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First evaluation of the damage related to alluvial events in torrential catchments of Campania (southern Italy), based on a historical database

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Abstract. This study presents an historical database of alluvial events in torrential catchments of Campania region, southern Italy. Detailed scrutiny and critical analysis of the existing literature, and of the data inventory available, allowed us to build a robust database consisting of about 500 events. Being this study the first step of a longer project, aimed at eventually reaching an hazard analysis, information about time and site of occurrence are known for all the events. The outlet zone of torrential catchments (represented mainly by alluvial fans or fan deltas) are highly urbanized in Campania region, thus collecting information about past events could provide useful information on future events, in terms of damage, and of spatial and temporal occurrence as well. In section 1 we introduce the issue of alluvial events in Italy. Existing database and published studies on hydrogeological events, in particular regarding Campania region, are presented in section 2, where we also discuss the importance of using the historical sources, and their limits and drawbacks. The geological and geomorphological settings of Campania region are introduced in section 3. Then, in section 4, we present our database by illustrating its general structure and the methodology used in collecting information. Statistical and data analysis carried out on the collected data are presented in section 5. Aimed at performing a complete hazard analysis, analysis on rainfall data and the application of numerical models on alluvial events will be the future steps.

1. Introduction

Alluvial events in Italy are a frequent natural hazard, due to the peculiar orographic and climatic setting of many sectors of the country. The young orogen (the Apenninic Chain) in the peninsular area is characterized by high relief. In such a setting, torrential stream catchments are one the most widespread landscape unit, characterized by peculiar flood scenarios. During an alluvial event, a torrential stream catchment may be interested by different types of processes, including both fluvial processes (water flood, "debris floods/hyperconcentrated flow" and "debris flow", sensu Costa 1988) and gravity processes (i.e., landslides). As regards the fluvial processes, variations in the flow typology are mainly caused by the concentration of the sediments entrained in the flow. The sediments captured by the stream and transported downvalley generally come from the bed and banks of the torrent, and they may eventually contribute to build alluvial fans or fan deltas, depending on the geographical setting of the catchment (inland or coastal). Although each process has unique diagnostic effects and products, in nature there exists a continuum of flow conditions and sediment concentrations. Identification of the specific hydrological and geomorphic process is thus a central problem for the correct hazard recognition, since each process has different associated hazard characteristics (O'Brien and Julien 1985; Costa 1988; Fema 2000; Jakob 2005). Another important aspect

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is that in torrential stream catchment a substantial difference of magnitude exists between the low water periods, including a seasonal lack of surface water in ephemeral streams, and flood events capable of heavily rearranging the river-bed topography. The low frequencies of important flow rates might cause the reduction of hazard perception and leads towards an incorrect land use and an unsafe management of the catchment. The collection of historical information of past events must be the starting point to deal with inhabitant security, land planning, and watershed management (D'Agostino, 2013).

Whilst in the Italian Alps, due to their high frequency, these phenomena have been quite well studied (Crosta et al., 2003, 2004; Sosio et al., 2007; Carrara et al., 2008; Simoni et al., 2011; Arattano et al., 2012, 2015; Marchi et al., 2013; Berti et al. 2014; Blahut et al., 2014; Tiranti et al., 2014), in the Apennines they have typically been object of lesser attention, mostly because of the lower recurrence (Sorriso Valvo et al., 1998; Zanchetta et al., 2004a; Santo et al., 2002, 2012, 2015; Cascini et al., 2008a; Santangelo et al., 2011, 2012; Alessio et al, 2013; Antronico et al., 2015a, b).

We focus our attention on torrential stream catchments of Campania region, in the Southern Apennines of Italy, which, during the last decades, has been affected by severe flooding with serious damage and fatalities (Santo et al., 2002, 2012, 2015; Calcaterra et al., 2000, 2003; Del Prete and Mele, 2006; Santangelo et al., 2006, 2011, 2012; Chirico et al., 2012; Alessio et al., 2013).

As the first step in the process of hazard evaluation, we compiled a database with the following main aims: i) to identify over the whole region the most susceptible areas to alluvial events; ii) to discriminate, in the available literature and historical data, alluvial events in torrential stream catchment from flood on large river systems and from gravity processes, such as rapid earth or debris flow (Del Prete et al., 1998; Crosta and Negro, 2003; Guadagno et al., 2003, 2005; Revellino et al., 2004; Zanchetta et al., 2004b; Di Crescenzo and Santo, 2005; Cascini et al., 2008b).

2. State of the art

2.1 Database on hydrogeological events (floods and landslides)

In any hazard and risk analysis the first step typically consists in collecting information about past events, starting from the concept that past events can provide information on future events, in terms of both spatial and temporal occurrence. Taking into account the loss of memory, it is important to reach the better knowledge possible about where hazardous events occurred in the past, what intensity they had, and what was the frequency of occurrence in the recent history.

Different types of information source can be considered to build a database on floods and debris flows. A high percentage of data and information typically is derived from collection and critical analysis of historical documents. In addition, this part of the work allows to get some hints about past events for which no evidence have been left in the field, or to confirm oral, often not exhaustive, documentary sources.

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To provide some examples, the CNR IRPI Institute in Turin built a database on landslides, debris flows and stream floods in Northern Italy, collecting hundreds of thousands of records contained in published and unpublished documents and historical reports on natural damaging events over the last 500 years (Tropeano and Turconi, 2004). Further, this work highlighted the importance of using historical documents in the evaluation of natural hazards, as also stated by other authors in different parts of Italy (Calcaterra and Parise, 2001; Gringeri Pantano et al., 2002; Calcaterra et al., 2003). Other studies were focused on the triggering events, by providing a chronological description of 2.256 climatically triggered events in Switzerland, occurred between the years 563 and 1988 (Röthlisberger, 1991).

The AVI project (an Italian acronym for *Aree Vulnerate in Italia*, Areas Affected by Landslides or Floods in Italy) was commissioned by the Minister of Civil Protection to the National Group for Prevention of Hydrogeologic Hazards of the Italian National Research Council (CNR) with the aim to compile an inventory of information on areas historically affected by landslides and floods in Italy (Guzzetti et al., 1994). It is the most complete archive of landslides and floods produced in Italy, and is continuously updated.

In Italy, again, Brunetti et al. (2015), within the framework of a project with the National Department of Civil Protection, analyzed rainfall events that have resulted in shallow failures and debris flows to define national and regional thresholds for the possible occurrence of rainfall-induced shallow landslides and debris flows in the country.

As concerns Campania, several studies have been conducted in order to collect historical information about hydrogeological events. In the majority of the cases these databases refer to landslides or floods, or put together different types of events. In this framework a regional-scale database on alluvial events in torrential catchment does not exist.

The area of Sarno, Quindici and Bracigliano, hit by the catastrophic event on May 5, 1998, was particularly object of detailed studies: Mazzarella and Diodato (2002), on the basis of old documents, collected alluvial events that since 1794 affected the town of Sarno, also including in their work information about rainfall by means of an index of strength (Mazzarella and Diodato, 2002). On the other side of the same mountain, where the village of Quindici is located, Calcaterra et al. (2003) analysed past slope instability by means of historical and geological data to assess the landslide hazard. A careful scrutiny of the historical information was made by the authors, who provided a critical evaluation of the examined sources in order to rank their reliability. Calcaterra et al. (2003) highlighted the importance of combined historical-geological investigations, since only the cross-analysis between historical research and geological, geomorphologic and engineering-geological approaches may help to get a good knowledge on both the spatial and temporal distribution of the events.

Other authors have performed sub-regional or regional studies in Campania on landslides and floods (Migale and Milone 1998; Esposito et al., 2003, Di Crescenzo and Santo, 2005).

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As regard the alluvial events in the torrential catchments of the region, [illegible]ssio et al. (2013) built a database on floods occurred in the Somma-Vesuvius area based on historical (19-20th century) and geomorphological data: they listed 87 flood events, and retrieved spatial and temporal information, hourly and daily rainfall recorded and numbers of victims. In addition, they also calculated geomorphological and planimetric paramete[illegible]f the catchments affected by the flood events. Further works dealt with the observed or documented damage (Porfido et al., 2013), or with morphological and morphometric parameters aimed at a susceptibility analysis (Santangelo et al., 2012). A geomorphological and morphometric analysis of 102 basin/fan systems, located along the border slopes of the carbonate massifs of Southern Apennines, was carried out by Scorpio (2011). In this study, in order to analyze the susceptibility distribution to alluvial fan flooding in the region, morphometric features of the basin/fan system were used to classify the fans in terms of transport process (debris flow or water flood).

Eventually, many papers are addressed to specific study areas, such as the Teglia catchment (Santo et al., 2015), the Sala Consilina area in the Maddalena Mountain Ridge (Santangelo et al., 2011), and Santa Maria a Vico and Arienzo in the Caserta Mountains (Di Crescenzo et al., 2013). After the November 10, 2009, event in the northern sector of the island of Ischia, Santo et al. (2012) performed a flood hazard, through collection of historical information about landslides and floods (Del Prete and Mele, 2006), combined with geomorphological and rainfall analysis.

Esposito et al. (2011) studied published and unpublished historical sources along the coastal areas of Campania, with greater detail in the Amalfi Coast. In the latter paper the authors also presented a level of quality of the available sources, similarly to what done by Calcaterra and Parise (2001).

2.2 Use of historical documents: strengths and weaknesses

Archival and historical data are typically descriptive, written by non-technicians, and rarely they do contain quantitative information on significant elements such as type of process, volume of sediments, runout distance or water height (Stoffel et al., 2013). Nevertheless, they represent an invaluable source of information.

Availability of historical documents, and the possibility to examine them, is a consequence of the history of the country, and of its socio-economic conditions as well. As stated by D'Agostino (2013), a debris flow during wars, famines, or in time of plagues probably does not represent a social priority; thus, the historical analyses could be affected by biases originating from different sensibility to similar events during different historical ages. Obviously, countries of ancient civilization offer a longer period of records, and greater possibilities to find interesting information. At the same way the urbanization history may influence the historical analysis, as a recent urbanized area may records only recent events because there were not witnesses in the past.

The quality of historical information is also related to the involved area and the severity of the event. If a heavy event hits only a catchment or municipality, it is likely to have precise temporal and spatial information. On the other hand. if the event affected a larger area, the information will likely be more generic. Figure 1 (modified after D'Agostino, 2013) illustrates the links between the time scale of the event (single, multiple years period, all documentable time) and the scale area involved (single catchment, part of a mountain valley, a region). Depending on both the factors, different levels of historical research have to be developed: specific, medium scale and extended historical research.

Frequently, errors in transcription can result in attributing wrong time of occurrence to an event. It is therefore fundamental to compare all the available information sources. As for location, it may occur that the source reports the locality name of the property being hit, or the name of a street that does not exist anymore, which makes difficult (and sometimes impossible) to exactly locate the site.

As concerns damage to people, in most cases the reported information are very generic, such as "some victims", or in other cases the source provides the total number of victims per event but not for the individual municipalities. The precise estimate of the number of victims is thus not easy. In some cases divergences exist in the numbers of casualties reported by different sources for the same event. The differences can be related to several reasons, including the fact that the exact number is typically available only at the end of the search and rescue operations, from a few days to weeks after the event. During this period, newspapers and even official reports may provide different and changing data (Salvati et al., 2010).

Typically, information sources mainly document the most remarkable events for number of deaths and damages caused. In the last decades, however, with the intensifications of land use, information about smaller events has become available (Stoffel et al., 2013), and might be relevant and useful in order to develop a better hazard assessment.

3. Study area

The study area is the Campania region (Southern Italy) extending from the Tyrrhenian Sea to the Southern Apennine Chain for about 13500 kmq. The orographic setting is characterized by the presence of a central mountain ridge made up mainly of Mesozoic carbonates, elongated for more than 200 km in a NW-SE direction, with maximum peaks reaching 2000 meters a.s.l. On the western side the chain is bounded by a deep (up to 2 km) coastal graben originated by Plio-Quaternary extensional tectonics, which were filled by marine/transitional sedimentary successions, and are now occupied by large and flat coastal plains (Ascione et al., 2008). During the late Quaternary a strong volcanic activity was registered in the Campania plain coastal graben with the growth of the Somma-Vesuvius and the Phlegraean Fields volcanoes (Romano et al., 1994). The landscape of the western portion of Campania is thus characterized by a wide flat area with isolated volcanic reliefs and islands. On the eastern side of the region the carbonate ridges pass to hilly landscapes of lower elevation, made up mainly by Miocene and Pliocene flysch successions. In this general orographic setting, torrential stream catchments are a

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widespread geomorphologic unit along the flanks of the main carbonate ridges, and the slopes of the volcanoes as well, where they have also the higher longitudinal gradients. In the remnant hilly part of the region stream catchments have lower mean longitudinal profiles, and wide alluvial plains linked to perennial river systems prevail. A simplified geological scheme of Campania region is shown in Figure 2.

The general climate is humid temperate with mean annual precipitation ranging from 1000 to 2000 mm. In short, the main situations responsible for abundant rains over the region are generally north-westerly or westerly winds bringing eastward-moving cyclonic depressions. Due to the rugged topography of the region, heavy convective precipitation often results in flash floods, with concomitant widespread floods and landslides.

4. Method

4.1. Sources used in data collection

The first step of our work was the collection of all available literature and archive data, including those coming by finalized projects like IFFI (*Inventario dei Fenomeni Franosi in Italia* - Inventory of Landslides in Italy, ISPRA-Servizio Geologico d'Italia, 2006), PAI (*Piani Stralcio per l'Assetto Idrogeologico* - River basin plans - Law 267/98) and AVI (*Aree Vulnerate in Italia* - Italian Sites Affected by landslides and floods; Guzzetti et al., 1994). All these data were located as precisely as possible, and included in the web gis database.

The second step involved the critical analysis of each input data aiming at discriminating between alluvial events and landslides, as in many reports these different types of processes are put together under the general classification of "hydrogeological events". In particular, we took into account the following event typologies:

1. Flood events in alluvial plain;
2. Flood events in torrential stream catchme
3. Landslides;
4. Mixed and/or doubt cases.

All the events that may be easily discriminated based on general description and geographic location were inserted in the database. For the mixed and doubt cases a second analysis was carried out, in order to classify them in one of the four classes, or to definitely exclude them from the database.

Once all the events were grouped in different typologies, we moved to exclude from our analysis the classes 1 and 3, focusing our attention on the class 2, which represented the 56% of the collected data (Fig. 3), and included a list of more than 500 events of alluvial events occurred in torrential stream catchments.

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4.2. Catchment typologies

The torrential stream catchments of Campania most affected by alluvial events in the last decades are mainly located in the carbonate and volcanic settings (Palma et al., 2009; Santangelo et al., 2012; Santo et al., 2012, 2015; Alessio et al., 2013). As regards their geographic location they may have both an inland outlet (generally represented by a fan or by a well defined foothill area; Santangelo et al., 2012), or a coastal outlet, generally represented by a fan delta (Esposito et al., 2011; Santo et al., 2012). They also show similar morphometric conditions (Santangelo, 2012; Alessio et al., 2013) which can be summed up as follows:

- Limited catchment area (from few km^2 to 10 km^2);
- High relief energy (from hundreds of meters up to 1000 m);
- High slopes gradient (generally greater than 35°);
- High mean gradient of feeder channel (greater than 15°);
- Low concentration time (from 30 minutes to some hours).

As the sediments captured by the stream and transported down-valley generally come from the bed and banks of the torrent, we tried to discriminate among different catchment typologies, basing on the following parameters:

- Bedrock of the catchment (carbonate/volcanic);
- Presence/absence of detrital cover and, in case of presence, its origin (weathered bedrock, soil, pyroclastic cover, etc.);
- Type of outlet zone (alluvial fan or fan delta in coastal area).

Thus, the collected events were eventually grouped, based upon their occurrence in the following five classes:

1. Carbonate catchment with pyroclastic cover;
2. Carbonate catchment without pyroclastic cover;
3. Carbonate catchment with pyroclastic cover and outlet to the sea;
4. Volcanic catchment;
5. Volcanic catchment with outlet to the sea.

4.3 Structure of the database, and collected information

The database contains about 500 events and is being continually updated. Each event is identified by an ID, and by the geographical coordinates (events are located by using Google Earth©). The catchment type for each event, according to the five classes defined, is also indicated in the database. Information about time of occurrence is mandatory to include an event in the catalogue. To evaluate the temporal degree of accuracy, five classes were introduced. Undoubtedly, going back to the past the accuracy decreases to the lowest level (annual accuracy). The highest value of temporal accuracy, on the other hand,

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is assigned when the availability of information on the time of occurrence is complete (hour, day, month and year of occurrence). As concerns the trigger, the rain gauge closest to the site of the event, along with the rainfall data, is also included for the events for which daily or hourly rainfall data were accessible. Particular attention has been given in the catalogue to damage to people and infrastructures. The documented events caused heavy damages to the society, primarily involving buildings, infrastructures and lifelines (roads, pipelines, etc.). Damage to the population includes number of victims, injured, homeless and missing people. In several cases the information source does not allow to quantify damage to people, since the reported information are typically generic, such as "some victims" or “several victims”. Thus, aimed at not loosing any useful data, information about damage are reported also as text, as from the original sources. Further, additional useful information can be included in the field “notes”.

The database is synthetically shown in Table 1, which contains the main information for each event, as date and site of occurrence, damage and victims.

5. Data analysis

The database on alluvial events in torrential catchments of Campania contains about 500 events at the time we write (September 2015). The oldest event occurred in 1540, and affected the town of Amalfi. Temporal distribution of the events on the territory (Fig. 4) reveals that most of the municipalities have been affected more than once during the time period covered by the data included in the database (from 1540 to nowadays). Despite there are several catchments with similar geological and geomorphological characteristics, many villages did not record any event, which is probably related to lack of inhabited areas. More than 60% of the events occurred during the last 50 years, but this outcome is likely related to the higher availability of information sources, to the numerous scientific studies carried out in the last decades (mostly as an effect of the Sarno-Quindici catastrophic event in 1998), and to the growing attention toward geological hazards from the society. Five grades of temporal accuracy have been defined in order to classify the different level of knowledge of time of occurrence of the events. Events for which only the year of occurrence is known have a low accuracy, while a high accuracy is assigned when hour, day, month and year of occurrence are known. The histogram in Fig. 5 indicates that most of the collected events have a middle-to-high accuracy, meaning that day, month and year of occurrence are known. The accuracy degree decreases for the oldest events, as well as also for the smaller events.

The recurrence of alluvial events in the same area was also investigated. As shown in Figure 6, among the 86 municipalities that have been damaged by torrential flooding, 16 recorded more than 10 events. At a greater detail 9 out of 16 were located in the outlet zone of coastal carbonate catchments (Sorrento peninsula - Lattari Mts. ridge), whilst the others are in the

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piedmont areas of inland carbonate massifs (Picentini and Matese Mts.) or in the volcanic area of Somma-Vesuvius. In all these cases the recurrence of the events is very low, ranging from 39 to 3 years, with a mean value of 15(Fig. 7). If only the most damaging events are taken into account the recurrence time increases to 50.

As regards the type of involved catchments, Figure 8 shows the events distribution on the territory, classified according to the aforementioned five classes. Most of the events took place in carbonate catchments with pyroclastic cover, both with and without an outlet to the sea (Figs. 8 and 9a). The widespread presence of carbonate catchments, and the high urbanization as well, affected the information source: as above mentioned, higher urbanization means typically greater availability of data, due to a higher attention toward occurrence of natural hazards. Distinguishing between different catchment types is important in order to discern the different bed and banks materials available, that the surge could entrap and transport downvalley. In a carbonate catchment the surge could take gravel without matrix or with low matrix (Fig. 10a), whilst in carbonate catchments with pyroclastic cover medium and coarse gravels with an high percentage of matrix are available (Fig. 10b). In the volcanic catchments, on the other hand, due to greater erodibility of the material, it is possible to find mainly silts and clays on bed and banks (Fig. 10c).

The monthly distribution of the events is quite variable in the different types of catchments. Figure 9b shows that all the events reach the peak in October, and that Autumn is the season with the highest frequency. After the dry period, heavy rainfall can generate sudden and high discharge, and the water runoff can carry downstream sediments accumulated as a result of the erosion processes.
On the basis of the collected data, in the carbonate catchments with pyroclastic cover the lower number of events is registered in April, or generally during the spring, if there is an outlet to the sea. In the carbonate catchments without cover during the spring season (March-May) there are no events, and the lower number of alluvial events is in January. As regards the volcanic catchments, February and March are the months with the smallest number of events. If the catchment has an outlet to the sea during the spring (March-May) no event has been recorded, and November-December are the months with the lower numbers of events.
As regards damage to people, about 18% of the events caused at least one victim. Figure 11 depicts their distribution in the region. The most dangerous events interested the province of Salerno, affecting the carbonate catchments with pyroclastic cover, both with and without an outlet to the sea. This means that carbonate catchments with pyroclastic cover (class 1) are the most hazardous. All the events with more than 100 victims took place in October; for the most damaging events the total amount of deaths was caused by landslides, debris flows and floods in floodplains. As a consequence, it is not easy to evaluate the victims caused only by alluvial events in torrential catchments. In many situations it was difficult to assign the precise number of casualties, since the information appear to be generic, under forms as "some victims”, or “few victims". Further, the attribution of the number of casualties to each municipality was very difficult, since typically the source provides the total number of victims per event, not distinguishing for the different villages. This was the case, for instance,

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for the events in 1581 (700-1000 victims), in 1899 (approximately 100 victims), in 1924 (approximately 100 victims), and in 1910 (over 200 victims) that have been the most harmful recorded in the history. Furthermore, as mentioned before, differences in the data reported by different sources for the same event had to be registered.

Taking into account the total amount of collected events, the database contains few cases with injured, homeless and missing people. As regards homeless, for instance, the number is too small when compared with the numbers of events that caused complete disruption of the buildings. This is probably an hint for evaluating that the documented data actually in some ways underrate the reality.

Alluvial events in torrential catchments caused severe damages to the society, primarily involving building, lifelines and infrastructures. In particular, roads and private buildings are the most affected categories. The most dangerous catchments types are carbonate catchments with and without pyroclastic cover. Table 2 reports the category damaged by each event included in the database. In Figure 12 some examples of alluvial events in different torrential catchment types are reported. Frequently they cause severe economic losses to society.

6. Final remarks

By analysing the existing literature we selected alluvial events occurred in torrential catchments of Campania, a land that has repeatedly been affected by severe flooding which caused serious damage and fatalities.

We collected temporal and spatial information on about 500 alluvial events, thus building the first specific database concerning this typology. To this aim, a critical scrutiny of the existing literature was performed, to provide a degree of reliability to the collected information. We also defined the accuracy related to the temporal information available, and for most of the collected events the accuracy resulted to be middle-high, meaning that day, month and year of occurrence are known.

In order to reconstruct flooding scenarios we defined different catchment types on the base of the main geological (bedrock lithology and presence/absence of detrital cover) and geomorphological parameters (type of outlet zone). This differentiation may be useful to understand the type of transported bed load (coarse vs fine grained) and to characterize the deposition area.

We collected also information about damage to people and society. Most of the events took place in carbonate catchments with pyroclastic cover, both with and without an outlet to the sea. Among the 86 municipalities that were damaged by torrential flooding, 16 recorded more than 10 events. In Campania the recurrence time of alluvial events is very low, ranging from few years for damages to buildings and infrastructures up to some decades in the case of events with victims. The widespread presence of carbonate catchments in the region and the high urbanization of the area affected the information sources, and these represent the main weaknesses of the historical documents. Notwithstanding volcanic areas are densely populated, alluvial events in carbonate catchments with pyroclastic cover caused more damage to people and society than in volcanic catchments.

The study has also shown that a significant number of catchments were interested by floods with high recurrence time The loss of historical memories of these events is for sure at the origin of an increase in the risk conditions.

The collection of this database represents the first step toward a full hazard analysis; furthermore, by analyzing triggering rainfall events and concentration time, it could also contribute to the development and implementation of specific early warning systems. Eventually, the application of numerical models on torrential floods could be useful to identify the flooded areas depending on the different peak discharge and the different bed material that can be entrained in the flow

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Table

Table1: N=ID event, Date, Municipality, Locality, D= damage (see table 2), V= number of victim (*=total amount of victims per events in the same date); R=references (see Table 3).

N	Date	Municipality	locality	D	V	R
1	08/10/1540	Amalfi				1
2	1550	Casamicciola	La Pera quarry, (Ervaniello)	4		11
3	30/9/1581	Cava dè Tirreni				3
4	30/9/1581	Salerno				3
5	30/9/1581	Vietri sul Mare				3
6	1/10/1581	Castiglione del Genovesi		4,3	700-1000*	8
7	1/10/1581	Giffoni sei Canali		4,3	700-1000*	3; 8
8	1/10/1581	Piedimonte Matese		4, 5	400	6
9	1/10/1581	San Cipriano Picentino		4,3	700-1000*	8
10	31/8/1588	Atrani				3
11	1626	Salerno	Fusandola	2.		1
12	06/1643	Casamicciola	Bagni square	4		11
13	06/1643	Casamicciola	Piazza La Rita	4		11
14	20/12/1683	Maiori	Regina Major catchment			1
15	15/10/1696	Minori	Regina Minor catchment			1; 2
16	26/9/1728	Piedimonte Matese	Vallata	4, 5		6
17	11/11/1773	Cava dè Tirreni	Passiano	4	400*	1
18	25/1/1736	Vietri sul Mare	Bonea catchment			2
19	26/9/1736	Vietri sul Mare	Bonea catchment			2
20	11/1738	Vietri sul Mare	Bonea catchment			2
21	3/11/1750	Salerno	Irno catchment			3
22	3/11/1750	Vietri sul Mare				3
23	10/10/1751	Amalfi	Canneto catchment. (now Grevone)			2
24	1/9/1753	Amalfi	Loc. Chiorito			1
25	23/1/1757	Amalfi	Canneto catchment (now Grevone)			2
26	23/1/1757	Vietri sul Mare	Bonea catchment			2
27	9/10/1757	Amalfi	Canneto catchment (now Grevone)			2
28	25/5/1762	Cetara	Cetus catchment			3
29	19/1/1764	Salerno				2
30	11/1770	Salerno	Irno catchment			2
31	11/11/1773	Cava dè Tirreni				3
32	11/11/1773	Cetara				3
33	11/11/1773	Pellezzano				3
34	11/11/1773	Salerno	Loc. Coperchia	5	7	3;1
35	11/11/1773	Tramonti				3
36	11/11/1773	Vietri sul Mare				3
37	20/11/1778	Alife		4		6
38	20/11/1778	Piedimonte Matese	Loc.Vallata	4		9
39	2/1780	Atrani	Dragone catchment			2
40	25/12/1796	Cava dè Tirreni	Cavaiola catchment			2
41	25/12/1796	Salerno	Irno catchment			2
42	25/12/1796	Vietri sul Mare	Bonea catchment.			2
43	10/1803	Piedimonte Matese	Loc.Vallata			6
44	21/01/1805	Solofra	Loc. Caposolofra	5, 4, 2., 3		15
45	22/1/1805	Serino	Ribottoli		67	6
46	9/6/1806	Sala Consilina	De Petrinisi street	4, 5	30	10
47	10/1810	Piedimonte Matese	Loc.Vallata			9
48	1811	Arienzo		5		6
49	1811	Santa Maria a Vico		5		6
50	21/12/1812	Positano	Parlati Mt.	5	3	1
51	30_31/7/1814	Bracigliano				1
52	4 -19/12/1814	Sala Consilina	Vairo, Marroncelli and Poerio streets	5		10
53	1814	Piedimonte Matese				6
54	12/11/1817	Cava dè Tirreni	Cavaiola catchment			2
55	12/11/1817	Salerno	Irno catchment			2
56	12/11/1817	Vietri sul Mare	Bonea catchment			2
57	1818	Cava dè Tirreni	Amalfi coast			2
58	1819	Cava dè Tirreni	Amalfi coast			2
59	1820	Cava dè Tirreni	Amalfi coast			2
60	1821	Salerno	Irno catchment			2
61	6/6/1822	Sala Consilina	Monteoliveto square, De Petrinis land	4, 3		10
62	27/10/1822	Corbara				1
63	8/11/1822	Salerno	Road to Vietri			1
64	24/1/1823	Amalfi				3
65	24/1/1823	Bracigliano				3
66	24/1/1823	Cava dè Tirreni				3
67	24/1/1823	Vietri sul Mare				3
68	8/10/1823	Corbara	Main square			1
69	3/10/1824	Minori	Loc. Torre			1
70	1825	Cava dè Tirreni	Amalfi coast			2
71	18/6/1827	Sala Consilina		4, 5		6
72	11/7/1829	Arienzo		5		6
73	19/10/1830	Arienzo		5, 1		6
74	16/7/1833	Arienzo				6
75	13/9/1834	Cetara	Cetus catchment			2
76	18/7/1835	Cava dè Tirreni	Cavaiola catchment			2
77	18/7/1835	Conca dei Marini	Irno and Bonea catchment			2
78	18/7/1835	Salerno	Irno catchment			2
79	27/9/1837	Salerno	Irno catchment			2
80	27/9/1837	Vietri sul Mare	Bonea catchment			2
81	27/10/1839	Padula		5		6
82	1/6/1841	Arienzo				6
83	20/9/1841	Piedimonte Matese	Loc. Vallata	4, 5	7*	6; 9
84	20/9/1841	San Potito Sannitico		4, 5	7*	6; 9
85	7/11/1842	Serino	Loc. S.Rocco, S.Lucia		16	6
86	26/10/1843	Cetara	Cetus catchment			2
87	26/10/1843	Maiori	Regina Major catchment			2
88	26/10/1843	Salerno	Irno catchment			2
89	26/10/1843	Vietri sul Mare	Loc. Molina			1
90	18/3/1845	Maiori	Regina Major catchment			2
91	18/3/1845	Vietri sul Mare	Bonea catchment			2
92	1/10/1846	Amalfi	Canneto catchment (now Grevone)			2
93	1/10/1846	Baronissi	Irno catchment			2
94	1/10/1846	Cetara	Cetus catchment			2
95	1/10/1846	Fisciano	Canneto, Regina Major, Bonea and Irno catchments			2
96	1/10/1846	Maiori	Regina Major catchment			2
97	1/10/1846	Pellezzano	Irno catchment			2
98	31/12/1847	Amalfi				2
99	13/9/1851	Alife				6
100	13/9/1851	Piedimonte Matese				6
101	13/9/1851	Sant'Angelo d'Alife				6
102	21/11/1851	Serino	Loc. S.Lucia, Troiani	4		6
103	1851	Padula		5		6
104	1851	Volturara Irpina		5		6
105	28/10/1852	Solofra		5, 6, 4		15
106	5/1/1853	Vietri sul Mare	Bonea catchment.			2
107	20/3/1853	Volturara Irpina				6; 9
108	13/9/1857	Piedimonte Matese	Loc.Vallata	4, 5	90*	6; 9
109	13/9/1857	Sant'Angelo d'Alife	Loc. S. Bartolomeo and S. Maria	4, 5	90*	6; 9
110	1857	Padula		5		6
111	13/6/1858	Sala Consilina	Indipendenza, Vairo, A. Da Brescia, U. Bossi and C.Battista streets	4,1, 5	18	10; 6
112	1859	Padula		4, 5		6
113	8/1866	Maiori	Loc. Cetraro, road to Tramonti, Regina Major catchment			1,2
114	11/11/1866	Vietri sul Mare	Bonea catchment			2
115	16/3/1867	Vietri sul Mare	Bonea catchment			2
116	10/10/1867	Padula		4, 5		6
117	1/4/1875	Conca dei Marini	Irno catchment.			2

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N	Date	Municipality	locality	D	V	R
118	1876	Padula		4, 5		6
119	1/2/1878	Conca dei Marini				2
120	1/2/1878	Salerno	Irno catchment			2
121	17/11/1880	Arienzo				9
122	1881	Padula		4, 5		6
123	1883	Padula		4, 5		6
124	5/2/1885	Amalfi	Canneto catchment (now Grevone)			2
125	1891	Tramonti	Regina Major catchment			2
126	1896	Baronissi	Irno catchment			2
127	1896	Bracigliano	Picentino, Fuorni and Irno catchment			2
128	1896	Castiglione del Genovesi	Picentino catchment			2
129	1896	Conca dei Marini	Picentino, Fuorni and Irno catchment			2
130	1896	Salerno	Irno catchment			2
	7/10/1899	Calabritto		4, 3, 5	100*	12
131	7/10/1899	Caposele		4, 3, 5	100*	12
132	7/10/1899	Castiglione del Genovesi		4, 3, 5	100*	12
133	7/10/1899	Cava dè Tirreni		4, 3, 5	100*	12
134	7/10/1899	Curticelle		4, 3, 5	100*	12
135	7/10/1899	Giffoni sei Canali		4, 3, 5	100*	12
136	7/10/1899	Giffoni Valle Piana	Secco stream and Colauro street	4	3	12
137	7/10/1899	Montecorvino Pugliano		4, 3, 5	100*	12
138	7/10/1899	Montecorvino Rovella		4, 3, 5	100*	12
139	7/10/1899	Quaglietta		4, 3, 5	100*	12
140	7/10/1899	Salerno	Irno catchment and Rafastia torrent	4, 3, 5	100*	12, 5; 1
141	7/10/1899	Vietri sul Mare	Molina di Vietri	4, 3, 5	5	12,2,
142	1900	Padula		4, 5		6
143	02/1903	Vietri sul Mare	Bonea catchment			2
144	1903	Cervinara		5		1
145	7/10/1904	Ravello	Dragone catchment			2
146	17-18/05/1906	Ercolano			2	4
147	01/06/1906	Sant'Anastasia				4
148	01/06/1906	Cercola				4
149	01/06/1906	Pollena Trocchia				4
150	1906	Torre del Greco	Cavallerizzi, XX Settembre and Purgatorio streets, Del Popolo square		26	4
151	04/01/1907	Ercolano				4
152	24-25/10/1908	Ercolano			2	4
153	24-25/10/1908	Napoli	Loc. Barra			4
154	24-25/10/1908	Napoli	Loc.San Giovanni a Teduccio			4
155	24-25/10/1908	Napoli				4
156	24-25/10/1908	Portici				4
157	24-25/10/1908	San Giorgio a Cremano				4
158	24-25/10/1908	Torre del Greco				4
159	04/10/1909	Boscotrecase				4
160	23/10/1910	Cetara	Cetus catchment, Loc. Utrio and. Cappetta, Federico street	5, 4	200*	15;3; 1; 2; 13
161	24/10/1910	Amalfi		5	2	3;1
162	24/10/1910	Barano d'Ischia	Loc. Casabona	4,5		11; 2
163	24-25/10/1910	Boscotrecase				4; 2
164	24/10/1910	Casamicciola		4,5	6	11; 2
165	24-25/10/1910	Cercola				4; 2
166	24-25/10/1910	Ercolano	Loc. Resina			4; 2
167	24/10/1910	Forio d'Ischia	Loc. Monterone	4,5		12; 2
168	24/10/1910	Furore		5		3
169	24/10/1910	Ischia		5		3;2
170	24/10/1910	Lacco Ameno		4 ,5		11; 2
171	24/10/1910	Maiori	Loc. Erchie, S.Nicola and Sovarano	5, 4	24	3; 15; 1
172	24/10/1910	Minori		5	4	3; 1

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173	24-25/10/1910	Pollena Trocchia				4
174	24/10/1910	Portici	Giordano street			4; 2
175	24/10/1910	Ravello		6, 5		3; 1
176	24/10/1910	Salerno	Fusandola stream	5		3;2
177	24-25/10/1910	San Sebastiano al Vesuvio				4; 2
178	24-25/10/1910	Sant'Anastasia				4
179	24/10/1910	Scala	Loc. Acquabona	2		3; 1
180	24/10/1910	Serrara Fontana		5		11
181	24-25/10/1910	Somma Vesuviana				4
184	24/10/1910	Vietri sul Mare	loc. Molina	5	1	3; 1; 2
185	02/01/1911	Cetara	Cetus catchment			2
186	02/01/1911	Vietri sul Mare	Bonea catchment			2
187	21/09/1911	Boscoreale				4
188	21/09/1911	Ercolano	Loc. Resina,(Pugliano, Mare, Cortile, Trentola streets)		6	4
189	21/09/1911	NA	Loc. San Giovanni a Teduccio			4
190	21/09/1911	Ottaviano				4
191	21/09/1911	Portici				4
192	21/09/1911	San Giuseppe Vesuviano				5
193	21/09/1911	Torre del Greco	XX Settembre, Nazionale, Fiorillo and Umberto streets			4
194	03/01/1915	Minori	Regina Minor catchment			2
195	1915	Alife				6
196	06/11/1916	Vietri sul Mare	Bonea catchment			2
197	21/09/1921	San Giuseppe Vesuviano				4
198	25/10/1921	Ercolano				4
199	25/10/1921	NA	Loc. Barra			4
200	25/10/1921	Portici				4
201	25/10/1921	San Giorgio a Cremano				4
202	25/10/1921	Torre del Greco				4
203	13/11/1921	Furore				2
204	26/03/1924	Agerola			100*	3; 8
205	26/03/1924	Amalfi	Loc. Vettica Minore, Baglio	2,5 4	60	3; 8
206	26/03/1924	Atrani			100*	3; 8
207	26/03/1924	Cetara			100*	1
211	26/03/1924	Minori			100*	3; 8
212	26/03/1924	Positano			100*	3; 8
213	26/03/1924	Praiano	Loc. Marina di Praiano	4	18	3; 8; 1;2
214	26/03/1924	Vietri sul Mare	Bonea and Regina Major catchments	4	100*	5
215	26/03/1924	Vietri sul Mare				3; 8
216	01/10/1927	Sala Consilina		4, 5		6
217	01/11/1927	Sala Consilina	Umberto I square	4, 5		10
218	21/09/1929	Giffoni Valle Piana	Picentino catchment			2
219	21/09/1929	Montecorvino Rovella				2
220	21/09/1929	Vietri sul Mare	Bonea catchment			2
221	31/08/1931	Castellammare di S.			1	1
222	01/03/1935	Cava dè Tirreni	Cavaiola catchment			2
223	01/03/1935	Conca dei Marini				2
224	01/03/1935	Minori	Regina Minor catchment			2
225	01/03/1935	Ravello	Dragone catchment			2
226	01/03/1935	Tramonti	Regina Major catchment			2
227	21/08/1935	Castellammare di S.				1
228	1935	Giffoni Valle Piana				1
229	14/09/1939	Amalfi	Canneto catchment.(now Grevone)			2
230	14/09/1939	Conca dei Marini	Canneto, Regina Major, Irno and Picentino catchments			2
231	14/09/1939	Maiori	Regina Major catchment			2
232	01/06/1941	Arienzo				9
233	18/06/1944	Minori	Regina Minor catchment			2

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234	02/10/1945	Minori	Regina Minor catchment			2
235	02/03/1947	Minori	Regina Minor catchment			2
236	30/06/1947	Sala Consilina	Umberto I square	4, 5	1	9;10
237	25/10/1947	Minori	Regina Minor catchment			2
238	23/05/1948	Minori	Regina Minor catchment			2
239	26/07/1948	Somma Vesuviana		4		4
240	05/09/1948	Minori	Regina Minor catchment			2
241	02/10/1948	Alife	Loc. S.Michele	5		6
242	28/10/1948	Minori	Regina Minor catchment			2
243	01/10/1949	Vietri sul Mare	Bonea catchment			2
244	14/08/1950	Somma Vesuviana				4
245	02/09/1950	Somma Vesuviana				4
246	25/12/1950	Castellammare di S.	Loc. Pozzano			1
247	21/01/1951	Minori	Regina Minor catchment			2
248	09/03/1951	Castellammare di S.	Loc. Pozzano			1
249	09/11/1951	Giffoni Valle Piana	Picentino catchment			2
250	09/11/1951	Montecorvino Rovella				2
251	11/09/1953	Agerola				2
252	11/09/1953	Ravello	Dragone catchment			2
253	1953	Ravello	Eastern side of Colonna Mt.			1
254	25/10/1954	Amalfi	Canneto catchment (now Grevone)			3
255	25/10/1954	Atrani				3
256	25/10/1954	Cava dè Tirreni	Loc. Alessia, Marini and Castagneto		31	3; 1, 18
257	25/10/1954	Maiori				3; 1, 18
258	25/10/1954	Minori		2		3; 1, 18
259	25/10/1954	Positano				3
260	25/10/1954	Praiano	Loc. Vettica Maggiore			3
261	25/10/1954	Salerno	Loc. Fratte,and Canalone	6, 4, 5	205*	3; 5; 18
262	25/10/1954	Tramonti		5		3; 8; 2; 22
263	25/10/1954	Vietri sul Mare	Loc. Di Molina and Marina			3, 18
264	05/11/1954	Ercolano				4
265	04/02/1955	San Sebastiano al Vesuvio				5
266	11/09/1955	Agerola				2
267	11/09/1955	Pellezzano	Irno catchment			2
268	11/09/1955	Tramonti	Regina Major catchment			2
269	10/01/1956	San Giuseppe Vesuviano			3	4
270	18/11/1956	Arpaia				6
271	21/01/1957	Sant'Anastasia				5
272	22/10/1957	Cava dè Tirreni				2
273	22/10/1957	Minori	Regina Minor catchment			2
274	22/10/1957	Tramonti	Regina Major catchment			2
275	30/12/1957	Cercola			2	4
276	19/09/1960	Ercolano			1	4
277	19/09/1960	Portici				4
278	07/07/1961	Torre del Greco			1	4
279	12/11/1961	Torre del Greco			2	4
280	27/06/1962	San Giuseppe Vesuviano				5
281	16/02/1963	Cava dè Tirreni	Cavaiola catchment			2
282	16/02/1963	Pellezzano	Irno catchment			2
283	16/02/1963	Petina				2
284	16/02/1963	Positano				2
285	16/02/1963	Sala Consilina		4, 5		6
286	16/02/1963	Tramonti	Regina Major catchment			2
287	17/02/1963	Pimonte			4	7
288	18/02/1963	Padula		4, 5		6
289	18/02/1963	Pesco Sannita				2
290	21/02/1963	Positano	Loc. Trara Genoino			1
291	13/05/1963	Sant'Anastasia				4
292	30/05/1963	Torre del Greco				5
293	25/09/1963	Agerola				2
294	25/09/1963	Cava dè Tirreni				2
295	25/09/1963	Cetara	Cetus catchment			2
296	25/09/1963	Minori				2
297	25/09/1963	Pagani				2
298	25/09/1963	Pellezzano	Irno catchment			2
299	07/10/1963	Amalfi	Canneto catchment (now Grevone)			2
300	07/10/1963	Cetara	Cetus catchment			2
301	07/10/1963	Maiori	Regina Major catchment			2
302	07/10/1963	Minori	Regina Minor catchment			2
303	07/10/1963	Salerno				1
304	16/12/1963	Pellezzano	Irno catchment			2
305	16/12/1963	Tramonti	Regina Major catchment			2
306	13/01/1965	Torre del Greco				5
307	06/04/1966	Torre Annunziata				5
308	25/10/1966	Castiglione del Genovesi			1	3; 8
309	25/10/1966	Giffoni sei Canali	Monna Mt.		2	7; 1
310	26/10/1966	Alife				6
311	26/10/1966	Baronissi				3
312	26/10/1966	Cava dè Tirreni				3
313	26/10/1966	Piedimonte Matese	Loc. Vallata			6
314	26/10/1966	Salerno				3
315	1966	Ravello				1
316	09/01/1968	Salerno				5
317	17/12/1968	Padula		4, 5		6
318	19/12/1968	Amalfi	Canneto catchment (now Grevone)			2
319	19/12/1968	Tramonti	Regina Major catchment			2
320	1968	Alife				6
321	15/03/1969	Agerola				1
322	15/03/1969	Cava dè Tirreni	Cavaiola catchment			2
323	17/09/1969	Cava dè Tirreni	Cavaiola catchment			2
324	22/09/1969	San Giorgio a Cremano				1
325	1969	Arpaia				5
326	08/04/1970	Salerno		5	2	1
327	01/10/1970	Portici			1	4
328	01/10/1970	Torre Annunziata			1	4
329	01/10/1970	Torre del Greco				4
330	02/10/1970	Amalfi	Canneto catchment (now Grevone)			2
331	02/10/1970	Baronissi	Irno catchment			2
332	02/10/1970	Minori				2
333	02/10/1970	Pellezzano	Irno catchment			2
334	09/12/1970	Forio d'Ischia	Loc. Montevergine			1
335	25/12/1970	Amalfi	Canneto catchment (now Grevone)			2
336	25/12/1970	Baronissi	Irno catchment			2
337	25/12/1970	Minori	Regina Minor catchment			2
338	25/12/1970	Pellezzano	Irno catchment			2
339	1970	Arienzo				6
340	19/01/1971	Torre del Greco				5
341	21/02/1971	Castellammare di S.		5		1
342	15/10/1971	Cava dè Tirreni	bacini: Cavaiola			2
343	15/10/1971	Tramonti	Regina Major catchment			2
344	23/11/1971	Amalfi	Canneto catchment (now Grevone)			2
345	23/11/1971	Minori	Regina Minor catchment			2
346	06/03/1972	Cava dè Tirreni	Cavaiola catchment			2
347	06/03/1972	Tramonti	Regina Major catchment			2
348	27/07/1972	Piedimonte Matese	Loc. Vallata	4		6
349	21/10/1972	Cava dè Tirreni	Cavaiola catchment			2
350	21/10/1972	Tramonti	Regina Major catchment			2
351	21/11/1972	Baronissi	Irno catch			2
352	21/11/1972	Cava dè Tirreni	Cavaiola catchment			2
353	21/11/1972	Pellezzano	Irno catchment			2
354	02/01/1973	Amalfi	Canneto catchment (now Grevone)			2
355	02/01/1973	Cava dè Tirreni	Cavaiola catchment			2
356	02/01/1973	Maiori	Regina Major catchment			2
357	02/01/1973	Minori	Regina Minor catchment			2
358	02/01/1973	Tramonti	Regina Major catchment			2
359	16/02/1973	Massa Lubrense	S.Costanzo-Mitigliano Mt., Termini		10	5; 14
360	19/09/1973	Torre del Greco			2	4
361	1973	Baiano	Loc. Lagno di Trulo	5		1

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362	21/02/1974	Capri	Loc. Fuosso Di Marina Grande		2	5
363	25/09/1974	Arienzo		4		6
364	25/09/1974	Arpaia		4		6
365	25/09/1974	Forchia		4		6
366	03/10/1974	Arienzo				6
367	03/10/1974	Sant'Angelo d'Alife				6
368	05/10/1974	Arienzo				6
369	28/06/1976	Salerno	Irno catchment			1
370	13/10/1976	Torre del Greco			1	4
371	29/10/1979	Torre del Greco	Cavallo street		2	4
372	12/10/1980	Cava dè Tirreni	Cavaiola catchment			2
373	12/10/1980	Maiori	Regina Major catchment			2
374	12/10/1980	Minori	Regina Minor catchment			2
375	12/10/1980	Tramonti	Regina Major catchment			2
376	15/10/1980	Cava dè Tirreni	Cavaiola catchment			2
377	01/06/1981	Forio d'Ischia	Paola Poli restaurant	4		5
378	19/12/1982	Torre del Greco	Cavallo street		2	4
379	15/08/1983	Barano d'Ischia	Scura and Olmitello quarries			15
380	30-31/10/1985	Ercolano	Palmieri street			4
381	30-31/10/1985	Ottaviano	Cemetery			4
382	30-31/10/1985	Portici	Railway			4
383	30-31/10/1985	San Gennaro Vesuviano				4
384	30-31/10/1985	Torre del Greco	Cavallo street			4
385	02/11/1985	Ercolano	Palmieri street		1	4
386	16-17/11/1985	Portici				4
387	16-17/11/1985	San Giorgio a Cremano	Tufarelli street			4
388	16-17/11/1985	Torre del Greco	Cavallo, Novesca and Sant'Elena streets			4
389	17/11/1985	Cava dè Tirreni	Cavaiola catchment			2
390	17/11/1985	Durazzano	Longano Mt.			1
391	17/11/1985	Maiori	Regina Major catchment			2
392	17/11/1985	Summonte		6, 5		1
393	17/11/1985	Tramonti	Regina Major catchment			2
394	01/02/1986	Castellammare di S.	Aragonese Castel			5
395	01/02/1986	Forio d'Ischia				5
396	13/03/1986	Cava dè Tirreni	Loc. Molina			2
397	13/03/1986	Pellezzano	Irno catchment			2
398	20/07/1986	Roccarainola				6
399	24/11/1986	Cava dè Tirreni	Cavaiola catchment			2
400	24/11/1986	Tramonti	Regina Major catchment			2
401	22/02/1987	Barano d'Ischia				6
402	16/10/1987	Baronissi	Irno catchment			2
403	16/10/1987	Pellezzano	Irno catchment			2
404	10/11/1987	Cava dè Tirreni	Cavaiolacatchment			2
405	10/11/1987	Minori	Regina Minor catchment			2
406	10/11/1987	Positano				2
407	10/11/1987	Ravello				2
408	10/11/1987	Tramonti	Regina Major catchment			2
409	13/11/1997	Ercolano				4
410	15/09/1988	Baronissi	Irno catchment			2
411	15/09/1988	Pellezzano	Irno catchment			2
412	15/09/1988	Tramonti	Regina Major catchment			2
413	15/07/1991	Torre del Greco	Santa Croce square			4
414	26/03/1992	Torre del Greco	port			4
415	18/04/1992	Portici				4
416	24/06/1992	Pellezzano	Loc.Cologna			1
417	05/08/1992	Torre del Greco				4
418	25/09/1992	Cava dè Tirreni	Cavaiola catchment			2
419	25/09/1992	Tramonti	Regina Major catchment			2
420	3-4/10/1992	Torre del Greco	Piazza Palomba			4
421	04/10/1992	Baronissi	Irno catchment			2
422	04/10/1992	Cava dè Tirreni	Cavaiola catchment			2
423	20/08/1993	Serino	Loc. Ribottoli, Puzzillo		1	6
424	20/08/1993	Solofra	Loc. Puzzillo	3	1	18; 5; 1
425	08/12/1993	Cava dè Tirreni	Loc. Rotolo			1
426	20/12/1993	Padula		4, 5		9
427	26/12/1993	Sala Consilina		4, 5		6
428	22/08/1996	Massa di Somma	Paparo street			4
429	22/08/1996	San Gennaro Vesuviano				4
430	22/08/1996	San Giorgio a Cremano	Matteotti street			4
431	22/08/1996	Torre del Greco	Port, XX Settembre street			4
432	20/09/1996	Cava dè Tirreni	Cavaiola catchment			2
433	20/09/1996	Giffoni sei Canali	Picentino catchment			2
434	20/09/1996	Tramonti	Regina Major catchment			2
435	26/11/1996	Padula		5		6
436	26/11/1996	Sala Consilina		5		6
437	9-10/01/1997	Casamicciola	loc. Montagnone, Molara, Cantoni, Tresta, Cognola, Campomanno; La Pera, Ervaniello and Puzzillo quarries, , Mt. Tabor,			11
438	09/01/1997	Castellammare di S.			4	5
439	09/01/1997	Corbara	Chiunzi pass			5
440	9-10/01/1997	Lacco Ameno	Cito Mt.			11
441	10/01/1997	Castellammare di S.	Loc. Pozzano	4, 5		14
442	10/01/1997	Cava dè Tirreni	Cinque street,SS18, Loc. Avvocatella			1
443	10/01/1997	Pimonte	Pendolo Mt.			7; 1
444	10/01/1997	San Cipriano Picentino	Loc. Campigliano			1
445	10/01/1997	San Giuseppe Vesuviano				4
446	10/01/1997	Vietri sul Mare	Loc. Guarno andTresaro			1
447	21/08/1997	Sant'Anastasia				4
448	21/08/1997	Somma Vesuviana				4
449	13/11/1997	Boscoreale	Diaz street			4
450	13/11/1997	Cercola				4
451	13/11/1997	San Sebastiano al Vesuvio				4
452	13/11/1997	Somma Vesuviana				4
453	13/11/1997	Torre del Greco	Beneduce street			4
454	05/05/1998	Avella				7
455	05/05/1998	Montoro			1	1
456	24-25/7/1999	Casamicciola	Loc. Montagnone, Cantoni	5		11;
457	24-25/7/1999	Lacco Ameno	Ervaniello quarry, La Rita	5		15
458	15/12/1999	Cervinara			5	5; 6
459	19/11/2000	Torre del Greco	Loc. Santa Maria La Bruna			4
460	27/12/2000	Ercolano	Caprile street			4
461	22/08/2001	Santa Maria a Vico				6
462	22/08/2001	Sant'Angelo d'Alife		4, 6, 5		16
463	15/09/2001	Barano d'Ischia	Olmitello quarry	6		15
464	15/09/2001	Casamicciola	Loc. La Rita	4	2	11
465	22/06/2002	Raviscanina		1		9; 6
466	26/07/2002	Caposele		6., 4		18
467	28/08/2002	Barano d'Ischia	Scura quarry			15
468	10/09/2002	Barano d'Ischia	Scura and Petrella quarries			15
469	23_24/09/2002	Barano d'Ischia	Olmitello quarry	64		15
470	09/09/2003	Castellammare di S.	Castel			18
471	20/04/2004	Cava dè Tirreni	Loc. Badia and Sant'Arcangelo	5, 4		18
472	28/09/2007	Montoro	Loc. Frazione Chiusa and Aterrana	5, 4		18
473	28/09/2007	Volturara Irpina	rione Candragone	4, 3		18; 6
474	10/11/2009	Casamicciola	Bagni square	4, 5	1	12
475	30/07/2010	Somma Vesuviana				4
476	31/07/2010	Giffoni sei Canali	Prepezzano stream, Loc.Madonna del Carmine	5		8
477	09/09/2010	Atrani		5, 4.,1	1	18
478	07/10/2011	Buccino	Loc. Teglia	5, 4		17; 18
479	07/10/2011	San Gregorio Magno	Loc. Matruro, Teglia	5		18

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480	21/10/2011	Pollena Trocchia			1	4
481	19/06/2014	Arienzo	Pinazzola street	5, 4.,3		18
482	19/06/2014	Tufino	Loc. Icap, Vignola and Ferone, Turati street	4		18
483	01/09/2014	Solofra	Loc. Madonna della Neve, Santa Lucia	5, 4.		18
484	01/09/2014	Volturara Irpina	Rimembranza street	5,4.		18
485	11/09/2014	Castellammare di S.	Loc. Quisisana	5		18
486	25/02/2015	Barano d'Ischia	Loc. Olmitello		1	18
487	19/09/1943	Quadrelle	Loc. Mugnano-Quadrelle			18
488	09/09/1973	Quadrelle	Loc. Mugnano-Quadrelle			18
489	20/08/1997	Quadrelle	Loc. Mugnano-Quadrelle			18
490	13/11/1997	Quadrelle	Loc. Mugnano-Quadrelle			18

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Table 2: Classes of damage caused by event

DAMAGE	CLASSES
agricultural lands	1
architectonical structures	2
industries	3
private buildings	4
roads	5
underground utilities	6

Table3: Classes of sources used.

REFERENCES	N
Migale and Milone, 1998	1
Porfido et al., 2013	2
Esposito et al., 2011	3
Alessio et al., 2013	4
Vallario, 2001	5
Santangelo et al., 2012	6
Di Crescenzo and Santo, 2005	7
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Figures captions

Figure 1: Relation between area and time scale for the research accuracy, modified after D'Agostino (2013).

Figure 2. Location and geological setting of the study areas. Key: 1) Mesozoic carbonate massifs; 2) Cenozoic hilly terrigenous areas; 3) Quaternary volcanic areas; 4) Quaternary intermountain catchments and coastal plains. The broken line indicates the boundaries of Campania region.

Figure 3: Event typologies collected during the database building.

Figure 4: Temporal distribution of alluvial events in Campania.

Figure 5: Temporal accuracy distribution of the collected events in Campania. The histogram shows the distribution in five classes of temporal accuracy: L low, ML Middle-Low, M Middle, MH Middle-High, H High.

Figure 6: Recurrence of alluvial events in the municipalities.

Figure 7: Recurrence time of the events in the municipalities that have recorded more than 10events.

Figure 8: Representation of the events on the territory, according to the catchment class.

Figure 9: a) percentage of events in each catchment class; b). monthly distributions of the events in the different catchment classes. Catchment classes: 1) Carbonate catchment with pyroclastic cover, 2) Carbonate catchment without pyroclastic cover, 3) Carbonate catchment with pyroclastic cover and outlet to the sea, 4) Volcanic catchment, 5) Volcanic catchment with outlet to the sea.

Figure 10: Different grain size deposits for the different catchment classes: a) Solopaca 2015, carbonate gravels and blocks (class 2); b) Atrani 2010, gravel and sands (classes 1 and 3); c) Casamicciola 2009: sands, silt and clay (classes 4 and 5).

Figure 11: Distribution of victims recorded in the territory.

Figure 12: Typical examples of damage caused by alluvial events: a) Casamicciola, November 10, 2009; b) Buccino-Teglia, October 7, 2011; c) Arienzo, June 6, 2014; d) Solofra, September 1, 2014.

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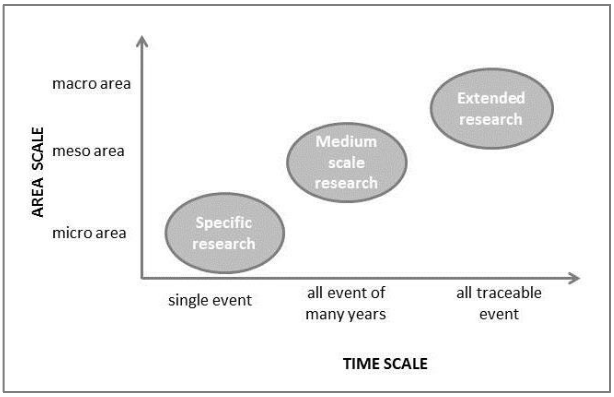
Figures



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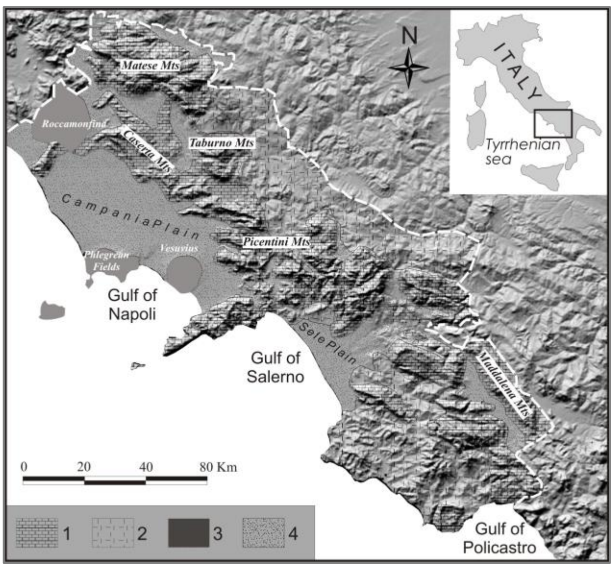

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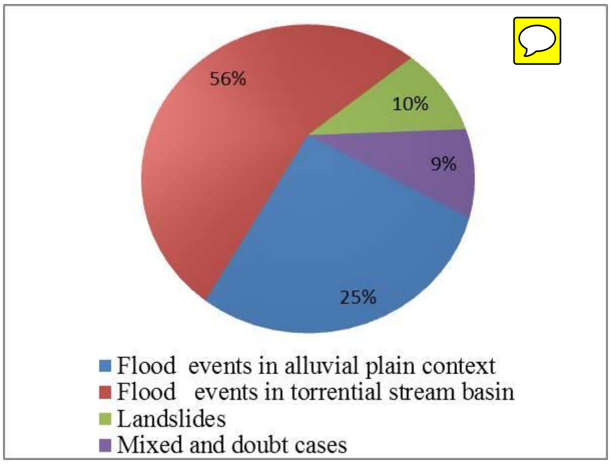

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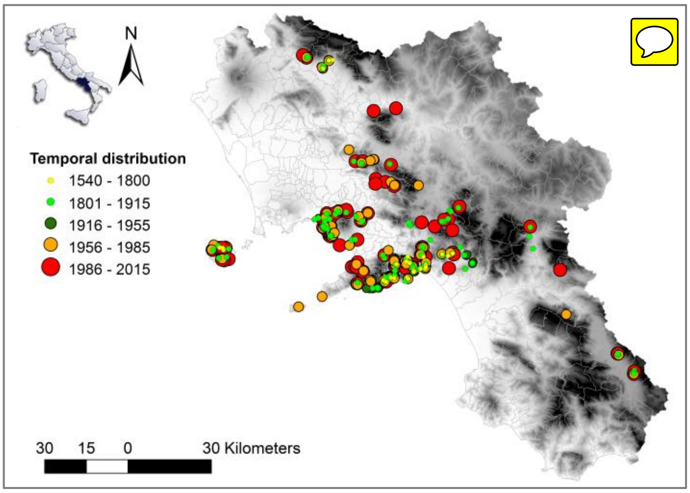

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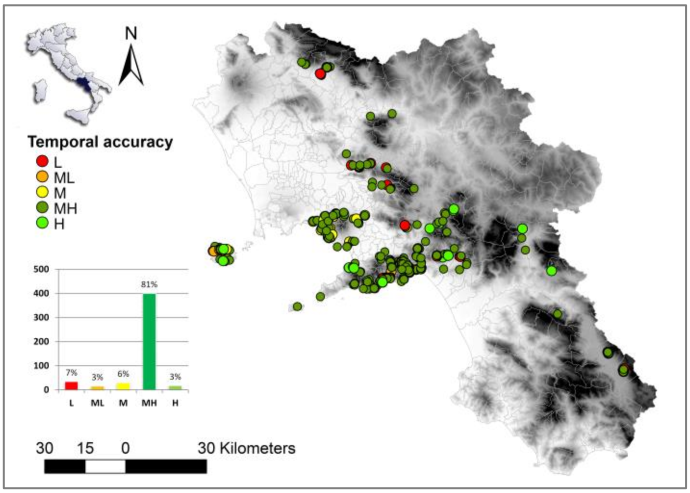

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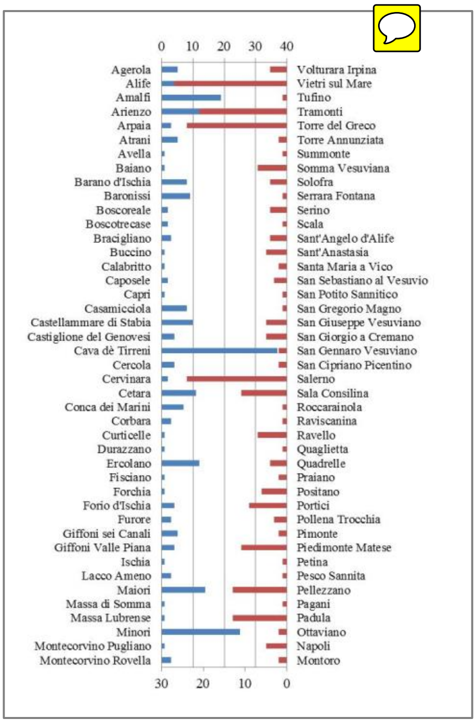

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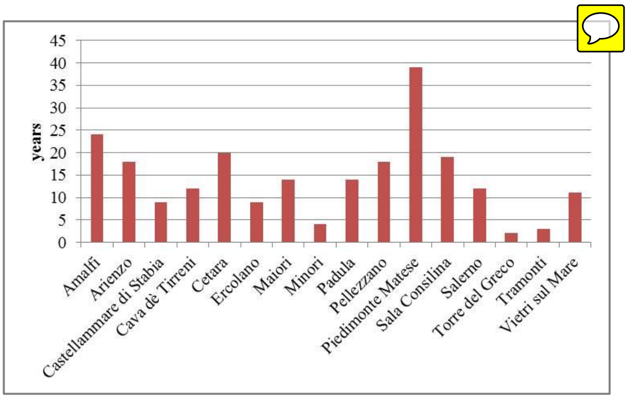

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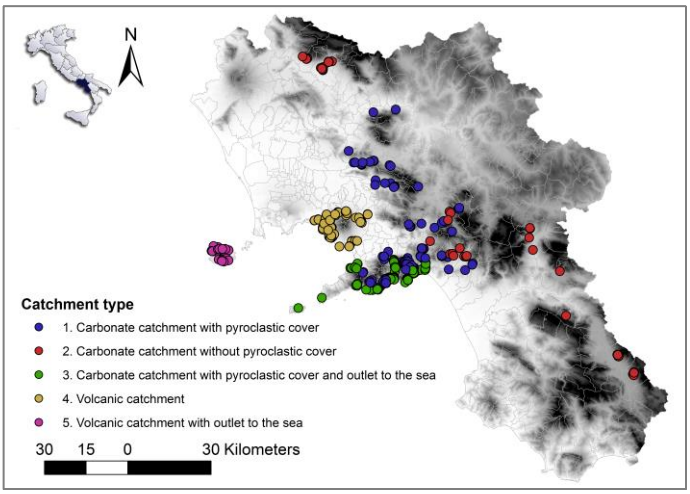

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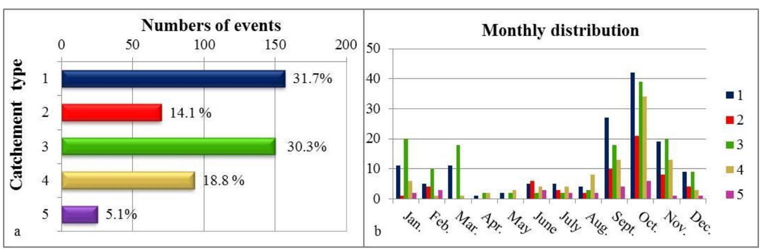

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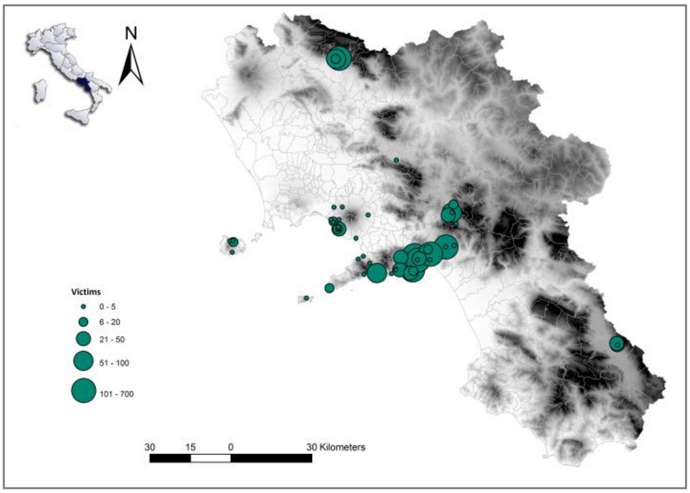

Fig11

Fig12