

A Deeper Look into Flood Risk in the City of Bari (Italy)

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Abstract. The design of more effective policies of flood risk management is a challenge for the entire scientific and institutional communities, in particular in the light of the implications that climate and land use changes can have on floods impacts, especially in urban areas. Here, in fact, different types of floods can coexist, and the availability of historical flood data is crucial for ensuring a proper flood hazard assessment. To this aim it is important to improve the knowledge about locations, occurrences, types and impacts of floods, in order to acquire more information about dynamics and issues that occurred in the past. In this paper we illustrate and discuss the results of a systematic collection of flood events occurred in the period 1950–2020 for the case study of Bari (southern Italy). This city has been hit by significant floods since early '900 due to the episodic streams that cross the city, but the characteristics of urban area make also possible the occurrence of pluvial and coastal floods. Results indicated how underpasses were among the most hit locations, together with flat areas of the city, and that events are generally attributable to a pluvial nature. A comparison with a study on risk perception carried out in the same area showed results consistent with our analysis, demonstrating that the integration of these approaches can provide an additional contribution to research aimed in providing more effective strategies for copying with flood risk in urban areas.

Keyword: Urban floods · Extreme events · Risk perception

1 Introduction

Natural disasters are a common and frequent threat that affect society and ecosystems. Floods, in particular, represent a predominant category in this field, and in literature a number of statistics about their impacts is reported [1, 2]. Back in 2004, the Commission of the European Community recognized floods management plans as crucial tools deemed to mitigate the impacts of floods, building a framework whose rationale has been transposed in the Directive 2007/60/EC, so called "Floods Directive" [3]. However, there is still a significant number of uncertainties in defining effective strategies for

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flood risk management, especially in urban areas. The complex implications about climate evolution and its analysis, together with the modifications in land use are among the most consistent challenges to be approached from the scientific community for properly tackling these issues [4, 5].

Flood risk analysis assumes a particular importance in urban areas, where the high concentration of people and assets make this areas highly vulnerable to various sources of risk [6–8]. Several approaches could be implemented for analysing flood risk in urban environments, with various degrees of complexity [9, 10]. However, acquiring knowledge about past flood events is of paramount importance for a preliminary assessment of floodable areas [11, 12]. In this respect, the availability and the creation of floods databases offer a relevant basis for implementing a reliable flood hazard assessment [12–14].

Flood databases can be considered very useful for flood analysis in urban areas, which are often characterized by a lack of gauging networks, thus complicating flood assessment especially in the case of pluvial floods [15]. In fact, deriving information about floodwater characteristics during flood events is fundamental for a proper use of hydrodynamic models, nowadays considered as reliable tools for flood hazard assessment at urban scale [16].

In addition, the investigation of social and cognitive factors affecting risk perception can provide a precious support for decision-makers responsible for flood policies, especially in the design of activities to be included in emergency plans [17–19]. Among these, evacuation can be considered one of the most effective measures for reducing hazard impacts. The use of a framework that supports the integration of social and psychological aspects of people in the decision-making process during the pre-travel phase of flood evacuation can reveal decisive during emergencies. Also, it has to be highlighted that when investigating flood risk, the specific nature of the floods that can affect an area have to be found. In fact, it can occur that people can perceive to be at risk areas that do not appear in the official risk maps [20–22]. It follows that the importance of combining decision models in case of hazardous behaviors with the acquisition of information about areas perceived to be flooded can provide useful information in building evacuation scenarios.

In this paper we provide an analysis of historical flood events in the urban area of Bari, a coastal city located in the South-East coast of Italy. The actual city area, before urbanization, was naturally crossed by episodic streams, which may generate considerable flows in correspondence of significant heavy rainfall events. Nowadays, the increased urbanization led to an increase in flood risk, also exacerbating effects of that of pluvial nature. This case study is particularly interesting, also because it has been investigated also from the perspective of risk perception analysis [23].

The paper is structured as follows: in Sect. 3 the study area and the related background are illustrated. In Sect. 2 the methodological framework implemented for the purposes of this paper is described. In Sects. 4 and 5 results and their implications are illustrated. Finally, in Sect. 6 the main conclusions of the work are illustrated.

2 Study Area

The case study is represented by the city of Bari, that is located along the Adriatic coast in the southeastern part of Italy. The nature of landscape is such to lead to the rise of episodic streams called *lame* (Fig. 1), characterized by flows only in correspondence of very intense rainfall events [23, 24].Such nature encouraged an intense urbanization in the areas interested by the presence of the stream network that – in some cases – has been encompassed in the urban fabric during the last two centuries [25].

Memories of the ancient presence of *lame* in the current urban area still remain in toponyms (e.g., the Picone neighborhood take the name of the homonymous river that crossed its area) and photographic and archival documentation [25].

Several destructive river flood events hit the metropolitan area of Bari since the early '900 and their history has been the object of several studies [26–28]. In fact, the destructive nature of part of those floods was such to trigger victims and relevant damage and made necessary the building of hydraulic diversion operas aimed in protecting the core of the urban area of Bari from river floods.

Today the city has to be considered potentially subject to pluvial, coastal and fluvial floods, to be related with exceptional events possibly involving failure of hydraulic structures aimed at the protection of surrounding areas.



Fig. 1. Metropolitan area of Bari and Stream Network

As illustrated in Fig. 1, the city is crossed from the railway network, which implies the presence of a number of underpasses to reach the central core of the city represented by

Murat and San Nicola neighborhoods. This made floods of pluvial nature very common in the city, which is also potentially influenced also from events of the coastal type. Unlike river floods, pluvial and coastal occurrences have not been systematically reviewed analyzed for the city of Bari. Providing an attempt to summarize their occurrence and phenomenology is one of the goals of this work and results are illustrated in Sect. 4.

3 Materials and Methods

3.1 Floods Data Collection from Newspapers

A preliminary catalogue of flood events - other than the riverine type (that have been extensively surveyed in the literature) - has been set up from a search on local and national newspapers. The strategy adopted for retrieving such data was the search of news and details about floods in urban area of Bari in those dates in which annual maxima of sub-daily rainfall depths occurred for rain gauges located in the urban area according to the Hydrological Yearbooks printed in Italy from the twentieth century. In addition, we used the analogous values reported for very short and intense rainfall events. However, it is not guaranteed that those values correspond to annual maxima [29]. For the purpose of our analysis, we deem appropriate to investigate years between 1950 and 2020, year of the dissemination of the survey illustrated in [25] and that will be discussed later.

In order to achieve data of flood events, we investigated two types of sources, and namely a local newspaper ("La Gazzetta del Mezzogiorno") and websites. In particular, this latter source was analysed only for years from 2015 to 2020 in order to obtain a reasonable compromise between the effort of manual research and coverage of local (web) newspapers in the study area. This justifies also the decision of not extending the search on social media, despite they represent a relevant source of information for floods data retrieval [16].

3.2 Web Content Analysis (WCA)

The WCA was developed in cascade of newspaper analysis in order to exploit the greater number of contents available on the web. WCA is a method for analyzing online content to identify themes, trends, and relationships from data collected from sources such as articles, blogs, social media posts, and forums [30]. From a methodological perspective, the procedure starts by clearly defining research objectives and selecting relevant online sources. Data is then systematically collected using specialized tools, web crawlers, or targeted search queries [31]. Once collected, the data is filtered and selected according to predetermined criteria. Next, a crucial coding and categorization phase is carried out, either manually or assisted by software, to classify content based on thematic patterns [32]. The analysis itself can be qualitative or quantitative, aiming to reveal meaningful patterns or correlations [33]. To ensure methodological rigor and reliability, researchers often employ inter-coder reliability tests or triangulation techniques [34]. Finally, findings are interpreted and clearly presented in relation to the initial objectives, along with discussions of their implications and limitations [32].

The research on urban flooding events was conducted through a systematic analysis of online news sources and reports available on the web. The main objective was to

collect detailed information on the frequency, intensity and impacts of flooding episodes that affected the city of Bari in recent years, evaluating the role of infrastructures and the reactions of the local community. The research was manually conducted using search engines (Google News, Bing) and directly consulting information sites with regular coverage of local news. According to the experience reported in [16], we supported the search by exploiting a couple of keywords fields which combine a location ("Bari") and a meteorological indication ("Pioggia", "Maltempo", "Allagamento", "Alluvione", "Bomba d'acqua"). The searches were carried out with time filters set from 2015 to 2020 and also in those days in which extreme rainfall events reported in the Hydrological Yearbooks. This allowed to get additional information with respect to rainfall events that are not considered annual maxima.

The collected articles (newspapers and online websites) were organized in a table, recording for each event:

- Date of the event
- Affected locations
- Flood dynamics and causes
- Effects recorded in the urban area (flooding, traffic disruption, damage to infrastructure, damage to commercial activities).

3.3 Knowledge Discovery in Databases (KDD)

Knowledge Discovery in Databases is a process structured in different steps, each of which assumes a key role in converting raw data in useful and understandable knowledge [35].

KDD begins with the screening of relevant data, identifying and isolating relevant information for the analysis. After this, data undergoes the preprocessing, i.e. a procedure aimed in the removal of detected error or noises, in order to build a robust dataset. In case data are in the form of text, activities include stop-word analysis, tokenization, stemming and lemmatization. Once cleaned up, data are converted into a format which can suit better to analysis. Normalization, dataset size reduction and creation of new variables are some of the processes that can be implemented. Such datasets represent the input of the so-called *data mining*, which exploits advanced techniques for detecting patterns and relationships between data. Among involved methodologies, we list classification, clustering, regression. KDD ends with interpretation and evaluation of results, which represents a crucial point for ensuring validity and utility of acquired knowledge. Detected pattern are analysed and addressed for understanding their meaning and practical implications. This step can also be supported by data visualization, which can improve effectiveness in comprehending and sharing results. Those listed are not one-directional steps: if needed, analysts can go back to previous and refine it. This makes KDD a very dynamic procedure.

In this paper this process has been practically implemented in retrieving codified information about landmarks, because a same landmark can be mentioned with different terms. It is important to note that this analysis implied to cope with toponyms of disappeared streets/neighborhoods, which required an additional search for retrieving their position.

4 Results

As stated in Sect. 3, flood events catalogue from newspapers has been built moving from the date of the sub-daily extreme rainfall events. In order to characterize these events, for each of the event durations under exam in Fig. 2 is illustrated the percentage of occurrence for each month of the year.

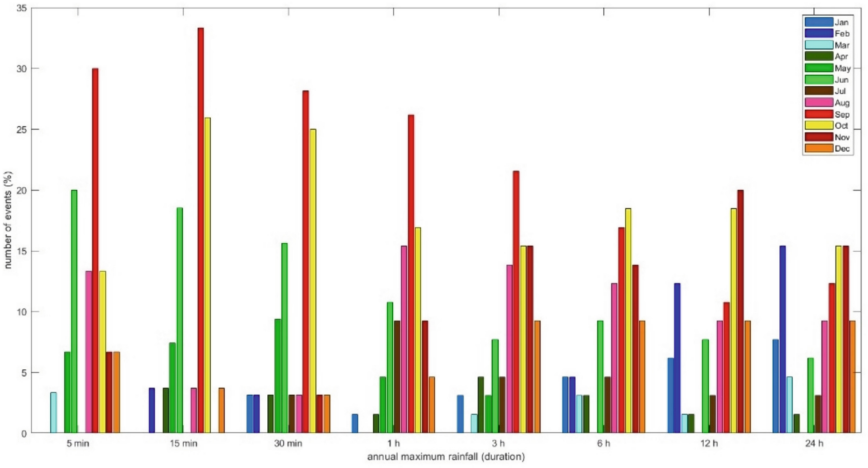

Fig. 2. Monthly distribution of rainfall extremes recorded at the Bari Osservatorio rain gauge

This figure shows some very interesting characters of the rainfall events typical of Italian areas [36]. In detail, very short events (from 5 to 30 min) are mainly concentrated in June, September and October, while from 1 to 24 h there is a progressive shift in the occurrence from August-September to winter months. Typically, shorter events are characterized by higher intensity than the longer, denoting very different characteristics also in their ground effects and dynamics.

Then, we checked the correspondence between those dates and journalistic reports and news, finding more than 80 descriptions of flood events in the metropolitan area of Bari. After rationalizing their content (in accordance with Sect. 3), we obtained the landmarks frequencies listed in Table 1. Locations of these landmarks in the urban area of Bari can be found in Fig. 3.

Most of these landmarks belongs to underpasses, which are recognized as very critical points for urban areas. In the city of Bari, they are generally associated with the railway network, which acts as a barrier between the city center and the peripheral areas.

It is very interesting to note that a consistent portion of these landmarks is not crossing areas related to a river flood event with a return period of 30 years: this is a further signal about the occurrence of floods attributable to pluvial/coastal nature. Some notes have to be made with respect to Table 1: as first, this is a cumulative list over around 70 years. During this period the city experienced significant urbanistic changes, which involved the setup of new vulnerable areas which obviously have a low frequency of occurrence but

Table 1. Landmark frequencies (if greater than 5%) of flood events retrieved from newspapers and web analysis

Landmarks	Occurrences (%)
Quintino Sella underpass	47.2
Bruno Buozzi underpass	20.9
Luigi di Savoia underpass	19.4
Modugno underpass	15.3
Giuseppe Re David street	12.5
Starita seafront	11.1
Giulio Petroni street	9.7
Nazario Sauro seafront	8.3
Giuseppe Capruzzi street	8.3
Domenico Nicolai street	8.3
San Nicola church	6.9
Benedetto Croce street	6.9
Giovanni Jatta street	6.9
Cavour street	5.6
Imperatore Augusto seafront	5.6
Michele Mirenghi street	5.6
Monte Nevoso street	5.6
Napoli street	5.6
Pietro Ravanas street	5.6
Vittorio Veneto street	4.2

can be actual. On the other side, the installation of new or redesigned drainage systems could potentially have mitigated the hazard and reduced floods impacts. Furthermore, the review of events from 1950 to 2015 could not be considered exhaustive: in fact, it has been carried out only considering extreme rainfall events reported in the Hydrological Yearbooks, but can be more of these if we consider that also rainfall events with lower recorded intensity could have triggered urban floods or, also, meteorological systems that have not been significantly recorded from raingauges network.

Furthermore, newspaper analysis allowed to gather knowledge about the changes in the urban fabric of the city and how it affected the occurrence of urban floods. In particular, the journalistic reports in many occasions have been a really useful provider of details about flood dynamics and motivations, and the effectiveness of *ad hoc* mitigation measures adopted during years for tackling floods effects.

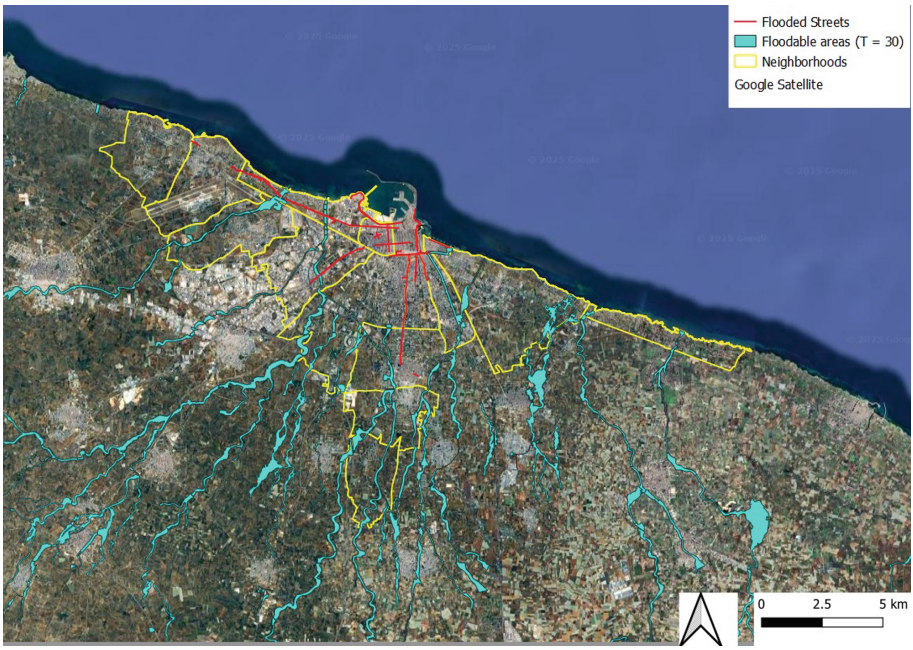

Fig. 3. Streets with the highest rate of flood occurrences in 1950–2020

5 Discussion

In this paper we retrieved historical flood events from newspapers and web contents for the city of Bari (Italy), in order to collect information and improve the knowledge about the different nature of floods that can affect the city. From the analysis of the results it is evident how floods due to local topographic depressions or to ineffectiveness of urban drainage systems are common events in the city, and that underpasses are among the highest vulnerable points. A positive and relevant feedback from this analysis can be made by comparing our findings with those of Santoro et al. [25], which exploited a survey-based strategy for investigating flood perception in the city of Bari. It emerged that pluvial flood exerts a strong effect on the survey respondents, and that city underpasses (especially those linking the historical core of the city with peripheral neighborhoods) are those with highest flood perception from respondents. Also, if regarded with respect to the perception of floodable neighborhoods, from Fig. 3 a significant feedback is verified. However, this comparison led also to explaining reasons for which resident population seems to be unaware of the risk due to episodic streams that cross metropolitan area, especially in the light of the devastating effects that they caused in the last 120 years [37]. This fact could be explained not only with the physiological decay of memory that occur after floods, but also with the lost of knowledge about the urban structure of the city. In fact, the strong link between *lame* and urban fabric in Bari is evident from the fact that the Picone lama crossed the neighborhoods of Picone and Libertà until the last two centuries, but has been culverted during some of the expanding steps of the city [25]. This is a critical point and should need to be properly assessed in emergency plans.

Interesting implications can be drawn from the results of the proposed analysis. In particular, our study allowed to detect not only historically flooded areas, but it allowed also a deeper reflection about changes occurred in the urban fabric in the last 70 years. For example, we gained information about causes and dynamics of flooding and about existence and building of drainage systems, which can reveal as a very useful information in the analysis of flood hazard. A deeper knowledge about land use and the effectiveness of new drainage systems in mitigating floods occurrences was also possible. In the case of coastal floods due to sea storms, our search allowed to depict clear evidence of benefits in the building of coastal protection structures offshore the historical urban waterfront. Our results also showed how underpasses (Quintino Sella, Bruno Buozzi and Luigi di Savoia in particular) are historically subject to flooding, also if the realization of mitigation strategies seems to have reduced at least the observed water depths and highlighted the effectiveness of emergency measures taken by local authorities. In fact, newspaper analysis showed that in the past it was not uncommon to rescue people by rafts.

This research also allowed to gain some knowledge about dynamics of accidents or flood behaviors of people during floods. In this latter case, for example, we found a document about a citizen swimming in the Quintino Sella flooded underpass, clearly for recreational purposes, depicting a clear tendence in hazardous behaviors already documented in studies about flood victims' dynamics [38]. A systematic analysis of such behaviors (and also in places and accidents dynamics) can be very useful for analysing people's behaviour during floods and plan some precautionary measures [20].

As clearly evident from the illustrated results, there is a relevant correspondence between perceived and observed landmarks. This is a significant conclusion, also in the light of the high frequency of events retrieved for underpasses, also showing a clear feedback with the typical transportation dynamics of the city. Results are also consistent with a similar case study [21]. On the other side, an underestimation of some landmarks has to be noticed, but it can be due both to the limited extension in time of our research (which stopped in 2020) and to the recent building of some urbanized areas. This can have influenced the perception of many of respondents to the survey, thus demonstrating how both floods and their perception have a strong dynamic component.

Some limitations of the proposed analysis have to be listed. As first, retrieved flood catalogue is not exhaustive. In fact, we collected only events related to the extreme of sub-daily rainfall reported in the Italian Hydrological Yearbooks. In particular, more other events could be retrieved by more systematic research of events both from newspapers and from the web. Finally, the sample used for collecting information about citizens' risk perception used in [25] cannot be homogeneous, and could be not fully representative of some areas (the suburbs, for example), which are widely documented to have been subject to floods, but are excluded from the top-rated.

6 Conclusions

In this paper we approached the topic of floor risk analysis in urban areas by retrieving flooded areas in the last 70 years and making a preliminary evaluation about the occurrence of flooding episodes. The analysis was carried out on the case study of Bari

(Italy), a coastal city in the south of Italy, characterized by a metropolitan area crossed by several episodic streams that have flows only in case of very intense rainfall events. Result highlighted that the high frequency of episodes of flooding due to heavy rainfall events hit underpasses, together with areas characterized by flat topography and prone to the accumulation of water. A comparison with a study showing results of a survey disseminated among the city population clearly highlighted how the same landmarks are perceived to be potentially floodable areas. In addition, the comparison demonstrated that the sporadic occurrence of river floods led to a neglection in perception of this type of risk from the population, which is instead more conscious about pluvial events, especially in underpasses. These findings are of particular significance, especially if regarded in respect to the need of updating flood management in the light of climate change: in fact, modified rainfall scenarios could lead to unprecedented floods events. It is therefore desirable to support analysis with an in-depth investigation about the knowledge of protective measures from the population and by testing and improving current structures for flood risk management in urban areas, also revisiting the perception of urban areas from people by improving the knowledge of the original structure of landscape.

References

1. Hammond, M.J., Chen, A.S., Djordjević, S., Butler, D., Mark, O.: Urban flood impact assessment: a state-of-the-art review. Urban Water J. **12**(1), 14–29 (2015). https://doi.org/10.1080/1573062X.2013.857421
2. Merz, B., et al.: Causes, impacts and patterns of disastrous river floods. Nat. Rev. Earth Environ. **2**(9), 592–609 (2021). https://doi.org/10.1038/s43017-021-00195-3
3. EU, European Union: Directive 2007/60/EC of the EuropeanParliament and of the council of 23 October 2007 on theassessment and the management of flood risks Official JournalL288 (2007)
4. Montanari, A., Koutsoyiannis, D.: Modeling and mitigating natural hazards: stationarity is immortal! Water Resour. Res. **50**(12), 9748–9756 (2014)
5. Serinaldi, F., Kilsby, C.G.: Stationarity is undead: uncertainty dominates the distribution of extremes. Adv. Water Resour. **77**, 17–36 (2015)
6. Mascitelli, A., et al.: Cultural heritage resilience in the face of extreme weather: lessons from the UNESCO site of Alberobello. Sustainability **15**(21), 15556 (2023)
7. Cantatore, E., Esposito, D., Sonnessa, A.: Mapping the multi-vulnerabilities of outdoor places to enhance the resilience of historic urban districts: the case of the Apulian region exposed to slow and rapid-onset disasters. Sustainability **15**(19), 14248 (2023)
8. Dawson, R.J., Speight, L., Hall, J.W., Djordjevic, S., Savic, D., Leandro, J.: Attribution of flood risk in urban areas. J. Hydroinf. **10**(4), 275–288 (2008)
9. Cea, L., Costabile, P.: Flood risk in urban areas: Modelling, management and adaptation to climate change. A review. Hydrology **9**(3), 50 (2022)
10. Schmitt, T.G., Scheid, C.: Evaluation and communication of pluvial flood risks in urban areas. Wiley Interdiscip. Rev. Water **7**(1), e1401 (2020)
11. Kandilioti, G., Makropoulos, C.: Preliminary flood risk assessment: the case of Athens. Nat. Hazards **61**, 441–468 (2012)
12. Du, S., Gu, H., Wen, J., Chen, K., Van Rompaey, A.: Detecting flood variations in Shanghai over 1949–2009 with Mann-Kendall tests and a newspaper-based database. Water **7**(5), 1808–1824 (2015)

13. Lang, M., et al.: Preliminary flood risk assessment for the European directive: inventory of French past floods. Compr. Flood Risk Manage. Res. Policy Pract. **423**(25), 303 (2012)
14. Llasat, M.C., et al.: Towards a database on societal impact of Mediterranean floods within the framework of the HYMEX project. Nat. Hazard. **13**(5), 1337–1350 (2013)
15. Mobini, S., Pirzamanbein, B., Berndtsson, R., Larsson, R.: Urban flood damage claim analyses for improved flood damage assessment. Int. J. Disaster Risk Reduction **77**, 103099 (2022)
16. Lombardo, M., Totaro, V., Chiaravalloti, F., Petrucci, O.: Street-scale hydrodynamic estimation from social media videos: a systematic approach to urban floods data collection. Int. J. Disaster Risk Reduction, 105419 (2025)
17. Najafi, M., Ardalan, A., Akbarisari, A., Noorbala, A. A., Elmi, H.: The theory of planned behavior and disaster preparedness. PLoS Currents **9** (2017). https://doi.org/10.1371/currents.dis.4da18e0f1479bf6c0a94b29e0dbf4a72
18. Liu, Y., Fan, Z.P., Zhang, Y.: Risk decision analysis in emergency response: a method based on cumulative prospect theory. Comput. Oper. Res. **42**, 75–82 (2014). https://doi.org/10.1016/j.cor.2012.08.008
19. Taillandier, F., Di Maiolo, P., Taillandier, P., Jacquenod, C., Rauscher-Lauranceau, L., Mehdizadeh, R.: An agent-based model to simulate inhabitants' behavior during a flood event. Int. J. Disaster Risk Reduction **64**, 102503 (2021). https://doi.org/10.1016/j.ijdrr.2021.102503
20. Santoro, S., Totaro, V., Lovreglio, R., Camarda, D., Iacobellis, V., Fratino, U.: Risk perception and knowledge of protective measures for flood risk planning. the case study of Brindisi (Puglia region). Saf. Sci. **153**, 105791 (2022). https://doi.org/10.1016/j.ssci.2022.105791
21. Santoro, S., Totaro, V., Mastrodonato, G., Balena, P.: Mapping citizens' knowledge and perception. What support for flood risk planning? Some Tips from Brindisi Case Study. In: Gervasi, O., et al. Computational Science and Its Applications – ICCSA 2023 Workshops. ICCSA 2023. Lecture Notes in Computer Science, vol. 14109, pp. 355–367. Springer, Cham (2023). https://doi.org/10.1007/978-3-031-37120-2_23
22. Douglas, I., Garvin, S., Lawson, N., Richards, J., Tippett, J., White, I.: Urban pluvial flooding: a qualitative case study of cause, effect and nonstructural mitigation. J. Flood Risk Manage. **3**(2), 112–125 (2010)
23. Santoro, S., Lovreglio, R., Totaro, V., Camarda, D., Iacobellis, V., Fratino, U.: Community risk perception for flood management: a structural equation modelling approach. Int. J. Disaster Risk Reduction **97**, 104012 (2023)
24. Balacco, G., Totaro, V., Gioia, A., Piccinni, A.F.: Evaluation of geomorphic descriptors thresholds for flood prone areas detection on ephemeral streams in the metropolitan area of Bari (Italy). In: Misra, S., et al. Computational Science and Its Applications – ICCSA 2019. ICCSA 2019. Lecture Notes in Computer Science, vol. 11622, pp. 239–254. Springer, Cham (2019). https://doi.org/10.1007/978-3-030-24305-0_19
25. Santoro, S., Totaro, V., Balena, P., Iacobellis, V., Fratino, U., Borri, D.: The interlink between urban growth and flooding: lessons from the city of Bari (Italy) (Sumbitted)
26. Borri, D., Di Santo, A., Iacobellis, V.: Bari: la piena del 1926. Continuità Rassegna Tecnica Pugliese, Bari, No. 3–4, pp. 83–88 (2002)
27. Moretti, M.: Le alluvioni nel settore Adriatico delle Murge (Terra di Bari): cause geologiche e ruolo dell'azione antropica. Geologi e Territorio, Ordine Regionale dei Geologi – Puglia, No. 3, pp. 11–22 (2005)
28. Bisantino, T., Pizzo, V., Polemio, M., Gentile, F.: Analysis of the flooding event of October 22–23, 2005 in a small basin in the province of Bari (Southern Italy). J. Agric. Eng. **47**(4), 197–204.40 (2016). https://doi.org/10.4081/jae.2016.531
29. Pelosi, A., Chirico, G.B., Furcolo, P., Villani, P.: Regional assessment of sub-hourly annual rainfall maxima. Water **14**(7), 1179 (2022)

30. Herring, S.C.: Web content analysis: expanding the paradigm. In: International Handbook of Internet Research, pp. 233–249. Springer, Dordrecht (2009)
31. Kim, I., Kuljis, J.: Applying content analysis to web-based content. J. Comput. Inf. Technol. **18**(4), 369–375 (2010)
32. Schreier, M.: Qualitative Content Analysis in Practice. SAGE Publications (2012)
33. Neuendorf, K.A.: The Content Analysis Guidebook, 2nd edn. SAGE Publications (2017)
34. Krippendorff, K.: Content Analysis: An Introduction to Its Methodology, 4th edn. SAGE Publications (2018)
35. Fayyad, U., Piatetsky-Shapiro, G., Smyth, P.: From data mining to knowledge discovery: an overview. In: Fayyad, U., Piatetsky-Shapiro, G., Smyth, P. Uthurusamy, R. (eds.) Advances in Knowledge Discovery and Data Mining, pp. 1–34. AAAI Press/The MIT Press, Menlo Park (1996)
36. De Luca, C., Furcolo, P., Rossi, F., Villani, P., Vitolo, C.: Extreme rainfall in the Mediterranean. In: Proceedings of the International Workshop on Advances in Statistical Hydrology, pp. 23–25. University of Catania-IAHS-STAHY, Taormina, May 2010
37. Mossa, M.: The floods in Bari: What history should have taught. J. Hydraul. Res. **45**(5), 579–594 (2007). https://doi.org/10.1080/00221686.2007.9521795
38. Diakakis, M.: Types of behavior of flood victims around floodwaters: correlation with situational and demographic factors. Sustainability **12**(11), 4409 (2020). https://doi.org/10.3390/su12114409