corrections. We have considered your suggestions and have replaced events for cases.

8. P5, l17: Please correct as ‘emphasized’. Also, please rephrase the entire sentence as it is not clear, especially the second part.

- **Manuscript changes:** we have corrected and revised this sentence in the revised manuscript.

9. P6, l4: Please explain the: (2003: 800)

- **Manuscript changes:** we have deleted “:800”.

10. P6, l5: please correct as: These situations.

- **Manuscript changes:** this mistake has been corrected

11. P6, l10: please use the same term: environmental or climatic

- **Manuscript changes:** we have replaced environmental by climatic

12. P6, l13: just a thought: is this sentence for Franco necessary?

- **Manuscript changes:** probably this sentence is not necessary. So, we have deleted this sentence.

13. P6, l18: please cut this sentence in 2 parts. it is too big and difficult to read

- **Manuscript changes:** we have corrected this paragraph and shortened the sentences in the revised manuscript.

14. P6, l19: it is weird the use of ‘it has:’ after ‘the following criteria’. I think it can be improved.

- **Manuscript changes:** we have corrected this sentence in the revised manuscript.

15. Table 1: what is MEDIFLOOD? do you mean SMC-Flood db? Also, the authors could enter an extra column to report the cities of head offices. The full newspaper names could be added here as a comment.

- **Manuscript changes:** we have corrected the mistake and replaced MEDIFLOOD by SMC-Floods database. We have also added an extra column in the table to report the head offices cities. Additionally, the full newspaper names are added as a footnote to the table.

16. P6, last paragraph: the different names are confusing. Consider keeping the short names of Table 1 everywhere in the text.

- **Manuscript changes:** We have considered your suggestion and for the sake of clarity, we have kept the short names of Table 1 throughout the text.

17. P7, l5: 1) the sentence is too big. Please enter full-stop before ‘Taking into account’. 2) Please consider avoiding the footnote since it concerns only one source. You could include it in the text instead.

- **Manuscript changes:** we have corrected this paragraph and shortened the sentences in the revised manuscript. Additionally, we have added the reference of note 1 in a sentence within the main text.

18. P7, l7:correct as ‘validated’

- **Manuscript changes:** this mistake has been corrected

19. P7,l8: please delete ‘de’. L10: please add space before ‘Secondly’. L22: please correct as ‘within’

- **Manuscript changes:** all this mistakes has been corrected

20. P10, l4: Please begin a new sentence at ‘Multiplying:

- **Manuscript changes:** we have corrected this paragraph and shortened the sentences in the revised manuscript.

21. Table 2: maybe it is better if you write ‘average severity index’

- **Manuscript changes:** we have added this suggestion

22. P11, l7: Please add ‘the’ before ‘number’

- **Manuscript changes:** “the” has been added

23. P11, l8: please consider defining ’average intensity’, as this is the first time we read this.

    - **Manuscript changes:** following this suggestion, the definition of average intensity has been added to this paragraph (See lines 5 to 6 in page 10 in the new manuscript version)

24. P15, l5: ‘concentration’ of what? I think something is missing

    - **Manuscript changes:** Thanks for detecting this mistake. In this sentence we want to show that during the fall there is a greater concentration of floods as intensity increases. Therefore we have modified the phrase to include the word floods: "during this season there is a higher concentration of floods as the intensity increases".

25. P19, l11: Please add ‘to’ before ‘add’

    - **Manuscript changes:** “to” has been added

26. P20, l3: please correct as ‘makes us’

    - **Manuscript changes:** this mistake has been corrected

Referee #2 responses:

Overall comment:

- **Reviewer General Comment:** The paper “SMC-Floods database: A high resolution press database on floods for the Spanish Mediterranean Coast (1960-2015)” provides a preliminary description and analysis of flood data collected from press news. It is not a novel initiative at European or Spanish level, but it comprises a large extension of a flood damage prone region. I admit that such effort merits publication somewhere, but not in the present format, which requires a major review before it can be published.
    - **Authors Response:** Thank you for your suggestions, we have included all of them in the new manuscript version. The focus of our work is to cover two main needs:
      1. Analyze the trends of flood cases and events in the Spanish Mediterranean coast. This is an area that has increased the number of floods and, according to the IPCC (2012), there are great uncertainties about the importance of the physical factor and the human factor in the balance of economic losses caused by floods.
      2. The final goal of this study is focused on knowing to what extent the variability of floods is caused by changes in the social systems. In this regard, we consider that other floods databases show a lack of data of floods in small towns (Paprotny et al., 2018) and we show that the lack of information has a substantial impact on observed trends.

- **Reviewer General Comment:** In scientific outcomes are highly bias by the journalist judgment of the flood damages and newspaper coverage and audience. Therefore, caution should be placed on the interpretation of the data.

- **Authors response and manuscript changes:** we share your view of this point, for this reason the manuscript included a paragraph of assumption of limitations that takes into account the possible bias indicated by the reviewer: "*However, there are other factors that should not be overlooked or dismissed. According to Llasat et al., 2009, it is important to consider that trends may be biased by various reasons: i) a greater sensitivity or perception towards natural risks from the public opinion could increase news about floods in newspapers; ii) a greater spatial coverage of the news thanks to the improvement of communications. The complexity of the factors (social, cultural, environmental and perceptual) involved in flood processes make us think about the influence of the mentioned items in the observed trends. Therefore, a deeper knowledge on climatic, geographic and socioeconomic variables involved is necessary*".

  To the above explanation we have added another possible biased commentary to the manuscript text: Eisensee and Strömberg (2007) argue that the coverage of natural disasters in the press depends on the availability of other newsworthy material at the time of the disaster. Additionally, and as you point out, there may be some spatial bias in the news based on the newspaper's spatial coverage (Walmsley, 1980). In this regard, and as explained in section 3 (Methodology and sources), the newspapers used are regional newspapers, which specifically cover the information of each of the Autonomous Communities studied throughout the study period. On the other hand, the experience of other related works (Llasat et al., 2009) and the way of gathering information, show that the subjectivity of the journalist or the newspaper can bias the level of intensity, but not the type of damage. In this regard, the type of damage may be under-documented, but it can rarely be over-documented. However, it is true that the increase of population has been able to influence the increase of news in small populations. This is precisely one of the facts that we highlight in this work, since a large part of the detected trends are influenced by the population increase. This fact can be observed when we analyze the trends in floods according to population growth. In making this analysis, we observed that the greater the population increase of the municipalities between 1960 and 2011 was (the two extreme census moments during the study period), the greater significance and intensity the trend detected has. In the following table (Table 1) it can be observed that in the set of municipalities where population have grown less than 50% between 1960 and 2011, the floods have no significant trend. However, floods have a statistically significant trend in municipalities that have grown more than 50%. The interesting thing is that the rate of increase in floods is greater as the population growth is greater. This shows that the detected trends are largely influenced by the increase in exposure.

Table 1: Floods trends in Spanish Mediterranean Coastal Municipalities related to ranges of population increase between 1960 and 2011.

Population increase range in %	Kendall's tau	P-value	Sen´s Slope
Less than 0%	-0.048	0.733	0
Between 0 and 50%	-0.060	0.550	0
More than 50 and less than 100%	0.280	0.005	0.127
More than 100 and less than 200%	0.340	0.000	0.286
More than 200 %	0.380	< 0,0001	0.471

**To calculate trends, we have used Hirsch and Slack's nonparametric test (1984), which is based on Mann-Kendall range. The trial version of XLSTAT software (Addinsoft, 2018) was used to calculate it. The Mann-Kendall test provides a level of statistical significance (p-value). The threshold of significance chosen was 95%, which indicates that p-values above 0.05 should lead to rejecting the hypothesis of a trend in the series. When the p-value is less than 0.05, the trend can be positive or negative. Sen´s Slope shows the annual change rate in floods. That is, the value informs about the annual increase or decrease of the floods.*

To clarify this point, we have added the previous table and part of the previous comments to section 4.5. in the new manuscript version (See lines 2 to 30/page 20). However, it is true that there are still many uncertainties regarding the possible information bias. For this reason, in the conclusions section we have included that, although the results are robust when relating population increase and increase in floods, the trends detected may be biased by journalistic issues (See lines 26 to 29/page 21).

- **Reviewer General Comment:** there is not a critical analysis of the results in relation to other more robust database, for instance the analysis from the National Insurance Consortium. As this database reflects risks (mostly exposure and vulnerability), most of the hydroclimatologic trends and changes on hydroclimatic conditions may not be valid.
    - **Authors response and manuscript changes:** we agree with the reviewer. In the new version of the manuscript, a critical analysis is included in relation to the National Insurance Consortium database (See lines 12 to 27/page 18). However, it should be noted that the Spanish insurance contract law does not require the insurance of the home. Therefore, this database could be even more biased than ours depending on the degree of insurance coverage in the municipalities of the study area (Clavero, 2016). On the other hand, the fact that the National Insurance Consortium database is based on private insured assets limits information on the impact of floods on public goods such as roads. In this regard, and taking into account the great weight that road damages have on our database, it is not surprising that the SMC-Floods database considers a number of cases far superior to the National Insurance Consortium database.

- **Reviewer Specific Comment:** 1.- The manuscript requires a detail English correction on the style. It looks a direct translation from a Spanish text, I would say that the authors used google translator, otherwise, I cannot explain the use of some very incorrect terms. Among the most critical one are "Cold Drop" cited in the paper, and probably authors refer to "cold pool" or "mean mobile" (cited in figure 7) instead of "moving average". These are only few examples, but the text is full of informal terms or sentences that do not make any sense in English.
    - **Authors response and manuscript changes:** a native English speaker has been responsible for reviewing in depth the text of the new version of the manuscript.

- **Reviewer Specific Comment:** 2.- The manuscript is very long and this makes difficult to read. The authors should analyze in each sentence and use proper language addressing the point in a direct way.
    - **Authors response and manuscript changes:** the deep revision of the language of the manuscript by a native English speaker, has been an important summary and synthesis of the manuscript. In this way, we consider that the ideas are now expressed more clearly.

- **Reviewer Specific Comment:** 3.- Several sections can be shortened, including the introduction and conclusions.
    - **Authors response and manuscript changes:** the same than the last point. Additionally, we have eliminated non-relevant text parts in the introduction and conclusions sections.

- **Reviewer Specific Comment:** 4.- Abstract: The abstract should be completely re-written. The way it is written looks and introduction rather than a summary. Sentences such as “Floods are the natural disaster that affects the greatest number of people and causes the highest economic losses in the world” are fine for the introduction, but not for the abstract. Please, start the abstract by telling the reader at once what the paper is: new data, a review of progress, a new technique, a synthesis, or whatever describes the nature of the paper. Unnecessary descriptive phrases and qualifiers should be left out of the abstract. Write the abstract as styled summary of its essential information; and include as much specific information as possible on the results.
    - **Authors response and manuscript changes:** we appreciate the comment of the reviewer and we have rewritten completely the abstract following his suggestions.

- **Reviewer Specific Comment:** 5.- Introduction: There is a long description of flood databases from press news in Europe and the world, and they do not provide any key information to objective or analysis to be addressed by the MSC database. I would suggest leaving only the most relevant databases, and includes the rest on a table indicating the country, region, time period covered, data source, type of data included, authors.
    - **Authors response and manuscript changes:** We appreciate your comment. Following your recommendation in comment 3, we have shortened the Introduction section. For this, we have chosen to describe the most relevant databases for the objectives of this work and for more general bases, we have chosen to refer to previous works that describe these databases in tables and graphs.

- **Reviewer Specific Comment:** 6.- Page 4. Introduction Lines 24 to 30 I suggest to move to methodology section
    - **Authors response and manuscript changes:** we agree with you that this part of the work is not appropriate for the introduction section and that it is more typical of the methodology section. However, in order to not repeat information in the methodology section, we have delete most of the text from lines 24 to 29 on page 4 in the new version of the manuscript.

- **Reviewer specific Comment:** 7.- Page 4 introduction. Lines 31 to end of section, I suggest to delete this paragraph. Instead you should describe the specific objectives of this study.
    - **Authors response and manuscript changes:** we agree with the suggestion and we have included a paragraph with the main objective and the sub-objectives of the work. Además, hemos eliminado las líneas 31 al final de la sección en la página 4.

- **Reviewer specific Comment:** 8.- Page 6, lines 13 to 15 probably not needed, delete.
    - **Authors response and manuscript changes:** we have deleted this lines.

- **Reviewer specific Comment:** 9.- Page 8. Indicate the list of damage types in a single line.
    - **Authors response and manuscript changes:** we have indicated the list of damage types in a single line.

- **Reviewer specific Comment:** 10.- Type of damages. Here roads and housing are the most common ones. I wonder if the news are bias to these two types because of most easy ones to be reported right after the event.
    - **Authors response and manuscript changes:** the most frequent impacts caused by floods are usually road cuts. Riverbeds of the study area are of ephemeral functioning, therefore, a great part of them are crossed by the roads without bridges or, even, used as communication routes between the headwater and mouth areas. Therefore, it is logical that most of the damages are those of the roads. On the other hand, if we consider that floods are a natural risk, its measurement is based on the affection to human societies (Bates and Peacock, 1987, Tapsell, et al., 2002), therefore, it is not rare that another important part of the damages reports is housing. So, if we consider that the fact that road and housing damages are the most numerous, it does not imply a bias, but rather an evidence of the

geographical and social reality of the floods in the study area. For clarity, we have added part of these arguments in section 4.4 (Flood damage variability) of the new version of the manuscript (see lines 12 to 16/page18).

- **Reviewer specific Comment:** 11.- page 10 line 25. How the quantity of damage was calculated?. In the case of housing, are you reporting the number of affected houses, or on roads, the number of cut roads...?
    - **Authors response and manuscript changes:** the number of houses, the number of affected roads, and the number of other types of damage are not reported. For example, for each newspaper news about floods we assign, a value of 0 is assigned if there is no damage in a specific damage variable. Thus, this information only informs of absence or presence of damage, and not of the amount of each type of damage.
    In this respect, and as we pointed out in section 3 of the manuscript, damages are constructed as dichotomic variables to point to the presence (1) or absence (0) of any of the studied damages by flood in each municipality. Thus, information regarding the type of damage suffered in each municipality was categorized in a simple way, it is, being aware of the difficulty involved in objectivizing quantitative information, consistently in time and space (Gil-Guirado et al., 2016).

- **Reviewer specific Comment:** 12 Page 15. “cold drops” is a direct translation of the Spanish informal term. Please, use “cold pool” or mesoscale convective systems.
    - **Authors response and manuscript changes:** thanks for detecting the mistake. We have corrected this word.

- **Reviewer specific Comment:** 13.- Page 15. From line 20 to 28, it is poorly written and they need major changes.
    - **Authors response and manuscript changes:** we appreciate your comment. We agree with the suggestion and we have made major changes to correct that lines.

- **Reviewer specific Comment:** 14. Page 17. Line 6. I don’t understand “the latitudinal gradient referred to above continues to be reflected.
    - **Authors response and manuscript changes:** we are sorry about the lack of clarity in this sentence. What we were trying to say is that the same latitudinal gradient is detected in that section (4.4 Flood damage variability) as the one mentioned in 4.2 Spatial Variability of floods.
    This latitudinal gradient is characterized by more severe, intensive, extensive and damaging floods as we move from north to south of the study area and it is mainly due to greater deficiencies in the spatial planning of the provinces in the south, although the climatic and orographic factors cannot be ruled out. In the new version of the manuscript, we have clarified line 6 on page 17, so that it is clear that we mean latitudinal gradient at this point.

- **Reviewer specific Comment:** 15. Page 18. Line 25-27. This is not surprising due to the press nature of the database. As more small villages are cited on the newspaper, the flood extend on the database increases.
    - **Authors response and manuscript changes:** as shown in panel b and c of figure 7, variability of annual cases of flooding and the annual area affected by floods seem very collinear. However, this should not necessarily be true, as there could be an increase in cases of flooding in municipalities with small size, while larger municipalities have a negative trend. In this way, panels b and c of figure 7 serve to confirm that there is no differential a flood trend in municipalities that has something to do with the surface of the municipalities. It is important to mention that, as indicated in section 4.2. of the manuscript, there is a great variability in the surface of the different municipalities studied.

- **Reviewer specific Comment:** 16 Page 19. Lines 10-11. The sentence "The fact that the floods of L1 consider not only river floods (also consider flash floods and in situ floods), can magnify the importance of the increase in exposure, as to the growth of the exposed surface in flood zones." I wonder if the main problem is the nature of the database, because social perception of risk increase with time, since any single damage is reported on the local news.
  - **Authors response and manuscript changes:** as we pointed out in the response to your second general comment, in the text of the manuscript we mention the possible biases that risk perception can introduce (Llasat et al., 2009) in the trends obtained. However, as we showed in that same response to your general comment, trends are mainly influenced by population growth and therefore, are influenced by the increased exposure to flood hazard. In any case, in the new version of the manuscript we have explained better the main idea in that paragraph.

- **Reviewer specific Comment:** 17.-Conclusions should go to the point of the main results. In the present format, there are too long, and they should be shortened.
  - **Authors response and manuscript changes:** taking advantage of the deep revision of the language, we have proceeded to rewrite the conclusions so that they are more concise and focused on the results of the work. Thank you very much for your important contribution.

- **Reviewer Other minor changes:** Other minor changes are suggested on the pdf document: https://www.nat-hazards-earth-syst-sci-discuss.net/nhess-2019-10/nhess-2019-10-RC2-supplement.pdf
  - **Authors response and manuscript changes:** we appreciate all your important suggestions. All minor changes has been taken into account in the new version of the document.

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SMC-FloodsFlood database: A high resolution press database on floods for the Spanish Mediterranean Coast (1960-2015).)

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Abstract. Floods are the natural disaster that affects the greatest number of people and causes the highest economic losses in the world. However, some areas, such as the Mediterranean Coast of the Iberian Peninsula, are especially exposed to this natural hazard. The problem takes on even more relevance when a changing social dynamic is added to the natural context. With a view to accomplishing correct spatial planning in the light of the flood hazard, it is necessary to carry out an exhaustive analysis of theHigh spatiotemporal variability of floods with a scale of analysis that allows the detection of changes and the search for causality. Databases compiled from journalistic documentation offer these possibilities of analysis and represent a vital flood databases are a necessary tool for correctproper spatial planning.
In, especially in areas with high levels of exposure and danger to floods. This study we present the SMC (presents the preliminary results of the Spanish Mediterranean Coast) Coastal Flood database forcovering the municipalities of the Mediterranean coast of mainland Spain. This database has enabled the reconstruction of 3,008 cases of flooding onin this region. This database collects information on flood cases that occurred between 1960 and 2015 by systematically consulting the digital archives of the main newspapers in the study area. The search for flood information was conducted by means of using links between municipality names and 7 keywords that correspond to the most common ways of referring to a situation that is likely to describe a flood in Spain. This methodology has enabled reconstructing 3,008 flood cases at a municipal scale and with daily resolution, with while gathering information on the typetypes of damagesdamage, intensity, severity and area affected. The spatiotemporal analysis of the data reveals blackhot spots where floods are especially intense and damaging, when compared to highly-developed areas where the frequency of the floods is very high. This situation is especially worrying, insofar as we have detected a growing trend in the frequency and area affected by floods. However, it isone positive aspect is that the intensity and severity of the floods follows a falling trend. The main novelty lies in the fact that the high-resolution spatial analysis has made it possible to detect a clear latitudinal gradient of growing intensity and severity within a north-south direction. This pattern subjects the coastal municipalities of the south of Spain to a complicatedcomplex floods adaptation scenario.

Keywords: SMC-Flood database, newspaper, Spanish Mediterranean coast, flood intensity, flood severity

1 Introduction

On the Spanish Mediterranean coast, the relationship between water systemsresources and societies has been marked over time by the succession of periods of drought and catastrophic floods. that have major socio-economic impacts. This dual system has determined the exposure ofleft societies to the reception of flowswho need water resources for their agricultural and domestic use, indemands exposed to an environment characterized by the torrential nature of rainfall (Gil-Guirado, 2013). Together withIn addition to the climatic situationconditions, it is also necessary to consider the social component. The situation of economic growth experienced onin the Spanish Mediterranean coast inregion over recent decades has generated an inordinate increase inincreased exposure and vulnerability to the hazard (Pérez-Morales et al., 2018)), with a significant rise in economic lossesloss caused by floods (Barredo, Saurí y Llasat, et al., 2012). This socio-economic growth process has occurred without proper planninghaving properly planned any strategies to reduce the impact of floodsflooding (Olcina-Cantos et al., 2010). One of the factors that facilitate theleading to a lack of strategic planning is the absence of a correct chronology of flood episodes (Hilker et al., 2009). InAs a result of this situation, land use plans are based on inadequate chronologies that do not report the real risk ofto the population ofin this area (Barriendos et al., 2014).

Several open and global flood databases have been developed over recent years by different bodies such as universities (Brakenridge, 2010; EM-DAT, 2018), insurance groups (Munich Re, 2017; Swiss Re, 2018), climatic agencies (WMO and UCL, 2014; NOAA, 2018; ESSL, 2018) or international organizations (Rodier and Roche, 1984), the results of which have boosted flood risk knowledge on a global and regional scale. One of the databases that includes the best spatial coverage of floods is the European Past Floods dataset of the European Environment Agency. This database contains information on past floods in Europe since 1980 (European Environment Agency, 2018) including the impact type and losses. However, the database has(Brakenridge, 2010; WMO and UCL, 2014; Munich Re, 2017; ESSL, 2018; EM-DAT, 2018; European Environment Agency, 2018; NOAA, 2018; Swiss Re, 2018)[1]. Nevertheless, most of these databases have two limitations: i) the level of spatial resolution is variable between the municipal and regional scales, and ii) there is a considerable underestimation of the number of events owing to the use of indirect sources. By the way of example, whereas the SMC-Flood database reconstructs 2,943 cases of flooding in the Mediterranean coastal municipalities for the period 1980 to 2015, the European past floods database includes for this period 2,849 cases for the whole of Spain; and ii) the number of events is considerably underestimated due to the use of indirect sources (Llasat et al., 2013a). Despite this, these databases have been used in a great deal of research to analyse the trends and changes observed in the behaviour of floods on different scales (Barredo, 2007; Ashley and Ashley, 2008; Kundzewicz et al., 2013; Jongman et al., 2015; Terti et al., 2017). Other studies, such as that of Adhikari et al. (2010), have compiled information from the main global-scale databases to increase the spatial resolution and improve the spatiotemporal representativeness of the data. Taking into account the bias of the original databases,

[1] For more detailed information, the studies of Adhikari, et al. (2010), Bouwer (2011), Llasat et al. (2013a) and Napolitanao et al. (2018) include a detailed catalogue of some of these databases and their scope.

the results of these studies may present biases related to underestimating the number of episodes and the failure to consider local variations.

The studies of Adhikari, et al. (2010), Bouwer (2011) and Napolitanao et al. (2018) include a detailed catalogue of some of these databases and their scope. Furthermore, their results have been used by a great deal of research to analyse the trends and changes observed in the behavior of floods on different scales. For example, Barredo (2007 and 2009) analysed the losses caused by floods for Europe between 1950 and 2006. Similarly, Kundzewicz et al. (2013) used the flood database of the Dartmouth Flood Observatory to analyse the trends of severity and scale of the floods in Europe between 1985 and 2009. Other types of studies have looked into the spatiotemporal reconstruction of fatalities due to flooding in the USA. For example, Terti et al. (2017) for the 1996 to 2014 period and Ashley and Ashley (2008) for 1959 to 2005. Neumayer and Plümper (2007) have analysed the impact of floods on the life expectancy of women on a national scale for a set of 141 countries between 1981 and 2002. Other studies such as that of Adhikari et al. (2010) have integrated the information of each flood event existing in the main databases on a global scale to increase the spatial resolution and improve the spatiotemporal representativeness of the data. Finally, Jongman et al. (2015) examine the role of vulnerability and capacity for adaptation of societies to confront floods between 1980 and 2010, to conclude that there is a trend for convergence in vulnerability levels between low- and high-income countries. However, the results of these studies may present biases relating to the underestimation of the number of episodes and the failure to consider local social-environmental variations. In addition, there are other problems related to the dispersion of the type and quality of information related to the same flood event (Guha-Sapir and Below, 2002) as well as the existence of inclusion criteria based on the crossing of human or economic loss thresholds (Hirabayashi et al., 2008).

On the other hand, there are several works other studies like this that have developed their own databases according tousing primary sources (newspapers, books, historical documents, reports and technical and scientific papersdocuments) for different regions of the planet[2]. With regard to the classification of historic sources, according to their originality and the way they have been generated, these may be (Barriendos et al., 2014): Primary or direct, when the material is first hand in relationship with the fact to be studied, that is, prepared at the same time as the event and by a direct witness; secondary if they are based on the primary sources; and tertiary, those made on the basis of the previous two. Secondary and tertiary sources are indirect sources..

In this respect, the studies developed in the Mediterranean countries stand out. For example, region are very remarkable. Some works have made notable efforts to synthesize flood data from different European regions in order to offer a homogeneous database for the western Mediterranean. In this regard, the works by Llasat et al. (2009) complete a high-resolution(2013a, 2013b) show the results of the FLOODHYMEX database for the north-east of analysis (produced in the framework of the HYMEX Project). Using newspaper sources with high spatial resolution, these works collect a large amount of data on flood events that occurred between 1981 and 2010. As for Spain between 1982, works of Llasat et al. (2009; 2013a, 2013b; 2016) and Barnolas and Llasat, (2007 based on journalistic information. For) show remarkable improvements in flood databases

[2] For example: FitzGerald et al. (2010) for Australia; McEwen (2006) for Scotland; Glaser and Stangl (2004) for Central Europe; Quan (2014) for Shanghai; and Brázdil et al. (2014) for Southern Moravia (Czech Republic).

through the ~~same region but for a much longer period of time (1035-2013),~~INUNGAMA flood database. Also in Spain, Barriendos et al. (2014) ~~make use of another~~analysed a historical database obtained from ~~historic documentation~~historical documents, newspapers, official reports and expert studies~~ by experts. Also in~~, covering the ~~Iberian Peninsula~~period 1035–2013. For Portugal, Zêzere et al. (2014) present a database~~ for Portugal and~~ for the period 1865 to 2010, which they obtained ~~via~~from 16 national, regional and local newspapers. Other Mediterranean countries present equally valid initiatives, such as Diakakis et al. (2012) for Greece, whose work covers the period ~~from~~ 1880 to 2010 ~~via the use of~~using journalistic sources and flood event databases from state civil protection agencies. ~~Italy~~Another important example in Greece is the ~~Mediterranean country~~NOA Database (Papagiannaki, et al., 2013), which is also based on press articles that are constantly updated with information on weather and impact intensity classification. Italy also has adopted ~~the most~~ a large amount of initiatives to ascertain ~~the flood risk of its populations with~~ at a high level of spatiotemporal resolution~~.~~ the flood risk to its populations. In this respect, projects have been developed for specific regions of Italy. Specifically, ~~in~~for the region of Calabria, Polemio and Petrucci (2012) and Petrucci et al. (2018) analyse the variability of ~~the~~ floods at the municipal level between 1880 and 2007 ~~using~~, doing so by using newspaper and historical documents for their reconstruction~~ journalistic information and historic documentation~~. For the region of Campania, Vennari et al. (2016) reconstruct more than 500 flood events for the 1540 to 2015 period using ~~for this purpose historic documentation of different types.~~historical documents. However, the project ~~with~~at the largest scale, the AVI Project, was ~~developed~~based on the ~~basis of the~~ studies of Guzzetti et al. (2005) and Salvati et al. (2013), whose results ~~enabled the establishment of~~made it possible to establish a high-resolution floods and landslides database for the whole of Italy between AD 68 and 2010. Basically, the AVI Project uses primary documentation, but with detailed information on ~~fatal victims, people~~deaths and displaced ~~persons~~people.

~~Outside the Mediterranean area, other regions with a high risk~~The aim of ~~flooding have conducted in-depth studies~~most of ~~this type. For Australia, FitzGerald et al. (2010) construct a database of people killed by floods between 1997 and 2008 by means of data from newspapers and historic accounts, as well as government and scientific reports. In addition, there are notable initiatives for the compilation of flood events for long periods of time via historic documentary sources. For example, McEwen (2006) for Scotland between 1200 and 2004; Glaser and Stangl (2004) for Central Europe between 1000 and 2003; Quan (2014) for Shanghai 251 to 2000; and Brázdil et al. (2014) for Southern Moravia (Czech Republic) between 1650 and 2000. Without doubt, these studies represent a notable advance in research on flood risk in their respective areas of study.~~
~~In short, the majority of all~~ these works is related to analysing ~~the~~ flood trends for the period of time reconstructed. However, the relationship between ~~the increase~~increases in exposure, losses and ~~impact~~impacts of ~~the~~ floods does not follow a growing ~~lineal~~linear function. In fact, climate variability, defence infrastructures, adaptation measures and the increase in exposure have changed both social perception and flood trends (Jongman et al., 2014). In this respect, it is necessary to stress the existence of a negative correlation between the duration and ~~the~~ direction of the trends~~, whilst the~~. Whilst negative trends appear in ~~the~~ studies ~~with~~using data ~~relating to~~that covers several centuries, ~~the~~ positive trends appear in studies that analyse data ~~of~~on the last half-century. These divergences are due both to ~~the~~ capturing~~ of~~ climatic oscillations in data with a long

duration (Barriendos et al., 2014) and to the heterogeneity of the sources used during recent years (Brázdil et al., 2014). Furthermore, the increase in exposure to flood risk has led to a rise in ~~the~~flood trends (Perez-Morales et al., 2018).

Among the different sources used for flood databases, ~~journalistic~~newspaper sources allow ~~a homogenization of~~homogenizing the documentary volume of different countries ~~during~~over at least the last 150 years. In fact, ~~the majority~~most of the studies ~~referred to which~~that reconstruct floods for more recent periods have ~~found~~used newspapers as their main source of data ~~in newspapers~~ (e.g.~~.~~., FitzGerald et al., 2010; Zêzere et al., 2014). Despite the fact that journalistic sources describe the impacts of floods on societies in great detail, ~~their~~they are of a high spatiotemporal resolution and ~~the~~have a large quantity of information ~~dealt~~to deal with~~ make~~, thus making it necessary to reduce both the area of study and the period analysed. ~~Obviously,~~ Although the compilation of information is obviously an arduous task ~~with~~involving detailed archive work, ~~but its~~it's the results accurately reflect the impact of ~~the~~ floods ~~accurately~~ (Barriendos et al., 2014).

To reduce the knowledge deficit regarding the spatiotemporal variability of floods and ~~contribute~~ to ~~a~~ more ~~efficient zoning of~~efficiently zone the Mediterranean coast according to flood risk, we have developed a high-resolution flood database~~.~~ by means of a methodology based on exploring the digital archives of the main newspapers published in the area. This database, ~~called~~the Spanish Mediterranean Coastal database (or, SMC-Flood~~,~~ database), includes all the ~~floods~~flood cases recorded in newspapers for the different municipalities of the Spanish Mediterranean coast from 1960 until 2015. ~~The methodology consists of exploring the archives of the main newspapers published in the area. The searches~~Here, we should clarify the difference between flood cases and flood events. We consider a flood case to be when a municipality has suffered some economic or social impact due to rain on a specific day. However, a flood event refers to an atmospheric situation on a specific day or in a time period that may have ~~been made by typing the name of each of the 179 coastal~~affected several municipalities ~~followed by 7 key terms. Later, each flood was classified according to dates, intensity level and damage~~at the same time (several flood cases). In this way, a flood case always corresponds to an affected municipality on a particular day, while an event may involve several municipalities and days. For example, during the flood event of October 1973, there were 27 flood cases along the coast in the provinces of Almeria and Murcia on the 18th and 19th of that month. Considering cases and not events implies a large number of records in comparison to databases that consider only flood events.

Therefore, the main objective of this paper is to present the preliminary results of the SMC-Flood database, thus providing an indicator of the potential of using this type~~. Finally, we consulted the specific bibliography to rule out any data gaps~~ of high resolution database for research. Our objective is especially relevant to areas like the Spanish Mediterranean coast, where population growth in recent decades has led to an unbridled increase in exposure to flood risk. In this regard, this paper has secondary objectives of analysing the temporal spatial variability of flood cases in the study area and detecting hot spots with high flood risk.

In future research, this database ~~is expected to~~will be used for various purposes, such as ~~the evaluation of~~ for evaluating flood prediction tools~~, the determination of acceptable~~ and validating risk thresholds according to ~~the conditions of~~ exposure and vulnerability~~, the characterization of seasonal and regional trends and,~~ conditions. In general, the SMC-Flood database will contribute to improving the understanding of the flood processes in an area of special economic, climatic and social interest.

~~The article is structured in four parts. First, the study area is explained and justified. The second part sets out the methodology used for the compilation of the SMC-Flood database. The third part presents the results obtained from the preliminary exploitation of the data. This is based on a general summary of the database, a spatial analysis of the distribution of flood episodes, a time analysis of when such events took place, an exposé of the variability of the damages caused by those floods and, the evolution and trends are presented for the period analysed. Finally, the main conclusions are presented followed by the lines of work to be followed.~~

2 The Spanish Mediterranean coast: "A flood risk-region"

The study area includes all the coastal municipalities of the Spanish Mediterranean Sea on the Iberian Peninsula. In total, there are 179 municipalities integrated ~~in~~into 11 provinces and 4 autonomous communities (see Fig. 1). The total area is 13,381 km^2 (2.64% of Spain's total ~~Spain~~ area~~)~~), with a population of 8,413,290 inhabitants in the year 2016 (18% of the Spanish population) (INE, 2018) and an average population density of 1,200 inhab/km^2, a figure far higher than the average for the EU (119) and for Spain (92).

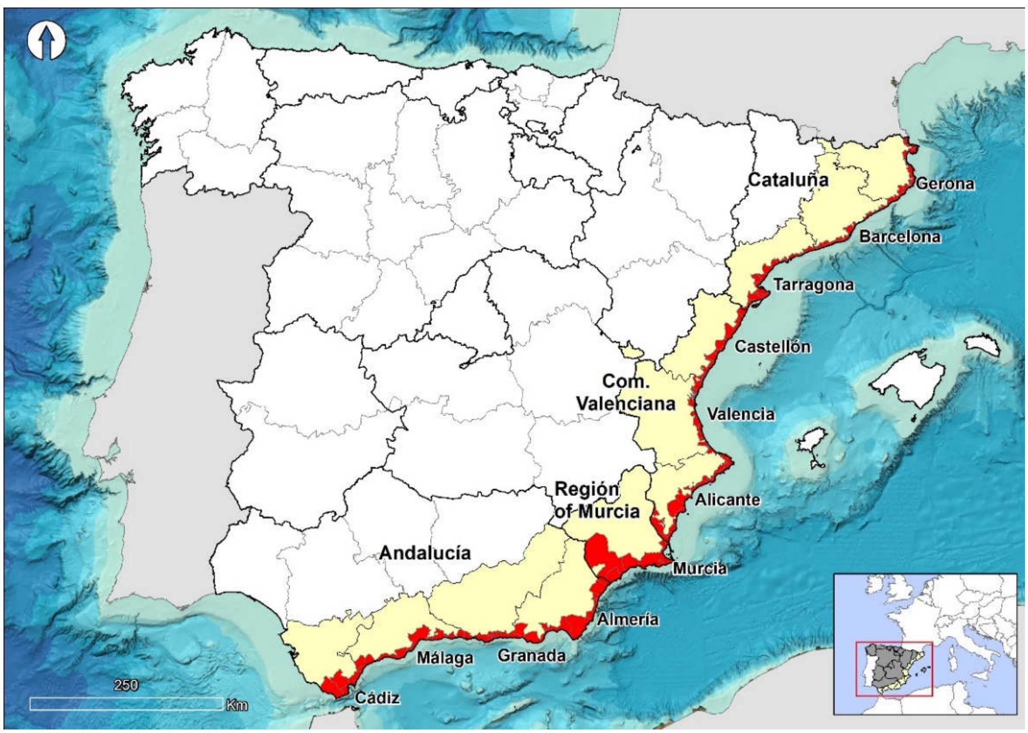


Figure 1: Coastal municipalities of the Spanish Mediterranean Sea ~~over~~along the Iberian Peninsula.

Due to the climatic and hydrological conditions of the Spanish Mediterranean basins, ~~together with~~as well as the intensive anthropic transformation that has taken place, ~~have converted~~ this space ~~into~~has become a "risk region" with a high level of vulnerability (Olcina-Cantos et al., 2010). The rainfall climatology in the western Mediterranean is marked by high variability coefficients (above 35%). Thus, 25% of rain days concentrate more than 75% of precipitation (Martín-Vide, 2004). A large proportionThe seasonality of this torrentiality is due totorrential rains over the recurrent “Cold Drops” (“Gota Fría”) which affect the east of the peninsula. The origin of this phenomenonSpanish Mediterranean region is marked by a maximum at the end of summer and especially during the autumn (Llasat et al., 2013a). This maximum is due to warm, humid air coming in at low levels from the sea (Gilabert and Llasat, 2018: 1864). These atmospheric situations can be accentuated by the presence of a closed upper-level low (Sumner et al., 2003), which has become completely displaced (cut off) from the basic westerly current and moves independently of that current (Pagán et al., 2016). These systems require the conjunction of a pocket of cold air in the upper layer of the tropopause, togetherHowever, convective precipitations are the trigger for a large number of torrential rain episodes that are of low spatial extent and especially related to flash floods (Gilabert and Llasat, 2018). What is more, this climate scenario can become more dramatic in the future. Sumner et al. (2003) highlighted a notable increase in most synoptic situations with the presence of Mediterranean seawater at high temperatures (Martín et al., 2006). Although this situation usually occurs at the end of summer and during the autumn, global warming is lengthening the calendar (until winter) (Trigo and Palutikof, 2001) and frequency of its appearance (Sumner et al., 2003). an easterly flow on the Spanish Mediterranean coast. These situations are prone to generating torrential rains and thus increasing flood hazards. Added to this climatic scenario is the effect of an abrupt relief, with sharp gradients (Gilabert and Llasat, 2018) and scarce vegetation, which increases the quantity of effective rain converted intorainfall becoming run-off. Furthermore, the presence of pre-littoral reliefs exacerbates these precipitations and explains part of the great spatial variability of the precipitation during a single atmospheric event (Romero et al, 2000).

In addition, this environmentalclimatic scenario is complicated with the addition ofby the social component. Because of the intensive agriculture, industry in the major urban centerscentres, trade and tourism make, this region is the main centercentre of urban growth (Burriel, 2015), economic dynamism and with one of). Thus, the resulting dynamic economy places it among the highest rates of population and economic growth ofin Europe inover the last 50 years. This process was boosted in the early nineteen-sixties, when Franco’s regime started to be more open abroad. Furthermore, climate conditions (warmer temperatures and a large number of sunny days) played a major role in tourist arrivals, in fact it became the slogan of the area (Cortés-Jiménez, 2008).

3 Methodology and sources

The SMC-Flood database contains information about floodsflood cases at the municipal level that were published in printed newspapers and which took place inamong the Spanish Mediterranean coastal municipalities (henceforth SMCM) between AD 1960 and 2015. The newspapers used were selected according to the following criteria: i) it has the highest circulation in each one of the four autonomous communities studied,; and ii) it has its head office is located in the same autonomous community (see Table 1). This criterion ensures the reliability of the data, since news coverage of the floodfloods is more extensive when the original source of origin of the data is a newspaper that has itswhose office is in the same autonomous community.

Table 1: Newspaper sources for the MEDIFLOOD SMC-Flood database:

Newspaper	Type of Access	Newspaper Library Link	Period	Main coverage region	Head office
ABC	Open	http://hemeroteca.abc.es/avanzada.stm	1903-Now	Andalusia	Seville
LV	Open	https://www.lavanguardia.com/hemeroteca	1881-Now	Catalonia	Barcelona
EMV	Restricted	-	1872-Now	Valencian Community	Valencia
LVM	Restricted for news before 2006	-	1903-Now	Region of Murcia	Murcia

*The head office of the newspaper ABC has its head officeis in the city of Seville (Andalusia),); that of the newspaper La Vanguardia (LV) has its head office is in the city of Barcelona (Catalonia),); that of the newspaper El Mercantil Valenciano (EMV) has its head officeis in the city of Valencia (Valencian Community). Finally,); and that of the newspaper La Verdad de Murcia (LVM) has its head officeis in the city of Murcia (Region of Murcia.

The information from these newspaper archives is available digitally, through both with open access (La VanguardiaLV and ABC),) and restricted access (Levante Mercantil and La Verdad de Murcia). For the cases whereEMV and LVM). When access was restricted, we obtained an unrestricted password for the Levante EMV, obtained free of charge within a the framework of scientific cooperation framework. In the case of La Verdad de MurciaLVM, we carried out the search on the central computer of the newspaper's head office of the newspaper in the city of Murcia.

The digitization ofdigitized documents enabled facilitated keyword searching for the information search to be performed by keywords in the archive search engines of the archives of each newspaper. In this respect, The first step consisted of relating each municipality (179) with the newspaper to its corresponding to its Autonomous Community. autonomous community's newspaper. However, the searchin some cases, searching for information in anysome other newspaper served in some cases to completecompleted the level of detail on specific cases and municipalities. Additionally, we consulted the specific bibliography to rule out any data gaps.

, for which the main source of information was the Catálogo Nacional de Inundaciones Históricas (Pascual and Bustamante, 2011). It is necessary to validate the results, especially when taking into account certain problems related to using newspaper sources, such as: inhomogeneity, duplicity of information and contradictory information (widely discussed by Llasat et al., 2009 and 2013a). Furthermore, these newspaper-source problems become more evident going back in time (more than 50 years), since journalistic sources are relatively more consistent over recent decades. In light of the issues above, the authors conducted the query procedure manually in order to eliminate some of the indicated problems from this database. Secondly, we carried out the systematic search for news where the name of each municipality appears together with any of the 7 keywords/phrases selected (see Fig. 2, Panel a). These keywords correspond to the most common ways of referring to a situation that is likely to describe a flood in Spain:

1. "Inundación" (Flood).
2. "Inundaciones" (Floods).
3. "Riada" (Flash flood).
4. "Lluvias torrenciales (Torrential rains).
5. "Fuertes lluvias" (Heavy rains).
6. "Intensas lluvias" (Strong rains).
7. "Tromba de agua" (Severe downpour).

In addition, the search was duplicated for those municipalities in Catalonia and the Valencian Community that have language variations (e.g~~.~~., Alicante/Alacant, La Escala/L'Escala, El Puerto de la Selva/El Port de la Selva, Sagunto/Sagunt). In this way, we ensured that the same search criteria were ~~complied with in~~fulfilled within all cases.

This initial search produced more than 1,500,000 possible results (news pages). Obviously, several keywords may be present on one page of news. In many other cases, the name of a municipality may appear on the page of a news item on floods, but without having been affected by that flood. In ~~relationship with~~relation to this last point, it is possible to limit ~~the search~~searches to cases in which the keywords are ~~directly~~ connected directly to the name of the town (i.e~~.~~., “Torrential rains in Barcelona”). ~~But~~However, we found that ~~in~~ this ~~way the results were~~ excessively restricted~~, and~~ our search results, thus leading to many missing news items that ~~did report~~ had actually reported on ~~a flood were missing, since it is frequent~~specific floods. The reason for ~~the~~this is that keywords ~~to~~frequently appear in the headlines ~~and for~~while the body of the news ~~item to describe~~report describes the impacts and ~~define~~identifies the affected municipalities ~~affected~~.

To filter the initial search results, each news item was saved in a digital file with the date of the news, followed by the initials of the newspaper (LVG, ABC, LVM or EMV) and, finally, the page ~~of the news (page~~number of the newspaper where ~~the news~~it was ~~located). In~~reported. On many ~~cases~~occasions, news about a flood in a specific town ~~is included on the same day~~appears on different pages within the same day, offering varied and complementary information. Fortunately, this system for the coding ~~of~~ news enabled ~~the~~ elimination of ~~duplications in both the~~duplicate keywords ~~and the~~as well as municipalities (the same piece of news describes floods in various municipalities). Thus, the file ~~of~~on possible floods was reduced to 23,580 pieces of news for the SMCM.

~~In~~ The next step~~,~~ involved transforming qualitative information ~~was transformed to~~into quantitative information (see Fig. 2, Panel a). To this end, we consulted all the news filed and proceeded to code the news text ~~of the news in~~onto spreadsheets ~~based on the consultation of all the news filed. The digitization of~~. Digitizing the news ~~sheets~~pages by means of Optical Character Recognition (OCR) substantially facilitated this arduous task. ~~In turn~~Furthermore, the coding complied with the following classification protocol (see Fig. 2, Panel b):~~ On the one hand,~~ every flood was assigned its exact date of occurrence (the date of the flood is at least one day before the date of the news). Next, the affected municipality or municipalities were defined. Finally, the intensity of each flood was determined according to 3 levels (Camuffo and Enzi, 1996; Barriendos et al., 2003; Llasat, et al., 2005; Barriendos et al., 2014):

- Level 1 (L1): **ORDINARY** flood. A flood without overflow and minor ~~damages~~damage.
- Level 2 (L2): **EXTRAORDINARY** flood. A flood with overflow and major ~~damages~~damage.
- Level 3 (L3): **CATASTROPHIC** flood. A flood with overflow, general destruction and deaths.

~~As a result~~Level 1 floods refer not only to cases of ordinary flooding in river flow, but also to flash floods and in situ floods outside the river’s floodplain. For this reason, Level 1 floods are valid for reporting variability in climate (changes in rain patterns) and social factors (changes in exposure or vulnerability) (Llasat et al., 2016), though they are not valid for reporting the hydrological variability of rivers. Accordingly, some works that analyse the hydrological variability of the rivers exclude L1 floods from their analyses (Llasat et al., 2005). For this reason, we obtained 10 ~~dichotomic~~dichotomous variables ~~to point~~

~~to~~ for indicating the presence (1) or absence (0) of any ~~of the following~~ effects/damages produced by ~~the~~a flood in each municipality. Thus, we categorized the information ~~regarding~~on the type of damage suffered ~~was categorized~~ in a simple manner, ~~being~~always aware of the difficulty ~~involved~~inherent in consistently objectivizing quantitative information ~~consistently~~ in time and space (Gil-Guirado et al., 2016). ~~The~~These variables that we created ~~allow an approximate~~give us a rough idea of the scope of ~~the damages of each flood:~~damage caused by each flood. Specifically, the damage variables are the following: agriculture; cattle; fishing; roads; industry; trade; buildings; tourism; fatalities; and injured.

- ~~Agriculture.~~
- ~~Cattle.~~
- ~~Fishing.~~
- ~~Roads.~~
- ~~Industry.~~
- ~~Trade.~~
- ~~Buildings.~~
- ~~Tourism.~~
- ~~Fatalities.~~
- ~~Injured.~~

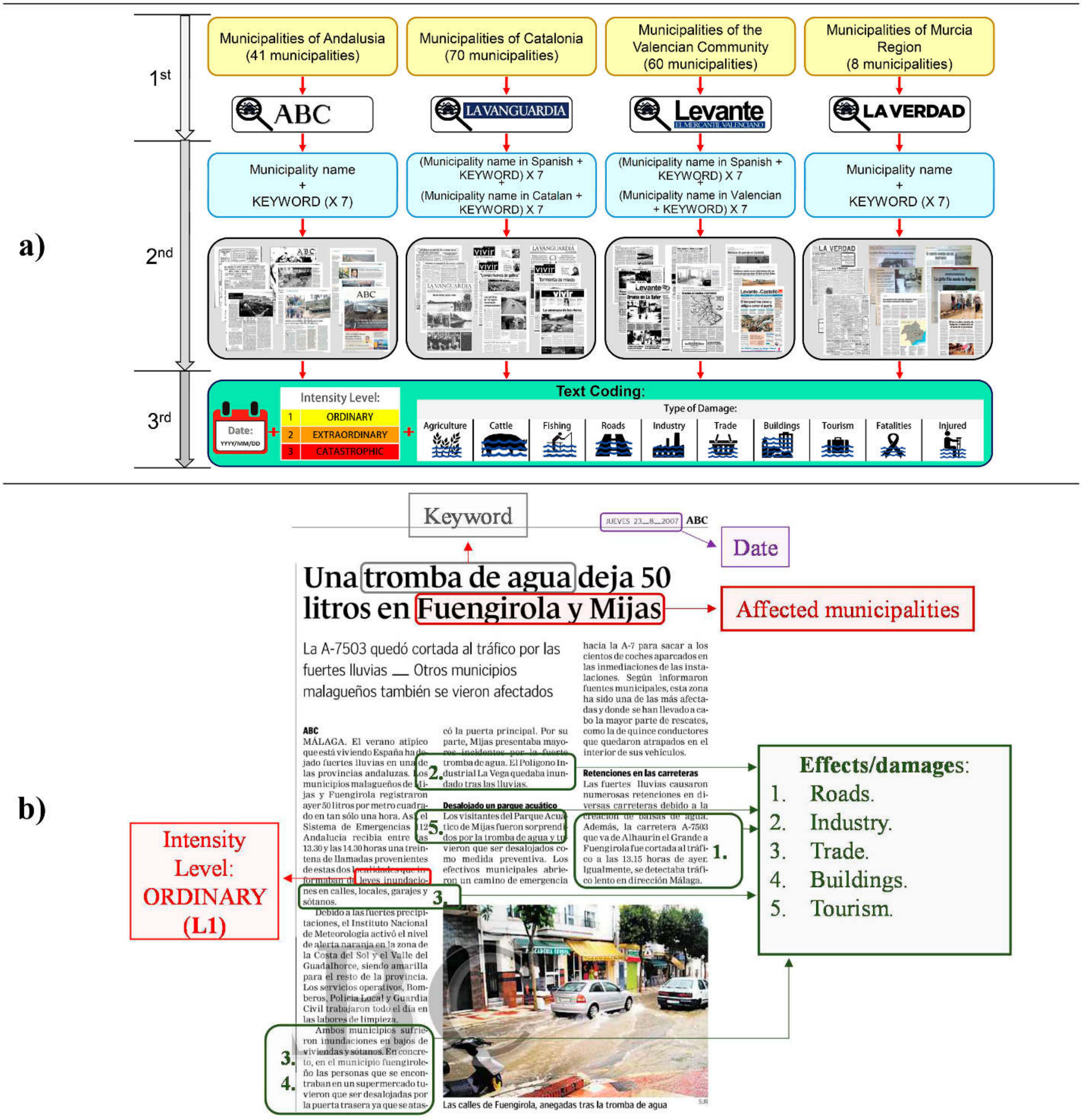


Figure 2: Method of cataloguing news, step by step (**Panel a**~~)~~), and example of the coding system for the news (**Panel b**). ~~Source: in~~ Panel b source: ABC Newspaper, news of 23 August 2007.

Furthermore, some ancillary indices and variables have been calculated to characterize floods in the SMCM (see Table 2, Panel b). The severity index is the sum of damage quantity multiplied by flood intensity for each case, and it provides additional information. As an example, a flood of intensity 2 could produce major damage, but with concentrated effects in agriculture

(Intensity = 2, severity index = 2); while a flood of intensity 1, could cause some weak damage but extend to a large number of sectors (for example, roads, tourism, commerce and agriculture) (Intensity = 1; severity index = 4 * 1 = 4). In other cases a flood could be very intense and also affect a large number of sectors, so its final impact is greater than if simply considering the intensity (for example, a flood of intensity 2 that affected roads, agriculture, tourism and trade would have a severity index of 8). Therefore, the severity index offers information that is complementary to the intensity level and the amount of damage. With regard to the affected area, we have assigned to each flood the area of the municipality where it took place. While we are aware that a flood does not affect a whole administrative area, we consider it to be a good measure for performing comparative analyses at a spatiotemporal scale. Moreover, although a flood does not directly impact the whole municipality, the effects are felt indirectly throughout the administrative territory.

Finally, with the results of the SMC-FloodsFlood database, we have conducted a trend analysis to analyse if ascertain whether floods and their intensity have increased or decreased over time. To determine whetherThe existence or notabsence of statistically significant trends exist,was determined by the improved non-parametric test of Hirsch and Slack (1984) has been used,), which is based on the Mann-Kendall range widely used in climatic and hydrological studies. This test informsgives information on two possible hypotheses: the null hypothesis (H0) which defends), indicating that the series does not present a significant trend; and the alternative hypothesis (Ha) which informs of), indicating a statistically significant trend, which that may be negative or positive. The chosen level of significance chosen has beenis 95%. In addition, we calculated Sen´s Slope has been calculated, which informs onindicates the bias and size of this trend,. Multiplying this value by the total number of observations, we would obtain an approximate value of the mean loss or gain of the variable over the time period.

4 Results

4.1 SMC-Flood records summary

According to the SMC-Flood database, between 1960 and the year 2015 the SMCM suffered 3,608 floods.flood cases between the years 1960 and 2015. Of these, 72% were of an ordinary intensity (Level 1), less than 25% were extraordinary (Level 2)), and slightly more than 3% were catastrophic (Level 3) (see Table 2, Panel a).

With regard to the typetypes of damagesdamage (see Table 2, Panel a), roads (almost 80%) and homes (45%) were the variables most affected by the floods. Trade and agriculture are also sectors that repeatedly suffer damagesdamage (in approximately 20% of cases). Tourism is another sector that suffers the impact of floods (16%). However, there are important differences in the typetypes of damages according todamage, depending on the level of intensity. In general, the amount of damagesdamage increases according towith the level of intensity. That is, , meaning that the greater the intensity, the more assets and people that are affected. Between intensity Levels 1 and 2, the largestgreatest increases occur inamong residential properties (almost 80% of the Level 2 floods involve damagesdamage to homes) and trade (almost half of Level 2 floods involve impactsimpact on trade). These two types of damage are interrelated, insofar as the overflow of the water body that affectsaffecting residential properties also affects trading establishments, which are generally located in the lower part of the buildings. Also notable are the increases in the impacts on agriculture and trade. Regarding the changes between the damagesdamage produced in Level

3 floods and those of other levels, the most notable is the increase in the direct effects on ~~the~~people's health ~~of people~~ (fatalities and injured). In fact, almost 100% of ~~cases of~~ Level 3 cases involve human victims~~. Indeed,~~ , such that the main criteria of the ~~very~~ classification method ~~includes in its main criteria~~consider that~~, if~~ a flood ~~causes~~having caused victims~~, this~~ is a fundamental factor ~~to be considered~~for considering it Level 3. In general, catastrophic floods are characterized by the fact that they affect ~~all~~ the whole economic and social fabric of a community.

~~Furthermore, some ancillary indices and variables have been calculated to characterize floods in~~Regarding the ~~SMCM (See Table 2 Panel b). The Severity Index is the sum of the quantity of damages multiplied by the intensity of each flood. With regard to the average area~~ affected~~, we have assigned to each flood the area of the municipality where it took place. While we are aware that a flood does not affect the whole of an administrative area, we consider that it is a good measure to perform comparative analyses on a spatiotemporal scale. Moreover, although a flood does not have a direct impact on the whole municipality, the effects are felt indirectly throughout the administrative territory. This calculation informs that~~ area, in the SMCM, each flood affects ~~an area of~~ 119 km^2. However, this value rises alarmingly as the intensity level of ~~the~~ floods increases.

Table 2: SMC-Flood database summary.

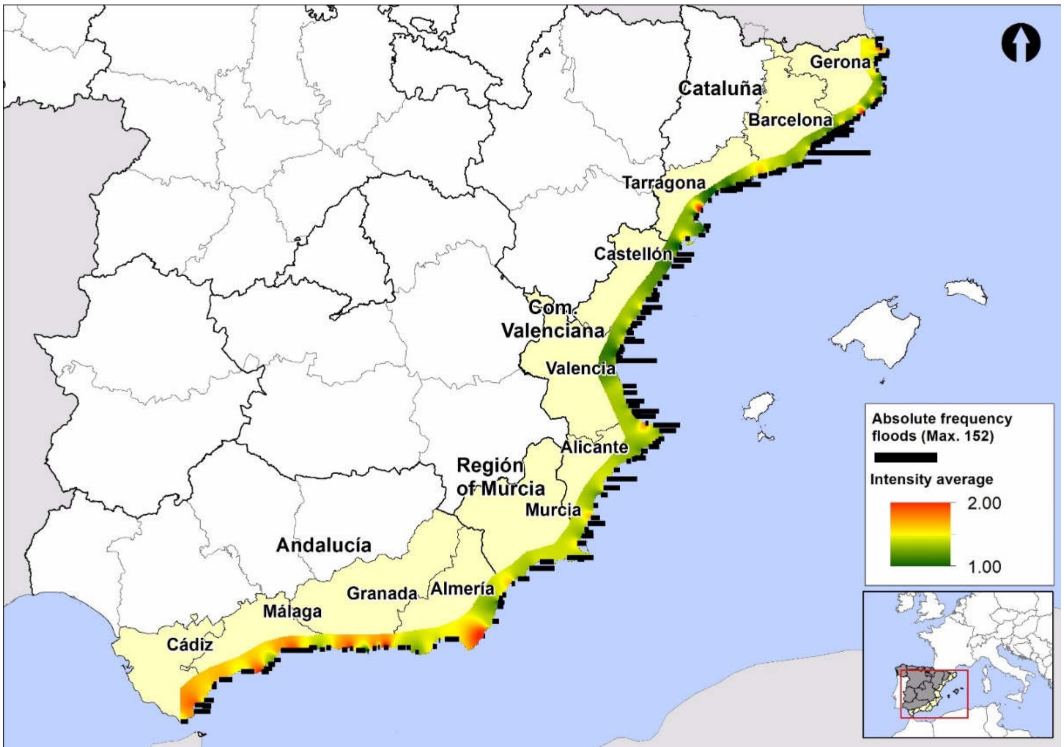
		L1		L2		L3		TOTAL FLOOD CASES~~S~~	
		N	**%**	**N**	**%**	**N**	**%**	**N**	**%**
	Cases	**2,599**	**72.03**	**887**	**24.58**	**122**	**3,38**	**3.608**	**100**
A)	**Agriculture.**	346	13.31	307	34.61	49	40.16	**702**	**19.46**
	Cattle.	10	0.38	33	3.72	13	10.66	**56**	**1.55**
	Fishing.	46	1.77	70	7.89	5	4.1	**121**	**3.35**
	Roads.	1,928	74.18	807	90.98	108	88.52	**2,843**	**78.8**
	Industry.	30	1.15	84	9.47	24	19.67	**138**	**3.82**
	Trade.	225	8.66	432	48.7	61	50	**718**	**19.9**
	Buildings.	850	32.7	697	78.58	82	67.21	**1,629**	**45.15**
	Tourism.	298	11.47	239	26.94	37	30.33	**574**	**15.91**
	Fatalities.	10	0.38	9	1.01	118	96.72	**137**	**3.8**
	Injured.	27	1.04	65	7.33	45	36.89	**137**	**3.8**

		L1	L2	L3	TOTAL FLOOD CASES~~S~~
B)	**Average Severity Index**	1.45	6.18	13.33	**2.57**
	Area (km^2)	115.86	118.04	181.48	**118.62**

*The different colours represent how the values deviate~~,~~ either above (red) ~~and~~or below (green~~), from~~) the 50th percentile (yellow) of the mean ~~damages~~type of damage (**Panel a**) or the level of intensity (**Panel b**). ** The severity index is calculated as the intensity of a flood multiplied by the sum of the ~~damages~~type of damage (sum of the ~~dichotomic~~dichotomous variables affected), divided by the number of floods (for each intensity level and for the total). ~~So~~Such that (Eq. 1): $\mathbf{Severity\ Index} = (\sum(\boldsymbol{Intensity\ Level} \times \boldsymbol{Damages})) \div \boldsymbol{Intensity\ Level_N}$.

4.2 Spatial variability of floods

A detailed view ~~on a~~at the municipal level reveals the existence of "hot spots" in the number and intensity of floods (see Fig. 3). Areas of high average intensity are found along most of the coast of Andalusia and, occasionally, in some sectors of the provinces of Gerona and Tarragona~~.~~ (for each municipality or province, the average intensity is the result of dividing the sum of the intensity levels of total floods by the total flood cases in this municipality or province). In fact, of the 20 municipalities with the highest average intensity, 12 are in Andalusia and 7 in Catalonia. Regarding the areas with the highest ~~number~~numbers of floods, it is necessary to differentiate between two types of areas: i) large urban conurbations (Barcelona, Valencia, Malaga and Alicante~~)~~); and ii) coastal spaces that highly ~~specialized~~specialize in tourism (north of the province of Tarragona, in the province of Castellón, south of the province of Valencia, and north of the province of Alicante). However, the most outstanding aspect is an opposing latitudinal gradient~~, since~~: whilst the average intensity of ~~the~~ floods increases as we go further south, their number increases in the opposite direction. ~~This relationship is magnified as from the central sector of the provinces of Almería and Alicante respectively. Moreover~~Thus, considering the combination of intensity and frequency, the metropolitan area of Malaga stands out as the most threatened area.



CC.AA	Province	Pop. (2016)	Area (Km^2)	Density (Pop/Km^2)
Cataluña	*Gerona*	243,098	666.2	365
	Barcelona	2,573,798	477.7	5,388
	Tarragona	406,536	1,014.4	401
Comunidad Valenciana	*Castellón*	365,002	920.2	397
	Valencia	1,152,087	710.0	1,623
	Alicante	1,085,013	1,663.2	652
Región de Murcia	*Murcia*	463,260	2,948.0	157
Andalucía	*Almería*	501,739	2,145.7	234
	Granada	115,177	447.8	257
	Málaga	1,252,694	1,384.2	905
	Cádiz	254,886	1,003.4	254
Total:		**8,413,290**	**13,380.7**	**1,200**

Figure 3: Intensity average and total floods by municipality and Spanish Mediterranean coastal municipalities, spatial summary. The **map** shows in different colours the average intensity of ~~the~~ floods in each municipality, and the black bars represent the total number of floods in each municipality.

The **table** reports the total population, the total area and the population density by province. The different colours represent how the values deviate above (from yellow ~~colours~~ to red colours) or below (from yellow ~~colours~~ to green colours) from the 50th percentile within the mean values of the variables (Pop., Area and Density). Source: INE, 2018.

~~If we analyse~~Analysing the variability of the data aggregated at the provincial level~~, we see the confirmation of~~ confirms some of the spatial patterns detected (see Table 3). The average area affected by each flood is directly related to the differential size of the municipalities in each province. In this respect, it is appropriate to point out that ~~in the province of Murcia~~ the average size of the municipalities in the province of Murcia is larger, which is reflected in the fact that ~~it is also the province where the~~ floods have a greater spatial impact in this province (each flood in Murcia affects an average of 574 km^2, compared to an average of 119 for the whole study area). ~~In any case, latitudinally,~~ As from the province of Alicante, a latitudinal change takes place ~~towards~~in the form of floods ~~with a~~affecting larger ~~affected area~~areas, which may also be due to climatic factors, governance, or the average size of the municipalities. On the other hand, the quantity of floods that occur in each province bears a direct relationship with the size and density of the exposed population ~~exposed and its density~~ (see Table in Fig. 3). This latter detail is especially important in the highly-developed provinces (Barcelona, Valencia and Alicante~~, respectively~~). These provinces, together with Castellón, are those that support a higher number of floods per kilometre of coastline; and they confirm the latitudinal gradient detected. This uneven N-S distribution is noticed in the intensity of ~~the~~ floods, i.e., the further south we go, the higher the proportion of ~~floods of~~ Level 2 and 3 floods, compared to ~~those of~~ Level 1. Likewise, this ~~appears to be~~is evidenced ~~if we consider~~by the severity index, the expression of which is even clearer. Therefore, we can affirm the existence of a spatial pattern in both ~~in~~ intensity and ~~in damages~~damage moving in a southerly direction. In this regard, between the severity index and the latitudinal gradient (the provinces ordered correlatively from north to south~~)~~)), there is a Pearson correlation of 0.91 with a significance level of 95%. Furthermore, the correlation between the percentage of L1 floods and the latitudinal gradient is -0.81. For the L2 floods, the correlation is 0.73. ~~In~~ Both cases ~~with~~have a significance level of 95%. This tendency may be related ~~with~~to the adoption of more efficient flood control measures in the northern provinces (the ~~Catalonian~~Catalonia and ~~Valencian provinces)~~Valencia), owing to their early tourism and economic development. Likewise, an explanation can also be found in the climatic factor, ~~to the extent that~~as the rains are more torrential in the southern provinces (Martín-Vide, 2004). However, given the clear differences between provinces ~~of~~in the same autonomous community ~~invites us to consider~~, we cannot avoid considering the economic and institutional factor, since other studies have detected ~~a~~ growing institutional vulnerability ~~according to~~following the aforementioned latitudinal gradient (López-Martínez et al., 2017).

Table 3: Spatial flood patterns in SMCM.

	CC.AA	Province	N-Flood cases~~s~~	N%-Flood cases~~s~~	% Province	Severity Index	Area (Km^2)	Flood cases~~s~~/ Coast (Km^2)
Level 1	Cataluña	*Gerona*	165	6.35	70.51	1.32	30.60	0.63
		Barcelona	520	20.01	77.15	1.37	33.41	3.23
		Tarragona	257	9.89	79.81	1.36	49.31	0.92
	Comunidad Valenciana	*Castellón*	292	11.24	76.04	1.45	63.02	2.10
		Valencia	426	16.39	74.74	1.53	61.54	3.16
		Alicante	348	13.39	71.46	1.62	120.56	1.43
	Región. Murcia	*Murcia*	203	7.81	73.82	1.59	592.32	0.74
	Andalucía	*Almería*	117	4.50	71.34	1.41	150.34	0.47
		Granada	43	1.65	58.90	1.26	70.19	0.53
		Málaga	167	6.43	56.04	1.41	158.76	0.80
		Cádiz	61	2.35	48.03	1.26	198.21	0.74
	Total L1		**2,599**	**100.00**	**68.90**	**1.45**	**116**	**1.23**
Level 2	Cataluña	*Gerona*	63	7.10	26.92	5.37	30.97	0,24
		Barcelona	124	13.98	18.40	5.66	41.06	0,77
		Tarragona	55	6.20	17.08	6.15	41.56	0,20
	Comunidad Valenciana	*Castellón*	88	9.92	22.92	5.93	64.21	0,63
		Valencia	139	15.67	24.39	7.15	65.84	1,03
		Alicante	123	13.87	25.26	6.08	129.33	0,50
	Región. Murcia	*Murcia*	59	6.65	21.45	6.58	471.98	0,22
	Andalucía	*Almería*	38	4.28	23.17	6.37	169.91	0,15
		Granada	21	2.37	28.77	6.38	77.25	0,26
		Málaga	117	13.19	39.26	5.76	163.78	0,56
		Cádiz	60	6.76	47.24	6.77	159.67	0,73
	Total L2		**887**	**100.00**	**26.81**	**6.18**	**118**	**0.42**
Level 3	Cataluña	*Gerona*	6	4.92	2.56	11.50	29.54	0,02
		Barcelona	30	24.59	4.45	11.50	29.16	0,19
		Tarragona	10	8.20	3.11	12.90	47.54	0,04
	Com. Valenciana	*Castellón*	4	3.28	1.04	12.00	79.57	0,03
		Valencia	5	4.10	0.88	14.40	91.19	0,04
		Alicante	16	13.11	3.29	15.75	161.43	0,07
	Reg. Murcia	*Murcia*	13	10.66	4.73	17.54	758.69	0,05
	Andalucía	*Almería*	9	7.38	5.49	15.67	229.35	0,04
		Granada	9	7.38	12.33	12.67	53.41	0,11
		Málaga	14	11.48	4.70	10.29	260.10	0,07
		Cádiz	6	4.92	4.72	14.00	201.21	0,07
	Total L3		**122**	**100.00**	**4.30**	**13.33**	**181**	**0.06**
TOTAL Floods	Cataluña	*Gerona*	234	6.49	100.00	2.31	30.67	0,90
		Barcelona	674	18.68	100.00	2.22	34.63	4,19
		Tarragona	322	8.92	100.00	2.15	47.93	1,16
	Com. Valenciana	*Castellón*	384	10.64	100.00	2.28	63.46	2,76
		Valencia	570	15.80	100.00	2.59	62.85	4,22
		Alicante	487	13.50	100.00	2.77	124.12	2,00
	Reg. Murcia	*Murcia*	275	7.62	100.00	2.82	574.36	1,00
	Andalucía	*Almería*	164	4.55	100.00	2.72	159.21	0,66
		Granada	73	2.02	100.00	3.34	70.15	0,90
		Málaga	298	8.26	100.00	3.09	165.49	1,43
		Cádiz	127	3.52	100.00	3.80	180.15	1,55
	Total Flood cases~~s~~:		**3,608**	**100.00**	**100.00**	**2.57**	**119**	**1.71**

N-Floods ~~informs of~~indicates the number of floods in each province between 1960 and 2015. *N%-Floods* reflects the percentage of the total floods that corresponds to each province. *% province* ~~informs of~~indicates the percentage of the total floods in each province that corresponds to each intensity level. *Severity index* reflects this value for each province and for each intensity level. *Area (km^2)* and *Floods/Coast (km^2)* show, respectively, for each province the km^2 affected and ~~the~~ floods which, on average, affect each kilometre of coast~~, respectively.~~

. *The different colours represent how the values deviate, above (red) or below (green),) from the average (yellow) of each variable (intensity level and total).

4.3 Seasonal flood variability over the SMCM

The Floods that affect the SMCM have considerable seasonal variability with regard to number and intensity. As is to be expected, according to from the climatic conditions (Barredo, 2007; Barrera-Escoda and Llasat, 2015), the majority of the floods (58%) take place during the autumn months, especially in October owing toas a result of the recurrent "cold Dropspool" that affectaffects the region. Furthermore, floods become more highly concentrated during this season there is a higher concentration as the intensity increases (55% of Level 1, 65% of Level 2 and 74% of Level 3). Therefore, autumn (September-November) is the season with the most danger of flooding, with regard to in terms of both quantity and intensity. Autumn is followed by winter (December-February), summer (June-August) and finally spring (March-May).) (Fig. 4 Panel a). However, there is little difference between the intensity of the autumn and winter floods (Fig. 4 Panel b) (mean intensity of 1.34 in the case of winter compared to 1.36 during the autumn). In spring, On the other hand, in spring and especially summer, the average intensities are lower (mean intensity of 1.22 and 1.16, respectively). The high intensity of the winter floods is probably related to the type of atmospheric situation that generates these floods and which usually leads to large accumulations of rainfall over several days (Muñoz-Diaz and Rodrigo, 2004). Related to this point, the climatic patterns will be studied in depth in successive studies within this same project will analyse the climatic patterns in depth.

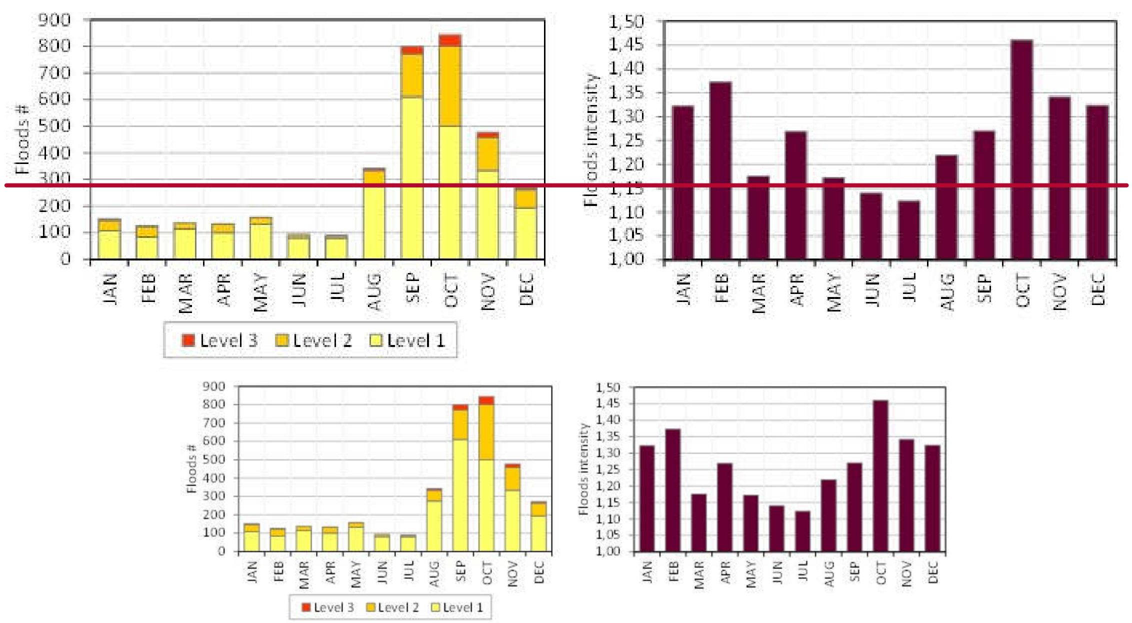


Figure 4: Monthly distribution of flood cases frequency and average intensity in SMCM.

This seasonal variability presents notable differences between provinces (see Fig. 5). Regarding the number of floods, whilst among the provinces of the east coast, the autumn seasonal pattern mentioned above is reinforced for the provinces of the east coast, while in the southern provinces autumn loses importance in favour ofbecomes less prominent compared to winter, which is the season ~~that concentrates~~with a ~~higher number~~greater concentration of floods. This reveals a rainfall pattern associated with intense rains owing to the variability of the polar front (Muñoz-Diaz and Rodrigo, 2004~~)~~), which especially affects the provinces ~~of~~in the south-west part of the study area. However, these ~~latter~~provinces are also not exempt from ~~the impact of~~being impacted by the frequent ~~"Cold Drops"~~synoptic situations associated with the same easterly flow that ~~affect~~affects the rest of the study area.

A similar spatial distribution can be observed in the average monthly intensity per province. In the provinces of Granada and Malaga, the autumn floods present the highest intensity values ~~of~~in the study area. However, unlike the frequency, the distribution pattern ~~seems~~is less clear. ~~There are coincidences in that~~ The autumn and winter months ~~are those that record~~coincide in more intense floods~~ of a more intensive nature~~, mainly in the provinces between and including Castellón and Granada~~, inclusive~~. However, in the provinces of Gerona and Cadiz, the mean intensity is higher in the winter months. Finally, in the provinces of Barcelona and Tarragona, late summer floods are also significantly frequent. This observation is consistent with those in previous works on these provinces (Llasat et al., 2013a, Gilabert and Llasat, 2018).

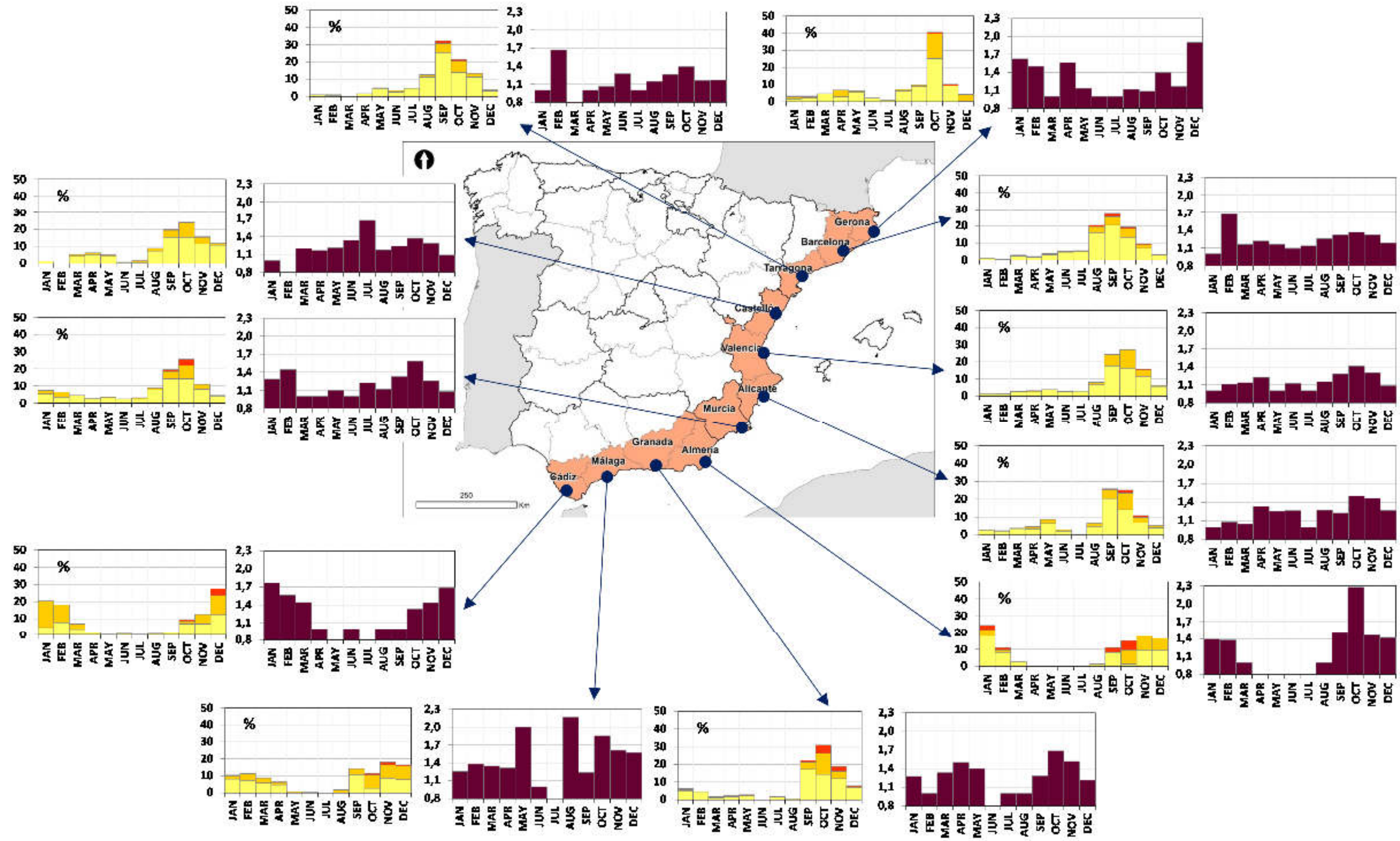


Figure 5: Spatial variability of flood cases frequency and average intensity in SMCM by province.

4.4 ~~Flood~~Type of damage variability

The ~~amount of damages reported and their type~~ type of damage also present ~~a~~ notable spatial variability. With regard to the total amount of ~~damages~~ type of damage per province (Fig. 6, Panel a~~)~~), the size of the exposed population is the main factor ~~to explain it.~~. In fact, the provinces with ~~a~~ higher ~~population~~populations (Barcelona, Valencia and Alicante) are those that report a higher number of ~~total damages~~type of damage (Fig. 6, Panel a). ~~Furthermore~~However, if we ~~compare~~consider the ~~total number of floods per province with the total damages reported (~~average quantity of ~~damages~~type of damage reported per flood~~)~~ case by province, we observe that the average amount of type of damage increases in a north-south direction. In this way, the average amount of type of damage also shows a latitudinal gradient ~~referred to above continues to be reflected. That is, whereas in~~ in a north-south direction. In other words, the provinces to the north of Valencia ~~the~~report an average amount of type of damage ~~reported~~ per flood that is lower than 2, while from Valencia towards the south this value is higher.

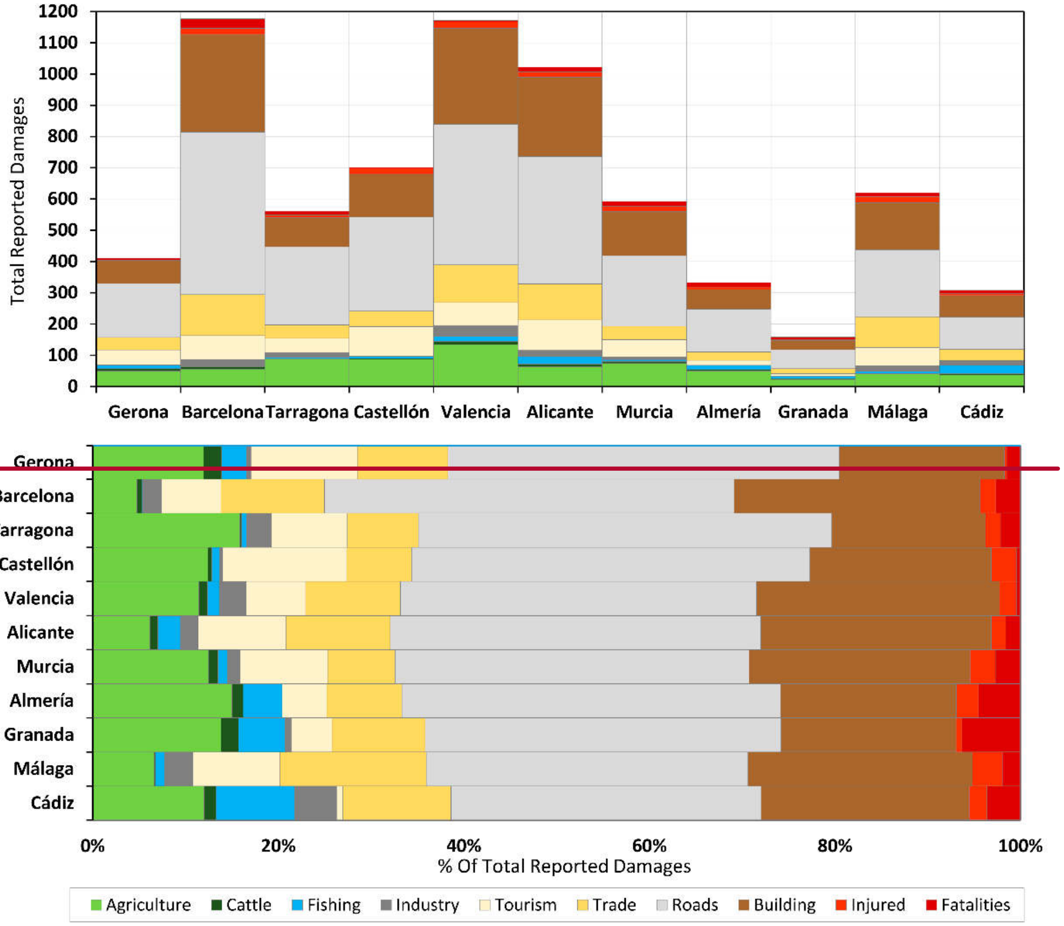
With regard to the different types of damage per province (Fig. 6, Panel b~~)~~), the highest quantity of damages affects roads and buildings, the sum of which represents over 60% of all the ~~damages~~ type of damage reported. In the case of roads, riverbeds in the study area are for ephemeral purposes and therefore a large part of them can be crossed by roads without bridges or even used as communication routes between the headwater and mouth areas. Therefore, it is logical that most of the damages pertain to roads. Regarding damages to buildings, if we consider that floods are a natural risk that affect societies (Bates and Peacock, 1987, Tapsell, et al., 2002), damage to buildings is perceived to be one of the most significant impacts on societies (Nadal et al., 2009).

The provinces of Barcelona, Alicante and Malaga are highly developed and specialized in ~~activities in~~ the service sector and tourism, ~~owing to~~ which ~~the damages~~ is why type of damage related to the primary sector are low. However, in the provinces of Tarragona, Almería and Granada, where the agricultural sector continues to have an important comparative economic weight, the ~~damages~~type of damage in this sector are considerable.

Lastly, ~~the~~an analysis of the type of damage reveals the same latitudinal gradient ~~is also observed in the analysis of the damages.~~, which this time ~~it~~ is ~~explained in~~indicated by the record of injured persons and fatalities. As we head further south, there is an alarming increase in the percentages of these variables: from 3% on average between Gerona and Alicante to 6% between Murcia and Andalusia.

a)

b)



Total Reported Damages
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
Gerona
Barcelona
Tarragona
Castellón
Valencia
Alicante
Murcia
Almería
Granada
Málaga
Cádiz
0%
20%
40%
60%
80%
100%
% Of Total Reported Damages
Agriculture
Cattle
Fishing
Industry
Tourism
Trade
Roads
Building
Injured
Fatalities

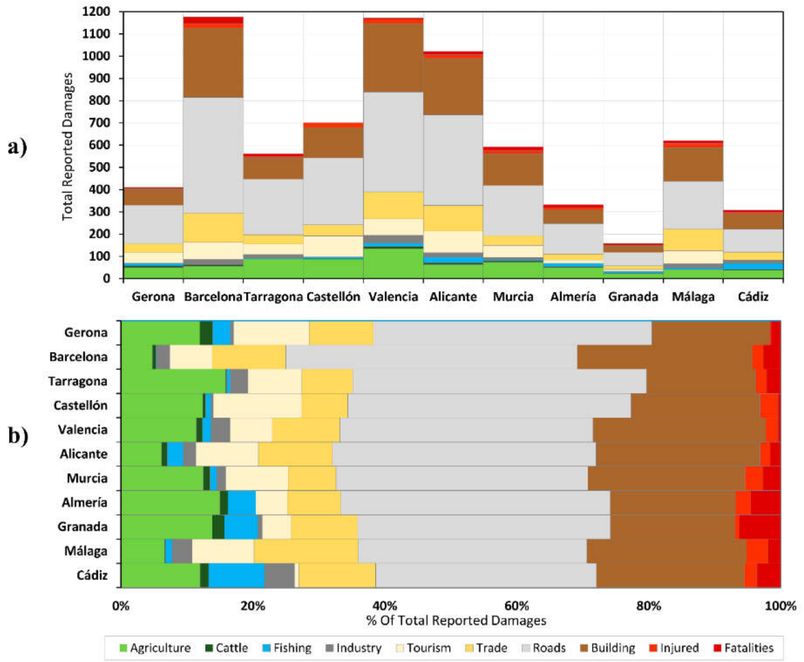


Figure 6: Types of ~~damages~~damage by province.
Panel a shows the total ~~damages~~types of damage per ~~type and~~ province. **Panel b** gives the damages per type, as a percentage of the total ~~damages~~type of damage in each province.

4.5 Flood evolution and trends

The floods in the SMCM present an annual variability in frequency, impact and intensity that are closely related ~~with~~to the variation in the frequency and intensity of precipitations (Martin-Vide, 2004).

With regard to the annual mean intensity (see Fig. 7, Panel a) from 1960 to 1994~~,~~ the data were more variable and extreme. In fact, the 10 years with greatest average intensity took place during that period. Furthermore, the five years of highest mean intensity were, respectively: 1973, 1987, 1962, 1965 and 1961. However, it is important to emphasize that the mean annual intensity presents a statistically significant negative trend, i.e., the average intensity of ~~the~~ floods ~~has descended~~descends during the period analysed. Likewise, ~~despite~~even though the severity index during the first five years of the nineteen-sixties was particularly high, their average annual value also presents a significant negative trend. According to the severity index rank, the following years should be highlighted: 1973, 1962, 1987, 1982 and 1964. Some of the highlighted years coincide with the most catastrophic floods occurring in the study area (1973, 1962 and 1987) in the last century.

With regard to the annual frequency of ~~the~~ floods (see Fig. 7, Panel b~~)~~), an increase is observed since the eighties and, especially, since 1996. Since then, ~~in~~the number of floods for the majority of years ~~the number of floods~~ is above ~~the~~ average. The trend analysis detects a statistically significant positive trend, which reveals that every year ~~the~~ floods increase by 2.3% compared to their average value. However, this increase is not homogenous according to the intensity level~~, since whilst~~ because the Level 1 and Level 2 floods present significant positive trends~~,~~ while those of Level 3 either remain stable~~,~~ or

~~with~~have no appreciable trend. The rising trend is more pronounced in the case of the Level 1 floods, ~~with~~which have an annual increase of 2.8~~%,~~% compared to 1.1% in the case of Level 2 floods.

Turco and Llasat (2011) and Llasat et al., (2010), have also found that flood trends over recent decades in Catalonia are due mainly to an increase in urbanization in flood-prone areas near torrential and non-permanent streams.

Lastly, the evolution of the ~~area~~ affected area presents ~~a~~ variability that is similar to the frequency behaviour of ~~the frequency of the~~ floods (see Fig. 7, Panel c). ~~There is a coincidence in pointing to~~ The decade of the nineteen-eighties ~~as~~ coincides with the time when ~~the~~ values began to increase. Especially outstanding ~~is~~as disastrous periods are the second half of the nineteen-eighties and the decade of ~~2000, as especially disastrous periods.~~the 2000s. However, it is necessary to point out some nuances and differentiations. The ~~area~~total values for the affected ~~has~~area have a positive trend ~~for the total values~~, but if we consider the size of the area affected according to intensity levels, a significant positive trend ~~has only been~~is detected only for Level 1 floods. That is, every year the area affected by ~~the~~ floods increases by 166 km^2 (an increase of 2.2%). This situation ~~takes on special importance~~becomes especially notable in the case of Level 1 floods, for which the new area affected is 158 km^2 per year (a growth rate of 2.9%).

During the comparable data period (1971-2015), the flood damage database on insured assets of the National Insurance Consortium of Spain (NISS) (Consorcio de Compensación de Seguros, 2019) also shows a positive trend in floods. In this case, it is evidenced by an increase in the annual amount of type of damage filed, i.e., in the amount of money indemnified. In addition, peaks in the amount of money indemnified detected in the NISS database coincide with the flood cases and impact peaks detected in our data base (1987, 1989, 1997 and 2007). On the other hand, the NISS database coincides with our database in indicating the most dangerous months for floods (mainly September and October). However, the different characteristics between these two databases lead to incomparable results from and utility of both databases comparable. While the NISS database offers aggregated data at the provincial level and refers only to the number of procedures for economic impacts and losses, the SMC-Flood database offers data at the municipal level for the Mediterranean coast and it refers to flood intensity, severity and type of impact. On the other hand, it should be noted that the Spanish insurance contract does not require insuring one's home. Therefore, this database could be even more biased than ours, depending on the degree of insurance coverage in the municipalities of the study area (Clavero, 2016). On the other hand, because the National Insurance Consortium database is based on private insured assets, we have limited information on the impact of floods on public goods such as roads. In this respect, and taking into account the great weight that road damages have in our database, it is not surprising that the SMC-Flood database considers a number of cases far greater than that of the National Insurance Consortium database.

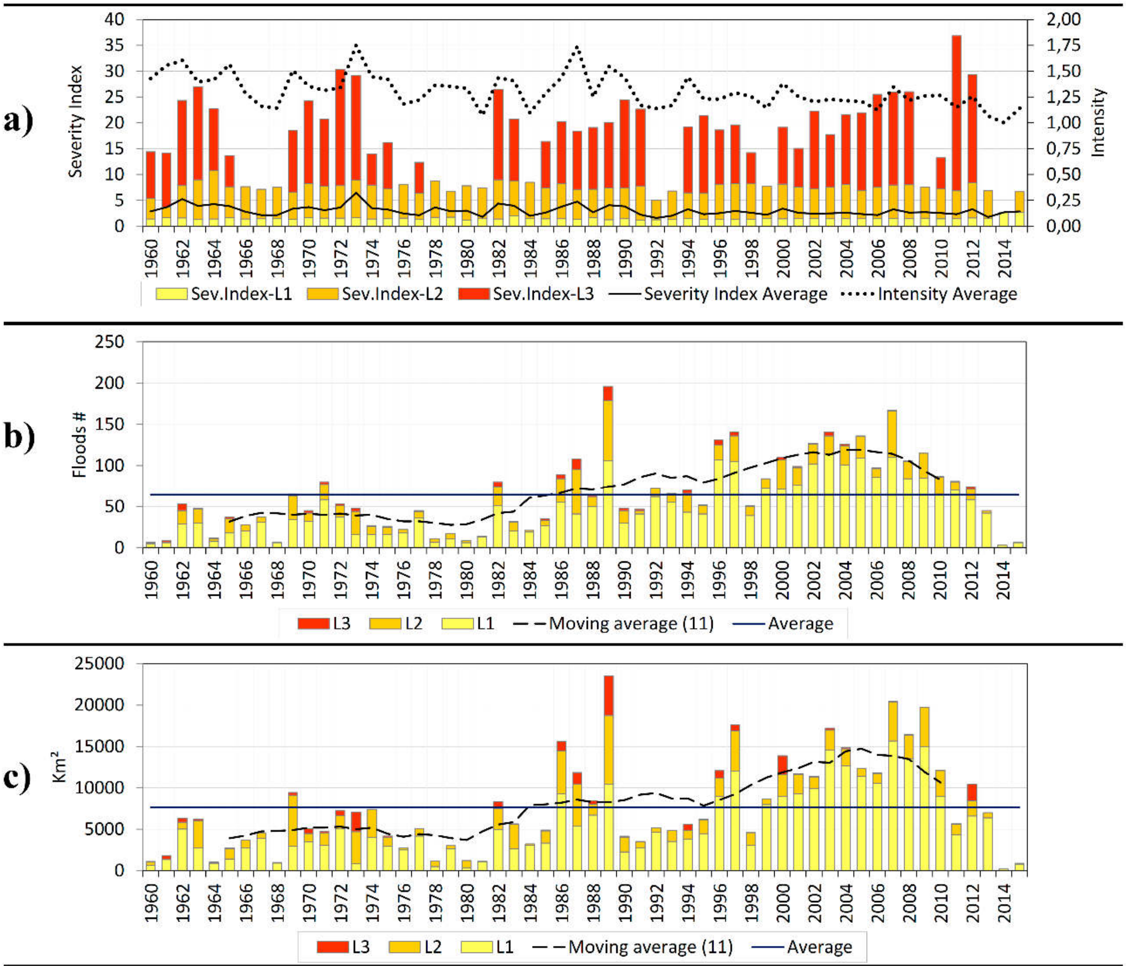


Figure 7: Temporal variability of the intensity, severity and spatial impact of floods cases in the SMCM.
The values ~~inform of~~indicate the annual accumulation per intensity level. The mobile mean of 11 years has been added to temper the variability, as well as the total mean of each variable, in order to identify years with values above or below the mean.
Panel a ~~informs on~~indicates the variability of the annual intensity and severity of ~~the~~ floods. **Panel b** ~~informs on~~indicates the variability of the annual number of floods. Finally, **Panel c** ~~informs on~~indicates the variability of the area affected.

Related to the positive trend observed in the data, Llasat et al. (2016) pointed out that it may be due to the following main factors: i) climatic issues (a greater recurrence of torrential rain events in the study area); and ii) the increase in exposure and vulnerability due to the increase in population and economic growth.

Due to the fact that L1 floods concern not only river floods but also flash floods and in situ floods, the increase in exposure could take on more importance as the exposed surface in flood-prone areas becomes greater. Thus it is necessary to include the growing surface outside the floodplain (Pérez-Morales et al., 2018), for which the evidence indicates that L1 floods have the most clear upward trends.

However, there are other factors that should not be overlooked or dismissed. According to Llasat et al., 2009, it is important to consider that trends may be biased by: i) public opinion having greater sensitivity or perception towards natural risks due to increased newspaper coverage of floods; ii) a greater spatial coverage of the news as a result of improved communications. Eisensee and Strömberg (2007) also argue that the coverage of natural disasters in the press depends on the availability of other newsworthy material at the time of the disaster. Additionally, there may be some spatial bias in the news based on the newspaper's spatial coverage (Walmsley, 1980). In this regard, the newspapers used in the SMC-Flood database are regional newspapers, which specifically cover the information on each autonomous community analysed throughout the study period. On the other hand, Llasat et al. (2009) show that the subjectivity of the journalist or newspaper can bias the flood intensity level, but not the type of damage. In this regard, the type of damage may be under-documented, but it can rarely be over-documented. However, population increase in the SMCM has been able to influence the increase in flood news for small populations. However, this last point does not imply a methodological bias. On the contrary, the positive correlation between population increase and increase in the number of floods shows that the increase in exposure is mainly responsible for the trends observed in the study area's floods. These results are in line with other works (Pérez-Morales et al., 2018) and are consistent with the general theory of risk, which postulates that risk is a social construction (Bates and Peacock, 1987; Tapsell, et al., 2002), and therefore the occurrence of a natural risk depends on their being an exposed population susceptible to suffering an impact.

The positive correlation between population increase and increase in the number of flood cases can be observed when we analyse the flood trends according to population growth. In making this analysis, we observed that the greater the population increase in the municipalities between 1960 and 2011 (the two extreme census years of the study period), the greater the significance and intensity of the trend. In the following table (Table 44), it can be observed that no significant trend in flood cases exists for the set of municipalities where population have grown less than 50% between 1960 and 2011. However, floods have a statistically significant trend in municipalities that have grown more than 50%. The interesting thing is that the rate of increase in floods becomes greater as population growth becomes greater. In spite of all the above, the social factors involved in flood processes generate such complexity that we are unable to rule out the abovementioned possible biases in the observed trends.

Table 4: Flood cases trends in Spanish Mediterranean coastal municipalities in relation to ranges of population increase between 1960 and 2011.

Population increase range in %	Kendall's tau	P-value	Sen´s Slope
Less than 0%	-0.048	0.733	0
Between 0 and 50%	-0.060	0.550	0
More than 50 and less than 100%	0.280	0.005	0.127
More than 100 and less than 200%	0.340	0.000	0.286
More than 200 %	0.380	< 0,0001	0.471

Note: To calculate trends, we used Hirsch and Slack's nonparametric test (1984), which is based on the Mann-Kendall range. The trial version of XLSTAT software (Addinsoft, 2018) was used to calculate it. The Mann-Kendall test provides a level of statistical significance (p-value). The chosen threshold of significance was 95%, which indicates that p-values above 0.05 should lead to rejecting the hypothesis of a trend in the series. When the p-value is less than 0.05, the trend can be positive or negative. Sen´s Slope shows the annual change rate in floods. That is, the value indicates the annual increase or decrease of floods.

5 Conclusions

~~The correct knowledge of the real situation of the territories in the light of flooding is of capital importance with a view to presenting optimum resilience and future adaptation.~~ In this ~~respect, high-resolution spatiotemporal flood databases are a key tool which, in the hands of spatial managers and scientists, may contribute to improving the situation in especially sensitive regions. In this respect, the municipalities of the Mediterranean Coast of mainland Spain are an area especially vulnerable to floods.~~

~~From the findings,~~paper we ~~can draw some important conclusions. The~~ present the initial results of the SMC-~~Floods~~Flood database ~~represents the flood~~ for the Spanish Mediterranean coastal municipalities between 1960 and 2015. This database ~~with the highest spatiotemporal resolution developed for the study area.~~provides information on local flood cases with information on affected area, intensity, severity and type of damage. The results have enabled ~~the reconstruction of~~reconstructing 3,008 flood cases~~ of flooding~~ that affected all the municipalities studied during the last 55 years.

~~The exploitation of~~Exploiting the database has made it possible to obtain a series of values that provide evidence of trends which reveal the socio-environmental dynamic. In this respect, the ~~damages~~type of damage show that the major impacts occur ~~in~~on roads, buildings, agriculture and trade. Furthermore, the average area affected per flood is 119 km^2. In general, the months that pose the greatest hazard with regard to the number of floods and their intensity are the autumn months, although the winter is also a highly hazardous season.

The detailed spatial analysis has ~~enabled~~allowed us to identify a series of black spots where the intensity of~~ the~~ floods and the amount of damage are very high (especially on most of the coast of Andalusia and in some areas of Gerona and Tarragona). Furthermore, there are places ~~where the~~with large ~~size of the population~~populations that are exposed, which in turn determines a high recurrence of~~ the~~ floods.

However, ~~the~~our main ~~conclusion observed~~contribution lies in ~~general in the majority of the variables and indices considered is~~establishing the presence of a clear latitudinal gradient~~,~~ that is characterized by more severe, intensive, extensive and damaging floods as we move from north to south. This spatial inequality is foreseeably explained by greater deficiencies in the spatial planning of the provinces in the south, although the climatic and orographic factors cannot be ruled out. Under these circumstances the southern ~~municipalities of the Mediterranean coast of the Iberian Peninsula~~areas are the places ~~where~~in need of the ~~biggest and~~ best adaptation plans~~ should be implemented~~, especially ~~if it is taken~~when taking into account that ~~in~~ these provinces ~~there is~~are also subject to a greater risk of mortality associated with floods.~~ It is understood, therefore, that without correct planning and adaptation, these places face a critical situation where the relationship between human and natural systems is called into question and compromises the future development and safety of the inhabitants.~~

Lastly, it is important to highlight that the intensity and mean annual severity of floods have ~~undergone~~begun to follow a statistically significant negative trend. That is, on average, floods tend towards ~~a~~ lower intensity and severity. However, the annual frequency and ~~the~~ average area affected by ~~the~~ floods has experienced a positive trend. Nonetheless, this increase is not homogenous according to intensity level, ~~since whilst the~~because Level 1 and Level 2 floods present significant positive trends~~,~~

while those of Level 3 remain stable. In this respect, a paradox is revealed~~, insofar as~~: although it is certainly positive that the ~~more~~most catastrophic ~~floods do~~flooding are not ~~increase, however with the~~ increasing, the society has become used to a larger frequency and area affected by flooding, even though the current flood management tools (structural and non-structural) ~~it would be feasible for the trends detected to be negative. That is,~~could avoid them.

As a final conclusion, the positive trends in the number of flood cases are highly correlated with the increase in the ~~light of a negative panorama, we consider~~exposed population. Nevertheless, the ~~lesser~~complexity of social factors involved in flood processes impedes us from ruling out possible biases in the ~~ills to be positive~~observed trends. Therefore, deeper knowledge is needed on the climatic, geographic and socioeconomic variables involved in flood processes. This will be the objective of successive research projects.

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Data availability. The systematic data of the SMC-~~Floods~~Flood database are not publicly accessible because they are currently being used in an ongoing research project. Aggregate data at the provincial level can be obtained by request addressed to the corresponding author.

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