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# 1 Damaging hydrological events during the exiting of the Little Ice Age in 2 a highland area of Southern Italy

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16 **Abstract.** Historical documentary sources reflect a myriad of social, cultural, political, and scientific  
17 narratives about weather, climate and hydrological effectiveness. Their use in climate research provides  
18 an important contribution to current debates about climate and related damaging hydrological events.  
19 In Europe, the end of the Little Ice Age (LIA, 1840-1920) was characterized by an unusual mixture of  
20 storms, floods and landslides. They have marked profoundly the regional landscape of the highlands  
21 of the Tammaro area (Campano Apennines, Southern Italy). In this way, we found that episodes of  
22 climate variability and its extremes have often disrupted ecosystems during stormy wintertimes  
23 (September-March) by injuring plant development phases, and causing sometimes disruption, while  
24 also creating new interactions with the agricultural and social environment. The results indicated that  
25 the end of the 19<sup>th</sup> century was the stormiest period of the series 1800-2000, in conjunction with  
26 landscape deforestation started in 1850.  
27

28 **Keywords:** Climate variability; Deforestation; Documentary sources; Extreme precipitation events;  
29 Floods; Hydrological hazards; Landslides; Tammaro basin; Southern Italy; Storms.  
30

## 31 1. Introduction

32 Historical analyses of weather records have shown that extreme precipitation, flood events and soil  
33 erosion increased in the Mediterranean area during the Little Ice Age (LIA, roughly AD 1300-1900) mainly  
34 due to cold and variable winters (Grove, 2001; Glaser et al., 2010; Guimarães Nobre et al., 2017). For the  
35 Mediterranean, concurrent climatic factors likely amplified cooling in the central part of the LIA. They  
36 include long periods of reduced solar activity (Steinhilber et al., 2009; Delaygue and Bard, 2011) and  
37 enhanced volcanic activity (Sigl et al., 2015), combined with atmosphere and ocean influences as  
38 reflected in the AMO (Atlantic Multidecadal Oscillation) and PDO (Pacific Decadal Oscillation) indices  
39 (Diodato and Bellocchi, 2018). The global and regional distribution of extreme hydrological events may  
40 have been exacerbated by sub-regional processes operating at finer spatial scales (Molnar et al., 2002).  
41 The dynamics of damaging hydrological events occurring at these scales still remain to be clarified  
42 (Luterbacher et al., 2012). This is the case in mountain areas in Southern Italy, where even a small  
43 increase in the number of precipitation extremes likely has a large impact on rainfall erosivity (Diodato  
44 et al., 2008). Rumsby and Macklin (1996) provided evidence from historical sources of an enhanced  
45 fluvial activity in north, west and central Europe between 1750 and 1900. But what happened elsewhere  
46 in Mediterranean at the exit of the Little Ice Age?

47 Several morphological, geographical, historical and societal characteristics make the Mediterranean  
48 region particularly interesting for climate studies (e.g. Porfido et al., 2009; Foscarini et al., 2013; Diodato  
49 and Bellocchi, 2014). The region is rich of documentary sources (e.g. databanks by CNR-ICTIMA for  
50 Italy and the surrounding seas, and by Barcelona University for the Iberian Peninsula and Western

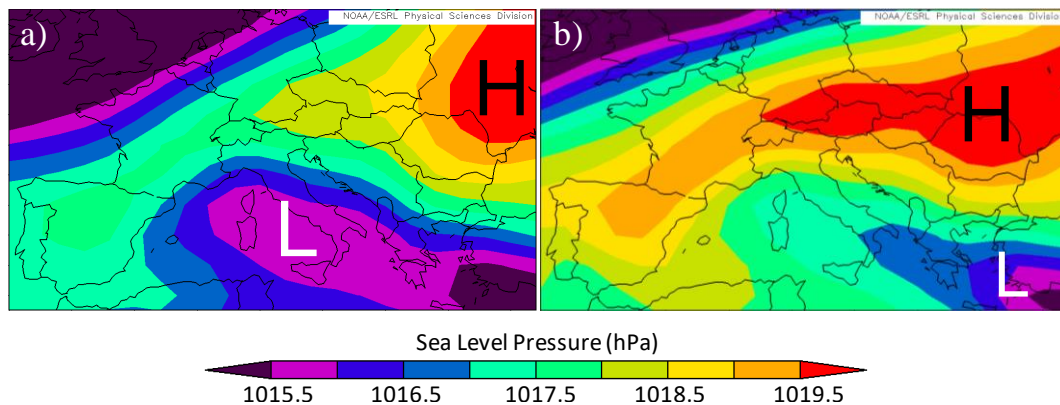
51 Mediterranean; Camuffo et al., 2000), including private diaries, notarial deeds and municipal acts, which  
52 constitute a unique set of weather archives. They provide information on past climate variability and  
53 injuries, and on the ways people interact with climate. Observations within documentary sources are  
54 affected by personal experiences and physical conditions, which make problematic the derivation of  
55 robust datasets for climatic studies. These documents can, however, become a precious source, as they  
56 represent an unbiased account of individual interactions with the 'weather world' (Adamson, 2015) and,  
57 in all cases, the ways in which Multiple Damaging Hydrological Events (MDHEs) manifest themselves  
58 (Catenacci, 1992; Petrucci and Polemio, 2003; Diodato et al., 2012). Narrative time-series of MDHEs are  
59 an important substrate for contextualization of information related to recent extreme events in the  
60 coastal and mountainous areas of the Mediterranean (Viles and Goudie, 2003; Petrucci et al., 2017).  
61 With regards to Italy, significant is the historical and meticulous work completed by the geographer  
62 Roberto Almagià (Almagià, 1910; Palmieri, 2004) in the early 20<sup>th</sup> century. Then, only after a long period,  
63 the geologist Vincenzo Catenacci performed an extensive collection of information for the post-Second  
64 World War (Catenacci, 1992). At the beginning of the 1990s, the AVI project (Areas Vulnerable to  
65 landslides and floods in Italy, [http://avi.gndci.cnr.it/docs/lavori/avi\\_en.htm](http://avi.gndci.cnr.it/docs/lavori/avi_en.htm)) was launched with the  
66 ambitious goal of documenting the disruption events occurred on the Italian territory since the 19<sup>th</sup>  
67 century. The AVI archive provides a comprehensive picture of such events only when one get close to  
68 relatively recent years. Otherwise, it can be accounted the volume of Guidoboni and Valensise (2013)  
69 on the natural disasters occurred in Italy from 1861.

70 At sub-regional scale and still back in time (from 1700 onwards), one can refer to Porfido et al. (2016),  
71 Diodato et al. (2017) and Luino et al. (2018) on the recurrence of floods and landslides for the Calore  
72 River Basin and, sometimes, for the Tammaro area too. Located in southwestern Italy, the Tammaro  
73 river (a tributary of the Calore river) extends over 78 km covering a catchment area of 673 km<sup>2</sup> (centred  
74 at 41° 08' N and 14° 49' E). Originating in the Molise region, it enters the Campania region via the  
75 Benevento province. Currently, according to data provided by the Ministry of Environment and  
76 Protection of Land and Sea of Italy, about 25% (499 km<sup>2</sup>) of the Benevento province area is affected  
77 by geomorphic instability phenomena. A landslide map of the Benevento province has been provided  
78 by Guadagno (2006). In this province, 20 municipalities (out of 78) are at "high" hydro-  
79 geomorphological risk while the level of risk is "very high" for 36 of them (Ministry of the Environment  
80 and Protection of Land and Sea of Italy, 2000). The phenomenon is of alarming proportions for both  
81 the territorial structures and the economy of the Province. Yet, despite its extraordinary relief, the  
82 problem has been almost ignored by historians. Various historical contributions on topics - mountain  
83 economies, deforestation, reclamation – related to hydro-geomorphological disorders are reported in  
84 the literature, together with the study of landslides and floods, but the issue has not been fully debated  
85 by historians. This gap, in truth, not only regards the province of Benevento, but the whole of Southern  
86 Italy and, with some important exceptions (Amarotta, 1994; Ruggiero and Aversano, 2000; Foscarini et  
87 al., 2013), the entire Italian peninsula. It can be considered part of a complex and detrimental removal  
88 process that involves all social actors.

89 The loss of historical memory of the climate and the floods that occurred in the previous decades and  
90 centuries contributes to heavily alter the common perception of the fragility of natural resources, and  
91 thus to the perpetuation of choices and behaviors which are highly damaging of environmental  
92 balances (Endfield et al., 2004; Palmieri, 2006). It is known that the period from the exit of the Little Ice  
93 Age (AD 1840-1920) is an important moment for the climate history, because it represents a transition  
94 phase towards the current climate. The end of LIA in the Mediterranean area was characterized by a  
95 cold climate, with deeper cyclones (Figure 1a) than to recent climate normal (Figure 1b).

96

97 **Figure 1** Sea Level Pressure (hPa) upon Southern Europe during the 1840-1920 period (a), and 1981-2010 normal  
98 reference period (b). The lower pressure (L) over central Mediterranean and in north Atlantic during the end of  
99 Little Ice Age indicates a more continue presence of cyclones (arranged from NCEP Reanalysis V2c by the NOAA-  
100 ESRL Physical Sciences Division, Boulder, CO, USA)



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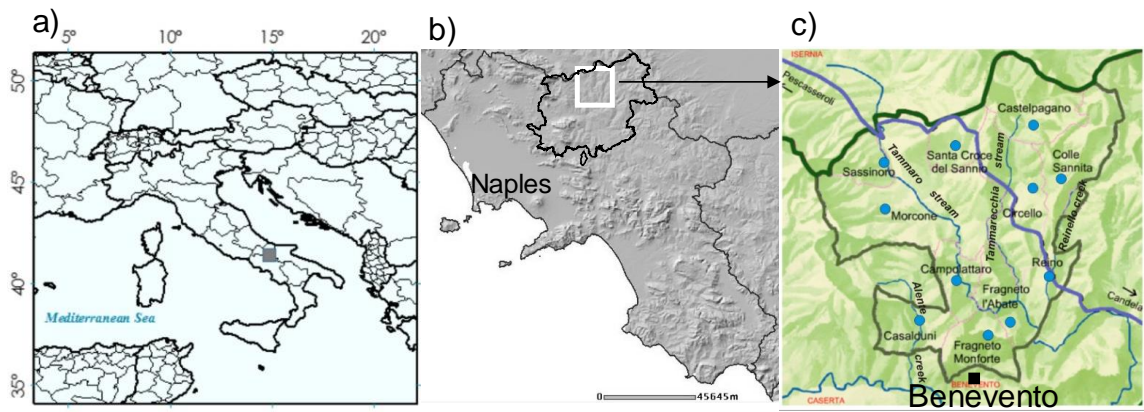
Climate variability is an important driver of spatial and temporal changes in hydro-meteorological variables in Southern Europe, where flood occurrence anomalies during winter are 181% higher during negative phase of North Atlantic Oscillation, and 40% lower in spring during negative phase of ENSO (Nobre et al., 2017). However, a simple connection cannot be found between the intensity of storms and hazardous extreme events, because different factors can be involved as different impacts are considered (Lionello et al., 2006). We carried out a documentary investigation of the major MDHEs, occurred in the High Tammaro Region over the last 200 years, with a focus on the exiting from the Little Ice Age. Our research has taken into consideration all the injuries that have a direct link with meteorological events, such as severe rainstorms and continuous rains that caused flooding, transport of loose materials, landslides, destruction of agricultural areas and transport infrastructure networks.

## 2. Environmental settings of the study area and methods

In living memory, the oldest flood remembered by the inhabitants of the Tammaro area is that occurred in 1949 (Soreca, 2012). However, minutes of municipal councils, excerpts from municipal resolutions of late 1800s and early 1900s, and other documents among the extant archive maps of various municipalities, indicate that the Tammaro area has always had to deal with a number of floods and landslides (e.g. Benevento, 1995). Whether human memory is in fact short and lasts no longer than the life of a person, the deposits of historical memory contained in archived documents hold out much longer. They can teach people, especially administrators, how to avoid today the mistakes that others made in the past, that is, what motivated us to write this contribution. The choice of High Tammaro as study area is due to its long history of floods and landslides. This territory has always had to face and defend itself from these events, which were in the past much more common than one might think. Such events have happened again recently too, as in fact occurred on 15<sup>th</sup> and 19<sup>th</sup> October 2015. These two recent floods affected the city of Benevento and its Province, with the flooding of the Calore river and the Tammaro stream and their numerous tributaries, including the Tammarocchia, a creek that, with one of its two spring-fed branches (called Vallone Monaconi), originates in the Castelpagano mountainous territory (Sannio, High Tammaro), on the border with Molise region. Even the High Tammaro area was hit on October 19<sup>th</sup>, 2015 by a series of storms that have caused the overflowing of several creeks, including the Pidocchioso and the Pescolle, which run behind the houses of the Castelpagano village. Previously, two intense storms hit wide areas of Central-southern Italy, both including the Tammano catchment, on 24-25 January 2003 and 4 March 2005, causing thousands of shallow and deep landslides (Fiorillo and Guadagno, 2007).

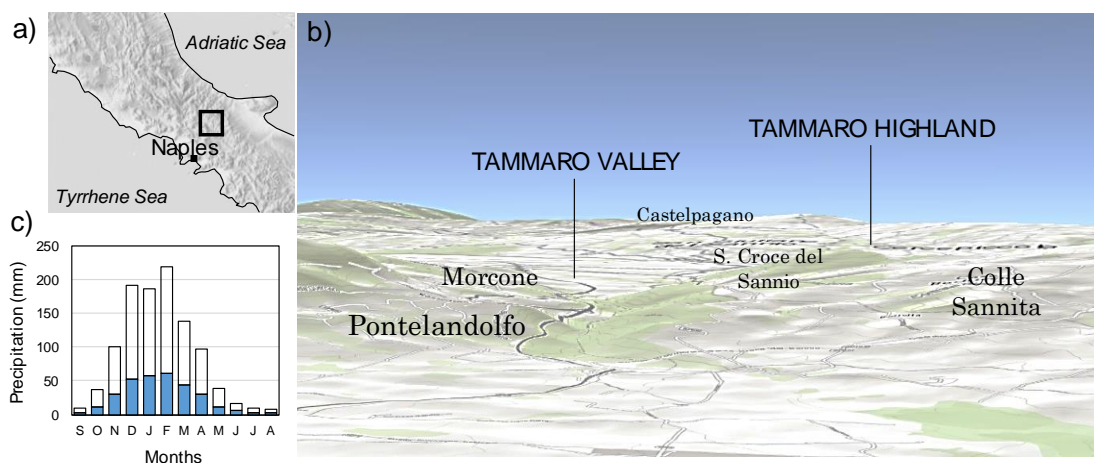
The High Tammaro Region (HTR, Fig. 2) is located in Southern Italy, in Campania administrative region (Benevento Province, Figure 3a), 70 km to the Tyrrhenian coast (north-east of Naples), between 400 and 1400 m a.s.l. (Figure 3b). Rain gauge stations over HTR indicate a moderate rainfall regime (Figure 3c): annual precipitation is around 900 mm in the southern part of the region, ranging from 1000 to 1400 mm in the remaining part, while exceeds 1400 mm along the north-western boundary (Diodato, 2005).

142 **Figure 2** Geographical setting of Italy (a) with the Campania region and Benevento province (b), and the Tammaro  
 143 area (c)



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 146 About 30-80% of precipitation returns to the atmosphere by evapotranspiration. Only a small part of  
 147 precipitation moves as surface runoff across the HTR, down into the great basin of Volturno River  
 148 towards the Tyrrhenian Sea (Diodato and Ceccarelli, 2006), although a greater amount of surface runoff  
 149 water is generated during rainstorm events, with torrential river regime. Average slope is about 3%,  
 150 but 19% of the area has a slope ranging over 13–15%, and slopes of about 30% are also present in  
 151 several hilly areas. As confirmed in the travel notes of Francesco Borbone, who passed through the  
 152 Tammaro valley in 1824, this area is characterized by intertwining of different landscape components:  
 153 *I passed the wooden bridge over the Tammaro stream, and there I saw the authority of the S. Croce  
 154 and Morcone and I began to go up the mountain that is to the left of the valley to go beyond a forested  
 155 mountain gorge called Sferracavallo. (...) It is then left to the right on the mountain that is on the other  
 156 side of the valley, the Sassinoro village and go down. Then, we cross the Morcone plain, not as  
 157 extensive as that of Sepino, but well cultivated and full of trees mainly on road and it is also possible  
 158 to see the low vineyards* (Zazo, 1972).

159  
 160 **Figure 3** Geographical setting of Central Italy (a) and related 3D-view of the Tammaro area area including the  
 161 main villages in the NNE (b), with the relative averaged area precipitation (blue histogram), and maximum  
 162 precipitation (empty histogram) in the period 1961-2000 (hydrological years) (arranged by ArcGIS Online ESRI,  
 163 <https://www.arcgis.com>)  
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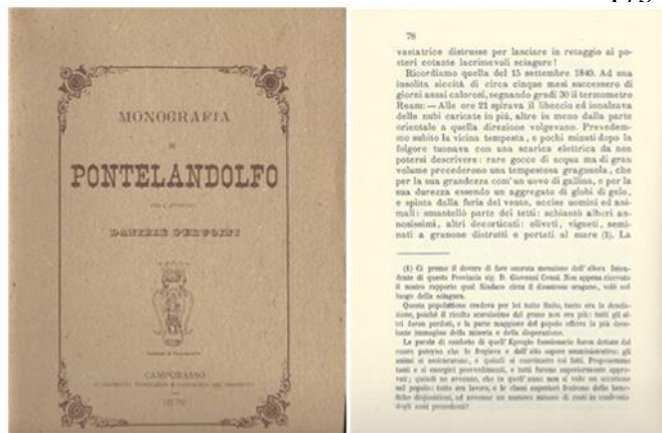


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 167 **2.1 Criteria for gathering and interpreting the historical information**  
 168 Our research has taken into account all those information that have a direct interest on weather effects,  
 169 such as damaging hydrological events that are related to extraordinary or continuous rainfall, and the

170 effects on the territorial system, and damages to transport infrastructural networks, for the concomitant  
 171 effects of flooding. An example is the event occurred in September 1840 in the village of Pontelandolfo  
 172 (Figure 4), as documented by Perugini (1878, pp. 77-78).

173  
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Figure 4 Cover and excerpt of the *Monografia di Pontelandolfo* by Daniele Perugini 1878, where it is mentioned



175

one of the most destructive hydrological events occurred in September 1840 in the Tammaro area

This event was also described in Giosué

188 Tedeschi's book of memories (Tedeschi, 1989, p. 30):

189 «Nell'anno 1840 nel dì 15 settembre di tale anno alle ore 20 succedette una gran tempesta con grandini  
 190 e vento impetuoso, che devastò vigneti, oliveti, frutta e quanto esisteva con mandare in aria tetti, e  
 191 rompere vetrate e mandare tutto in ruina. Nel nostro comune <Campolattaro> morirono pecore,  
 192 capre, polli, ma nel tenimento di Pontelandolfo, e Casalduni morirono uomini, donne, e fanciulli. La  
 193 tempesta venne dalla parte di Terra di Lavoro, con danno maggiore da quelle contrade, avendo  
 194 buttato a terra quercie, olive, tanto che nella strada consolare s'impedì il passaggio alle carrozze, ed in  
 195 Guardia dove successe più il danno morirono quattordici persone circa. Era orribile vedere un turbine  
 196 di vento con tuoni, che alzando gran quantità di polvere in aria si oscurò e tutto mostrava lutto e  
 197 spavento. Trovammo molte quantità di uccelli morti, e nella tenuta nostra ai Toppi soffrimmo molto  
 198 danno, non esistendo né uva, né ulive anzi tutto appariva come il mese di gennaio senza fronde gli  
 199 laberi, e le viti senza pampini. Orribile vista. Le abitazioni sconquassate nei tetti venivano inondate da  
 200 gran quantità di acqua, sembrando il diluvio universale, e non si sentiva altro per le abitazioni che  
 201 pianto, e gemito di donne, che piangevano i loro figli, e parenti assenti, e sparsi per la campagna. Nei  
 202 comuni di S. Lupo, Casalduni e Pontelandolfo morirono otto persone, e questi paesi della nostra  
 203 provincia di Campobasso furono più subbissati. In Terra di Lavoro poi Guardia fu distrutta nel generale,  
 204 non che Solipaca. In Guardia morirono cinque o sei persone, e in Solipaca due o tre, ed essendo caduto  
 205 un tiglio in mezzo della piazza ammazzò una vecchia, che stava sotto le croci ivi apposte. Grandi  
 206 querceti ed olivi spiantati con danno e perdita grave dei proprietari. Cosa mai sofferta» [In 1840, on  
 207 the 15<sup>th</sup> of September of that year, at 8.00 pm, a great storm followed by hail and impetuous wind,  
 208 which devastated vineyards, olive groves, fruits and what existed with sending roofs into the air,  
 209 breaking glass windows and ruining everything. In our municipality <Campolattaro>, sheep, goats,  
 210 chickens died, but in the holding of Pontelandolfo, and Casalduni men, women and children died. The  
 211 storm came from the side of Terra di Lavoro, with greater damage from those quarters, having thrown  
 212 to the grounds oaks, olives, so that in the consular road the passage to the carriages was prevented,  
 213 and in Guardia where the most damage happened about fourteen people died. It was horrible to see  
 214 a whirlwind of wind with thunder, which darkened with a great deal of dust in the air and all showed  
 215 mourning and fear. We found many quantities of dead birds, and on our estate to the Toppi we  
 216 suffered much damage, since there were no grapes, no olives; on the contrary, everything appeared  
 217 as the month of January without the branches, and the vines, without vines. Horrible sight. The shabby  
 218 dwellings in the roofs were flooded with a great deal of water, looking like the universal flood, and  
 219 nothing else was heard of for the houses that wept, and the groan of women, who wept for their  
 220 children, and absent relatives, and scattered throughout the countryside. Eight people died in the  
 221 towns of S. Lupo, Casalduni and Pontelandolfo, and these villages in our province of Campobasso were

222 more overwhelmed. In Terra di Lavoro then Guardia was generally destroyed, not Solipaca. In Guardia  
223 five or six people died, and in Solipaca two or three, and having fallen a linden in the middle of the  
224 square, killed an old woman, who was under the crosses attached to it. Large oaks and olive trees were  
225 stripped with damage and serious loss of the owners. Something never suffered].  
226 Information of this type were contextualized to the historical moment at which they were referred in  
227 order to include any contributions on environmental impacts due to human work. The documentation  
228 relating to the hydrological events and sources is reported (see Appendix) according to the protocol  
229 proposed by Camuffo and Enzi (1991) for cataloging archive data for the regional reconstruction of  
230 historical climatology. For any winter season (September-March), it is possible to establish a class of  
231 damaging hydrological severity, based on some specific objective consequences, discernible in the  
232 historical documentation. Useful values from documentary evidence are thus obtained by transforming  
233 the basic data into ordinal data in the form of a time series of simple damaging hydrological indices.  
234 In this way, it was set a grade of MDHEs index per annum, equal to 0 (normal), 1 (stormy event, with  
235 moderate damaging hydrological), and 2 (very stormy event, with strong damaging hydrological).

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237

### 238 3. Results and discussion

239 The correlation between bad weather and natural disasters forms a frame where the joint actions of  
240 the *humans* and the *earth's climate system* drive the evolution of the *landscape of events*. However, it  
241 is not easy to perform a critical analysis of documentary sources for historical climatology of a given  
242 area and to evaluate the impact of climate on landscape evolution. So it is because implications of  
243 climate and land-use change for landscape processes depend on both climate forcing agents and the  
244 ability of landscapes to adapt to them. In order to identify possible trends in discrete MDHE data, the  
245 available time series was split into stationary components with 'fast' and 'slow' variability, with a low-  
246 pass 11-year Hamming filter (HF).

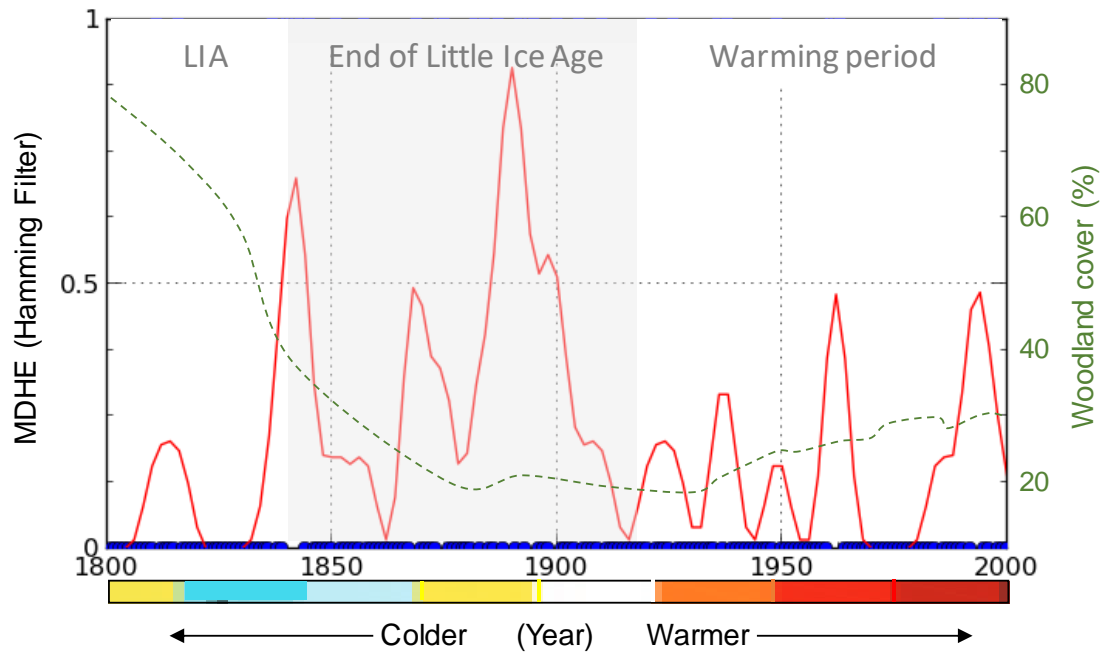
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#### 248 3.1 Time evolution of multiple damaging hydrological events (MDHEs)

249 Interpolating Hamming filters are popular for fitting data because they provide a temporal continuity  
250 to discrete data, a property that permits them to satisfy a desirable smoothness constraint. Overall, the  
251 time series of MDHE(HF) data exhibits a multidecadal increasing trend as approaching the 20<sup>th</sup> century  
252 (Figure 5, red curve). Afterwards, MDHE(HF) data are undergoing a decline that lasts almost throughout  
253 the rest of the 20<sup>th</sup> century, concurrently to warmer climate. This makes clear that if natural causes in  
254 historical and recent times were meant to express their effects according to just a random and human  
255 independent distribution, what makes the 19<sup>th</sup> century different from the previous centuries - which  
256 justifies its choice for investigations - is instead an unstoppable rise of combined anthropic and climatic  
257 influences. Climatic, geological and hydrographic conditions are no longer the only basis for the  
258 occurrence of instability events. An unusual human pressure on resources operates alongside with an  
259 inevitable impact on the territorial equilibrium. In this perspective, the deforestation criticized by Zurlo  
260 (Mancini, 1937) is definitely not a phenomenon related only to the mountains of Matese, nor it is limited  
261 to 1811. It appears as being part of a more comprehensive process of forest destruction, which has  
262 affected important areas of the entire South of Italy (including the Tammaro basin) throughout the 19<sup>th</sup>  
263 century (Figure 5, green hatched curve).

264

265 **Figure 5** Evolution of multiple damaging hydrological events (MDHEs) with 11-year Hamming Filter (red curve)  
266 during the period 1800-2000 in the Tammaro highland (calculated with CurveExpert Professional software,  
267 <https://www.curveexpert.net>). In grey band, the end of Little Ice Age. Evolution of woodland area in Southern Italy  
268 (arranged from Ellis et al., 2010) for different climatic periods (PAGES2k Consortium, Abram et al., 2017) is also  
269 shown (green hatched curve and coloured bands, respectively)



270  
271

272 In this regard, Sereni (1996) provided data on the distribution of cultivated areas in the whole of the  
273 *Mezzogiorno* (i.e. Southern Italy) of Italy (including the islands), which can certainly be taken as  
274 representative of the territory under consideration. The historian pointed out the extent of the  
275 deforestation carried out between 1860 and 1929, with strong upheavals in the first decades following  
276 the political unification of the country, which had deeply affected the degradation of the southern  
277 landscape. The words of Sereni himself are eloquent when he evokes that *in little more than fifty years,*  
278 *the surface of the forests is reduced in almost half of these regions as a result of deforestation, which*  
279 *now threaten the integrity of the Agricultural land and inland provinces.* The hypothesis is that human  
280 contributions to deforestation and successive erosion during the exiting of the LIA, have risen to an  
281 extent that the landscape has undergone local geomorphic changes that made floods worse,  
282 associated with more variability in weather patterns. This is also in agreement with the archaeological  
283 hypothesis of Bintliff (1982, p. 157), who writes as *in the not too distant past the local climate was highly*  
284 *variable, with severe drought inhibiting scrub colonization and loosening the topsoil, alternating with*  
285 *dramatic rainfall, producing these great colluvium sediment flows; such as climate may have*  
286 *characterized the latter part of the Little Ice Age in Mediterranean up till the middle of the last century.*  
287 However, the results discussed above show that, being about halved the hydrological hazard, and  
288 doubled the vulnerability of the area involved in this study, the hydrogeological risk from flooding in  
289 the Tammaro would have remained unchanged from the end of the LIA until present (Soreca, 2012).

290

### 291 3.2 Spatial pattern of extreme events associated with weather injuries in the context of Mediterranean 292 area

293 Although this research falls in the framework of the novel branch of historiography, climate history, it  
294 goes without saying that this study contributes to a cross-cutting reading. Among the sources of  
295 historical documents, one can discover the skinny and quick references to the conditions of peasant  
296 life of the past, in particular the almost total lack of main, secondary and local roads until the early 20<sup>th</sup>  
297 century. In this way, it is observed how the local communities have been able, from time to time, to  
298 face them more or less successfully. It is also observed how human constructions, yet built with dry  
299 walls, were precarious and how the ability to move was difficult at a time when the bridges, where  
300 present, were simple wooden catwalks. One was forced to wade the rivers walking at any time of the  
301 year, along mule tracks and muddy paths in winter and dusty in summer, on deserted and poor to  
302 intrafficable streets *for which, continually, robberies and other wickednesses are heard*<sup>1</sup>, both to get

<sup>1</sup>Folder n. 29, Deliberations Year 1800 and following, Council of September 2<sup>nd</sup>, 1861 (in Italian).



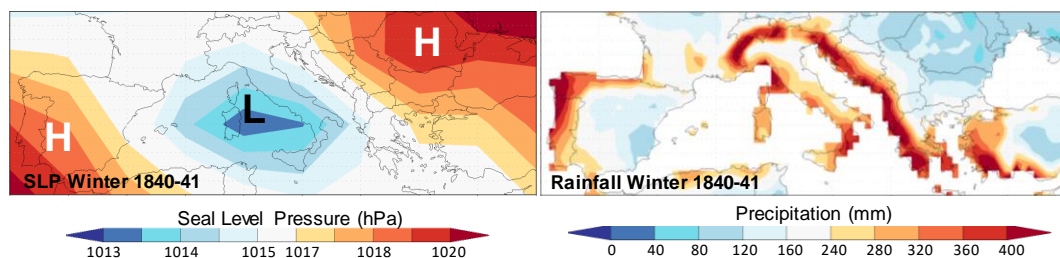
303 to work in the fields and in the woods or in the pastures, and to bring wheat to the mills downvalley  
 304 and to return charged of flour. The same problem existed when one had to travel from country to  
 305 country, both for businesses or trades, and for the necessary communications with the executive and  
 306 judicial bodies of the State, because the lack of roads was almost complete and one still goes along  
 307 ancient sheep tracks<sup>2</sup> of transhumance. The weather-hydrological events that occurred on September  
 308 1841 are exemplary: *On September 25<sup>th</sup> a downpour affected the Matese Mountains, which caused a*  
 309 *swelling of waters to our Tammaro stream, which flooded the surrounding campaigns and caused*  
 310 *exorbitant damage. The flood arise 12 palms above the wooden bridge and it was swept away without*  
 311 *knowing where the remains of the transported wood where deposited. Besides the damage suffered*  
 312 *by the vineyards, wheats and the same land, many casualties occurred. About 40 casualties occurred*  
 313 *at Morcone. A poor young man was found tied to bushes over an oak and another one buried in the*  
 314 *silt in our estate. Another one saved himself over a poplar. One our fellow countryman saved himself*  
 315 *climbing over a wall of the Fragneto l'Abate mill, ruined and swept away by the flood, another his*  
 316 *companion miller of S.Croce from the water falling down the wall where he had gone for salvation*  
 317 (Tedeschi, 1989).

318 Especially in the winter months, the roads became impracticable, isolating entire villages. del Re (1836),  
 319 in an analytical description of the physical constitution of the internal Apennine areas, stressed the  
 320 unceasing corrosion due to the surface waters coming down from the hills along the west of Sassinoro  
 321 and Morcone, and the south of Pontelandolfo, Campolattaro, Casalduni, with the result that in those  
 322 places, landslides and earthy currents frequently occurred, and the same happened in the hills of  
 323 Baselice, Fojano, Castelpagano, Castelvetere, Gambatesa, Riccia, Jelsi and Gildone. In this context,  
 324 changes in storm temporal pattern had an impact on material and energy movement by changing a  
 325 series of hydrogeomorphological processes, such as floods and landslides. Storm erosivity and soil  
 326 erosion are a primary problem in this part of Mediterranean Europe, which is characterized by strong  
 327 climate variability and moderately disturbed land-surfaces. An example is given by the continuous rains  
 328 occurred on the winter 1841-1842 (Figure 6, right panel) driven by the formation of a stationary low-  
 329 pressure minimum across the central Mediterranean (Figure 6, left panel), which leads to hypothesize  
 330 a possible escalation of landslide phenomena in the Campano Apennine (Corradi, 1865-1894;  
 331 Millosevich, 1882).

332  
 333

334 **Figure 6.** Sea Level Pressure (left panel) and rainfall (right panel) during the winter 1840-1841 across Mediterranean  
 335 area (maps arranged from KNMI-Climate Explorer on data of Luterbacher et al., 2002 for Sea Level Pressure, and  
 336 from Pauling et al., 2006, for precipitation). Note that (H) is for high pressure and (L) for low pressure

337



338  
 339

340 The events collected above testify, effectively, how the problem of the hydraulic disorder has created  
 341 heavy economic and social constraints to settlement throughout the 19<sup>th</sup> century, and how, at the same

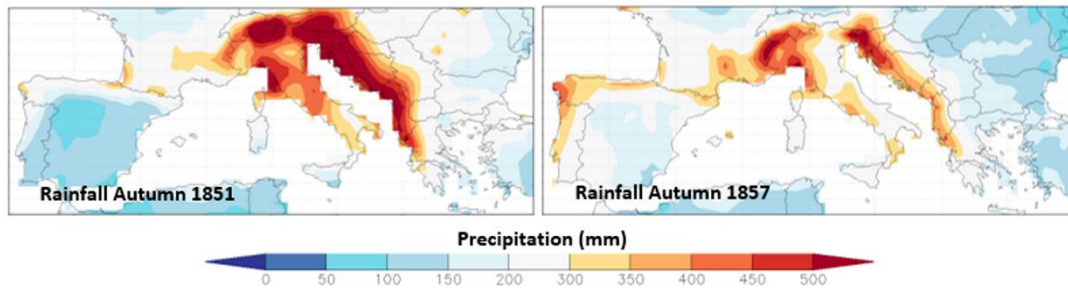
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<sup>2</sup>Folder n. 29, Deliberations year 1800 and following, Council of May 31<sup>st</sup>, 1871 with object «*Apertura delle strade*» [Opening of the roads]. A note from the Royal Prefecture «recommends to the Municipal Authority surveillance to oversee the roads and tracks, which are in a very bad condition [...] because they are considered all usurped and restricted to a sign that in most of them two cars cannot pass at the same time, and in the winter season they have become completely not trafficable, also because the sewage of the surrounding funds are illegally discharged there» (translation from the original in Italian).

342 time, the current geomorphic instability problems embed their own roots in that historical stage which  
 343 preceded modernity (Palmieri, 2006). It should first be noted that the identified cases are only a part of  
 344 the extreme hydrological events affecting, with alarming cyclicality, many areas of the High Tammaro.  
 345 Nevertheless, the 43 events recorded upon the period 1801-2015 (23 of the which in the last parte of LIA)  
 346 can be considered a sufficiently large and representative sample, which provides a sound basis for  
 347 understanding the MDHEs. These are phenomena that - and this is a second point that should be made  
 348 clear - occurred with different characteristics and sizes. In fact, along with minor landslides and floods,  
 349 also disastrous episodes occurred. In particular, in the autumn 1851, rain in Italy fell in extraordinary quantity  
 350 (Figure 7, left panel).

351

352 **Figure 7** Two among the rainiest autumns (1851 and 1857) at the end Little Ice Age across the Mediterranean area  
 353 (maps arranged from KNMI-Climate Explorer on data of Pauling et al., 2006)



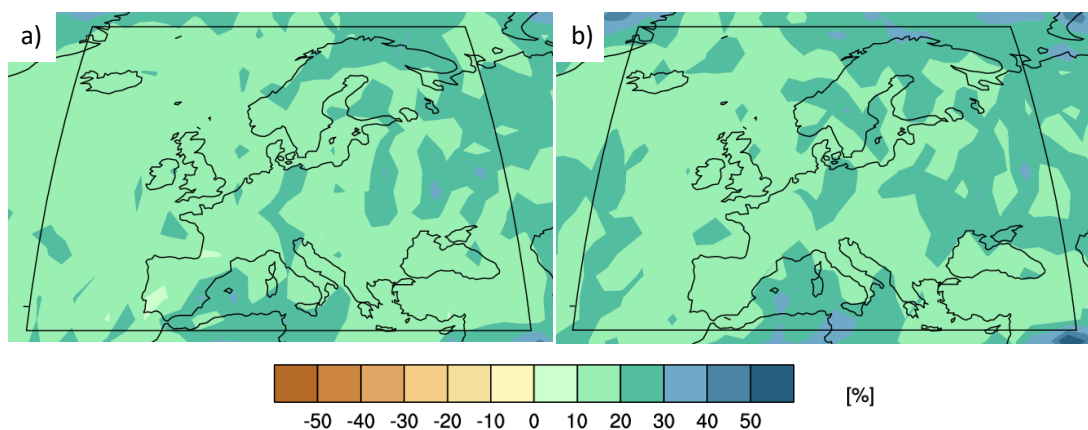
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355

356 For high Tammaro, Giosuè Tedeschi write: *On November 20<sup>th</sup>, 1851, a triduum by exposing of Jesus*  
 357 *Christ was made in our church to implore the calm of a bad thunderstorm of about 20 days of*  
 358 *continuous heavy rain during the day and night, which caused floods in various campaigns and*  
 359 *impediment to the wheat sowing; and this was practiced in Naples, Benevento and all the neighboring*  
 360 *countries. Various damage are heard, among whom a rural house fell causing five casualties in*  
 361 *Pontelandolfo; the iron bridge at Solopaca was broken by the flooding of the river* (Laudato, 1989). At  
 362 Casalduni however, as the intendant wrote after a visit made in 1858, a deep and wide landslide had  
 363 already demolished about three hundred houses and threatened the rest of the town (Zazo, 1965).  
 364 Even at the beginning of autumn 1857 a heavy rain occurred (Figure 7, right panel), causing flood of  
 365 the Titerno stream: campaigns and streets ravaged, buildings torn down at Faicchio, San Lorenzello,  
 366 Cerreto Sannita, Cusano Mutri and Pietrarroia; heavy rain, flooding of Resicco creek, campaigns flooded  
 367 at Pontelandolfo. The flood of the Tammaro stream destroyed the wooden bridge. It flooded also at  
 368 Casalduni (Palmieri, 2006).

369

370 **Figure 8** Percent anomalies of the 95<sup>th</sup> percentile of annual maximum 1-day rainfall (projections at 2015-2055 minus  
 371 the reference period 1986-2005) from CMIP5 ensemble with RCPs 4.5 (a) and 8.5 (b) emission storylines  
 372



373

374

375 Finally, to get an insight into future scenarios of extreme events in the Mediterranean area (Figure 8a, b),  
376 we used projected 95<sup>th</sup> percentile of annual maximum 1-day rainfall (95<sup>th</sup>prcAM1-dayR, as reproduced by  
377 the CMIP5 model mean and provided by KNMI Climate Explorer) to estimate anomalies for 2015-2055  
378 compared to 1986-2005, under two storylines representing medium (RCP4.5) and high (RCP8.5) emission  
379 trajectories. The results indicate a relative increase in the 95<sup>th</sup>prcAM1-dayR of about 20% with respect  
380 to the baseline period 1986-2005 with both scenarios.

381 The millennium-long evolution of hydrological extreme events for the Mediterranean Basin has  
382 hitherto only been studied to a limited extent (Camuffo et al., 2011). For instance, Bradley et al. (2011)  
383 and Ljungqvist et al. (2016) identified periods during the past two millennia of Mediterranean  
384 hydroclimate showing similarities to that of the present. However, many regions have experienced an  
385 increase during recent decades in precipitation extremes (Min et al., 2011; Asadieh and Krakauer, 2015;  
386 Donat et al., 2016), and the projected climate change is expected to continue to exacerbate storms in  
387 Southern Europe (Bindi and Olesen, 2011). This would increase the risk at local scales of devastating  
388 impacts because storms and other extreme weather events such as flash floods and downpours may  
389 become more intense and thus drive MDHEs (Diodato et al., 2011). In this perspective, investments in  
390 high quality meteorological forecasting and early warning systems (e.g. Deiminiat and Eslamian, 2014)  
391 will become increasingly valuable.

392

#### 393 4. Concluding remarks

394 We have presented the first, annually resolved, two century-long (1800–2000) reconstruction of the  
395 variability of MDHEs over a fluvial basin in the central Mediterranean region (Italy). With focus on the  
396 inter-annual variability of MDHEs in the Tammaro area, this study provided an opportunity to access  
397 past records, reflect on memory and story, and build on this combined information to establish new  
398 understanding. In particular, the end of LIA appears to have been a period of increased sub-regional  
399 hydrological events, compared to the MDHE patterns occurred during the early LIA and recent times.  
400 In this way, historical records alongside modern observation data offer a valuable chance to extend  
401 information about storms, floods and landslides, and on how their impacts propagate over time and  
402 space. In addition, helping to facilitate a better knowledge of the complex nature of the hydrologic  
403 challenges and their management, this detailed analysis offers a spectrum of evidence to orient further  
404 research towards sub-regional and local actions. In particular, in order to better assess the  
405 unpredictable impact that extreme events may cause in the future, it would be important that experts  
406 in land management and those involved in the Italian Civil Protection monitor them with reliable  
407 scientific weather data and geological risk maps. In fact, history shows that where a landslide has  
408 already occurred, landslides will likely occur again in the future and where *water has already risen once*,  
409 one can be reasonably sure that within a few years or a decade, it will rise again.

410

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- 595



596 APPENDIX: List of the Multiple Damaging Hydrological Events during the exiting of the LIA in the  
597 High Tammaro Region

598

599 *The continuous rainfall on January 1841*

600 January 1<sup>st</sup>-January 20<sup>th</sup>: heavy and almost continuous rainfall in the Naples area, 223 mm, and in the  
601 Benevento area; flooding in the Caudina valley; flooding of the Sarno stream; floods at Capitanata.

602

603 *The rainfall and flood on September 25<sup>th</sup>, 1841*

604 On September 25<sup>th</sup> heavy rainfall occurred that affecting the Matese Mountains, causing floods of the  
605 Tammaro stream at Campolattaro, destruction of vineyards and fields of maize, casualties at Morcone.  
606 «Nel dì 25 Settembre 1841 vi fu un diluvio di acque sulle Montagne del Matese, che portò un  
607 gonfiamento al nostro Tammaro, il quale sboccò nelle campagne continue e recò un danno  
608 esorbitante. La piena avanzò 12 palmi al di sopra del ponte di legno che lo portò via senza saperne  
609 dove avesse depositato gli avanzi dei legni trasportati. Oltre il danno delle vigne, granoni e degli stessi  
610 terreni, vi succedero molte morti. In Morcone ne morirono da 40 persone circa. Si trovò un povero  
611 giovane legato da cespugli sopra una quercia e un altro nel limo nel nostro tenimento. Un altro si salvò  
612 sopra un pioppo. Un nostro paesano si salvò salito sopra un muro del molino di Fragneto l'Abate e  
613 portato via e diroccato dalla piena, un altro suo compagno molinaro di S. Croce dall'acque cadendo il  
614 muro dove si era situato per salvarsi» (Tedeschi, 1989) [On September 25<sup>th</sup> a down pour affected the  
615 Matese Mountains, which caused a swelling of waters to our Tammaro stream, which flooded the  
616 surrounding campaigns and caused an exorbitant damage. The flood arise 12 palms above the wooden  
617 bridge and it was swept away without knowing where the remains of the transported wood where  
618 deposited. Besides the damage suffered by the vineyards, wheats and the same land, many casualties  
619 occurred. In Morcone about 40 people died. A poor young man was found tied to bushes over an oak  
620 and another one buried in the silt in our estate. Another one saved himself over a poplar. An our fellow  
621 countryman saved himself climbing over a wall of the Fragneto l'Abate mill, ruined and swept away by  
622 the flood, another his companion miller of S. Croce from the water falling down the wall where he had  
623 gone for salvation].

624

625 *The continuous rainfall on autumn-winter 1842-1843*

626 1842-1843 fall / winter: continuous rains, partial obstruction of sowing in *Principato Ultra*. Extraordinary  
627 rains in Molise from August 29<sup>th</sup> to September 3<sup>rd</sup>, 1842. Due to the unusual and continuous rainfall  
628 occurred in this year [1842] at finish of the summer and lasted until the next fall and winter, the wheat  
629 was sown late and wrong; and even some fields were fallow (Intendant of Avellino G. Lotti, missive to  
630 Minister of Interior, in Zazo, 1965).

631

632 *The continuous rainfall on November 1851*

633 November 1<sup>th</sup>-November 20<sup>th</sup>: intense and continuous rain, storm, prevented planting in highland of  
634 Benevento and surrounding areas; November 21<sup>st</sup>: damaged homes and some casualties at  
635 Pontelandolfo, flooding of the Calore river, extensive damage to the Maria Cristina bridge at Solopaca  
636 in the Teleso valley.

637

638 *The floods and damages on September 13<sup>th</sup>, 1857*

639 «*Se la tempesta del 13 settembre principalmente infuriò su Piedimonte, di S. Angelo e di Raviscanina*  
640 *non minori i danni produsse ne' Comuni siti nella parte orientale del Distretto. Le strade rurali di Gioja*  
641 *soffersero in modo da doversi spendere vistose somme affine di rendere agevole l'accesso nei fondi*  
642 *lateralmente a tacere delle altre campagne dalle acque sommerse e devastate. Faicchio non ne rimase illeso,*  
643 *ed agl'immensi danni dei campi ebbe a deplorare quelli gravissimi dell'antico ponte di Massa, che per*  
644 *tradizione volersi monumento della Romana grandezza. Sono nello impegno di rinvenire i fondi per*  
645 *restaurare, e mantenere siffatta opera, mercè un ratizzo tra i Comuni cointeressati, non essendo le*  
646 *finanze di Faicchio atte ad una tanta impresa. S. Lorenzello, oltre i gravissimi danni sofferti al molino*  
647 *comunale ebbe a deplorare l'abbattimento del ponte a tre archi sull'imponente Titerno, messo*  
648 *all'estremo dell'abitato. A memoria di uomo niuno ricordava quel torrente sì gonfio che all'impeto*  
649 *delle onde unitosi il valido urto di maestosa quercia svelta dalla forza di quelle, venne quel ponte*  
650 *abbattuto, ed in meno che non dico nelle acque rovesciato, e travolto. (...) Cerreto, Cusano, Civitella e*  
651 *Pietraroja ebbero eziandio a deplorare non ordinari disastri tra per l'abbondanza delle acque e tra per*  
652 *la violenza dell'istesso Titerno, che quelle campagne serpeggiando maestosamente le domina.*  
653 *Macchine idrauliche interrate, conquassate e sconvolte. Molini quasi abbattuti, terre denudate e*  
654 *degradate in quanto alla coltura. La strada da Cerreto a Cusano per circa mille palmi fu totalmente*  
655 *distrutta, di modo che si dovè dare al cammino altra direzione provvisoria, secondo che si fece a*  
656 *proporre l'Ingegnere provinciale sig. Eugenio Scarpati superiormente delegato a percorrere quella*  
657 *campagna» (Viti, 1858) [If the storm of September 13 mainly raged on Piedimonte, S. Angelo and*  
658 *Raviscanina, no minor damage was produced on the municipalities located in the eastern part of the*  
659 *District. The rural roads of Gioja, suffered damage so heavy as forcing to spend conspicuous amounts*  
660 *of money in order to allow access to the lateral fields to avoid complaints from the other campaigns*  
661 *that were submerged and devastated by waters. Faicchio was not left unscathed, which in addition to*  
662 *the immense damage to fields, it had to deplore those to the ancient Massa bridge, which tradition*  
663 *says to be monument of Roman greatness. Being the finances of Faicchio not capable to restore and*  
664 *maintain such work, a financial economic effort involving all the affected municipalities is required. S.*  
665 *Lorenzello, besides the serious damage suffered by the municipal mill, had to deplore the destruction*  
666 *of the bridge with three arches over the impressive Titerno, at the extreme of the town. On living*  
667 *memory no one remembered that torrent swollen so that the impetus of the waves joined to the*  
668 *impact of a majestic oak caused the bridge shot down, and it was quickly overturned and overwhelmed*  
669 *in the waters. (...) Cerreto, Cusano, Civitella and Pietraroja had to deplore not ordinary disasters due to*  
670 *both the abundance of water and the Titerno violence that meandering those campaigns majestically*  
671 *dominates. Hydraulic machines were buried, battered and shaken. Mills were almost shoot down, fields*  
672 *were bared and degraded. The road from Cerreto in Cusano for about a thousand palms was totally*  
673 *destroyed, forcing to found other provisional way, according to the proposal of the Provincial Engineer*  
674 *Mr. Eugenio Scarpati, top delegate to go through that campaign].*

675

676 *The downpour on February 12<sup>th</sup>, 1868*

677 On February 12<sup>th</sup>, a cloudburst occurred at S. Marco dei Cavoti. *Municipal Resolution* of S. Marco dei  
678 Cavoti. The Town Council then sent a resolution to the Sub-prefect as the water source called "Conca"

679 had been heavily damaged by the flood occurred on February 12<sup>th</sup>, 1868, for which urgent repairs were  
680 needed (Fuschetto, 1977).

681

682 *The rainstorm on June 26<sup>th</sup>, 1868*

683 Heavy rains affected the Kingdom of Naples; June 26<sup>th</sup>: wide storm lasting six hours caused flooding  
684 and extensive damage to the campaigns of the districts of Cantalupo, Boiano in the Campobasso  
685 province and surrounding areas; flooding of the Biferno river cause casualties and destruction of mills  
686 along its riparian zones. Flood with lightning and hail on Wards of Cantalupo, Bojano and neighboring  
687 countries. Campaigns are destroyed, various mills are ruined, and some people were swept away by  
688 the waters of the Biferno river. The hurricane lasted from 10 AM to 4 PM (Perrella, 1891). It is a rather  
689 turbulent summer in various regions of Italy; the chronicle found in the Parish Archive of the Church  
690 of St. Christina of Pontremoli reports what Don Luigi Marsili wrote about the year 1868: «*Dopo*  
691 *un'estate piovosa, grandi piogge anche in settembre, fino al terribile diluvio di San Matteo (21*  
692 *settembre), quando il fiume portò via il ponte di Nostra Donna...»* (1989-1991) [After a rainy summer,  
693 heavy rains even occurred in September, until the terrible flood on the St. Matthew day (21 September),  
694 when the bridge of Nostra Donna was swept away by the river ...].

695

696 *The heavy rainfall on November 1869*

697 On November 30<sup>th</sup>, 1869<sup>1,2</sup>, the Mayor Tommaso De Matteis informed the Council «*che le ultime dirotte*  
698 *piogge cadute gonfiando oltremodo i ruscelli invernali presso S. Rocco o Ariella ed a Fontana Vecchia,*  
699 *nonché l'altro che nascendo nell'abitato cammina lungo la strada che mena alla così detta Fontana*  
700 *Grossa, in prodotto enormi sprofondamenti da rendere quasi intrafficabili tre strade che sono più*  
701 *interessanti per questo pubblico poiché conducono ai molini, al Cimitero<sup>3</sup>, al bosco ed a buon'altra*  
702 *parte del tenimento e che se di breve non si apporta riparo avranno a deplorarsi più gravi disastri*  
703 *venendo dalla parte di S. Rocco minacciata la Cappella ed un antico pozzo Comunale e dalle altre parti*  
704 *anche le case di abitazioni.»* [that the latest heavy rains exceedingly swelling the winter torrents at St.  
705 Rocco or Ariella and at Fontana Vecchia, as well as the other torrent originating into the inhabited area  
706 and runs along the road that leads to the so-called Fontana Grossa, produced huge sinkholes causing  
707 heavy damage to three roads that are interesting to this audience as they leads to the mills, to the  
708 Cemetery to the woods and to other territories and if in short time the necessary defense works will  
709 not be undertaken, more severe disasters will occur as the S. Rocco Chapel, as well as an ancient  
710 municipal well and also inhabited houses are threatened.] The Mayor and the Council, considering that  
711 there was no need of the project of an architect for such defense works, had «*sollecitamente elevare*  
712 *una perizia dal muratore Angelo Vetere»* [promptly requested an expert opinion to the mason Angelo  
713 Vetere] and proposed to carry out the work in the administrative heading. The Council, noted  
714 «*ocularmente lo stato delle cose»* [the state of things by direct observation], thought this issue of  
715 «*somma necessità ed urgenza»* [utmost necessity and urgency] and they decided «*che*  
716 *immediatamente ed in linea Amministrativa si eseguano i lavori occorrenti per l'oggetto suddiviso a*

---

<sup>3</sup>It is the old cemetery of San Rocco; the new one at Pescolle village, currently in use, began to function by order of the Prefect in 1880 because the construction works, which started in 1876, lasted until 1879; then, until the year 1885 disputes took place between the contractor Giuseppe Grimaldi and the Municipality, that did not take over the work, judging it not conform to the original projects and built with shoddy materials and poor quality of work.

717 *norma del progetto del Sig. Vetere ed a cura della Giunta Municipale e de' Deputati delle opere*  
718 *pubbliche»* [that immediately and in Administrative heading the necessary works will be executed,  
719 according to the draft of Mr Vetere and organized by the Town Council and the Deputies Members of  
720 public works].

721

722 *The continuous rainfall on May 1874*

723 «*Le continue piogge con geli che in Maggio del 1874 cadevano fecero concepire il triste timore a*  
724 *tutti, perché nocevoli alla ricolta di tutti i prodotti che si manifestava ubertosa. La popolazione mossa*  
725 *da spavento, anche per la carenza del vivere in cui si trovava, mentre il prezzo del grano era risalito*  
726 *fino a ducati 4,50 il tomolo, e quello del granone a ducati 3,90 il tomolo, vedendosi perciò il pane di*  
727 *grano a grana otto il rotolo, si determinò di voler ricorrere con le solite penitenze alla Vergine Assunta*  
728 *in Cielo,...* Il giorno otto Giugno ebbe luogo la processione del Rione Croce.... Il giorno nove procedette  
729 alla processione il Rione Portella.... Nel giorno 10 procedette alla processione il Rione Fontanella... Il  
730 giorno 11 procedette alla processione il Rione Piazza... Il giorno 12 ebbe luogo la processione de' Fratelli  
731 delle due Congreche, e nel giorno 13 quella de' Sacerdoti... Nel giorno 14 si procedette alla  
732 processione generale con la Vergine che fu fittata per ducati 23,53, ed in detta processione vi accorse  
733 moltissima gente de' limitrofi paesi, e tutti con diretto pianto chiedevano alla Vergine la grazia della  
734 buona ricolta, stante la loro fame» (Giordano, 1981) [The continuous rainfall with frosts occurred on  
735 May, 1874, caused fear in people for possible damage to the harvesting, which manifested abundant.  
736 The scared population, even for the shortcomings of life in which it found itself, while the price of  
737 wheat had risen up to 4.50 ducats for 0.33 ha, and that of maize to 3.90 ducats for 0.33 ha, so seeing  
738 the price of the wheat bread rise up to eight grain a roll, it was determined to resort with the usual  
739 penances to the Vergine Assunta in Cielo, ... On June, 8<sup>th</sup> the procession of the Rione Croce took place  
740 ... On June, 9<sup>th</sup> the procession of the Rione Portella took place ... On June, 10 the procession of the  
741 Rione Fontanella took place ... On June, 11<sup>th</sup> the procession of the Rione Piazza took place ... On June,  
742 12<sup>th</sup> the procession of the Fratelli delle due Congreghe took place ... and also on June, 13<sup>rd</sup> those of  
743 Sacerdoti ... On June, 14<sup>th</sup> the general procession with the Virgin, who was rented for 23.53 ducats,  
744 took place and in that procession a lot of people from 'neighboring countries rushed, and all with tears  
745 asked the Virgin the grace for good harvest, because of their hunger].

746

747 *The torrential rainfall on October 24<sup>th</sup>, 1875*

748 Heavy rains in Benevento; storm, thunderstorms with hail, damage to factories, some casualties at  
749 Altavilla Irpina; landslides in Molise region; 14: landslide in Montella «*L'anno 1875 è rimasto memorabile*  
750 *per la grande alluvione, che, il 24 ottobre, funestò il nostro paese. Una pioggia torrenziale allagò tutto*  
751 *il paese e molte case. Il corso S. Pietro e le altre strade non si vedevano più: tutto l'abitato sembrava*  
752 *ergersi su di un immenso lago torbido e minaccioso. Quando il volume d'acqua poi si fu riversato giù*  
753 *per i punti più bassi del paese, formando enormi pantani, si videro nelle vie massi di melma e pietre,*  
754 *come nel letto asciutto di un impetuoso torrente. Rombi sinistri, folgori, gragnuola e pioggia: uno*  
755 *spettacolo nuovo e terrificante, che costernò tutta la popolazione! Il torrente Vellola crebbe tanto, da*  
756 *oltrepassare il livello della strada presso il ponte del molino Severini. I molini del Fisco rimasero*  
757 *sommersi. Un fulmine caduto sul campanile della chiesa madre, trapassando l'organo, andò a colpire*  
758 *e uccise un contadino di Terranova. Meno male che la raccolta era quasi tutta terminata; quindi pochi*

759 *furono i danni alle campagne»* (Millosevich, 1882) [The year 1875 was memorable for the great flood,  
760 which, on October 24, devastated our country. A torrential rainfall flooded the whole country and many  
761 buildings. The St. Peter course and the other roads were no longer visible: the whole town seemed to  
762 stand on an immense, murky and threatening lake. When the volume of water was then poured down  
763 to the lowest part of the village, forming huge quagmires, masses of mud and stones were seen in the  
764 streets, as in the dry bed of a rushing creek. Sinister rhombus, lightning, hail and rain: a new and  
765 terrifying spectacle, which dismayed the entire population! The Vellola river grew so much, to rise  
766 above the street level at the bridge of the Severini mill. The Fisco mills remained submerged. Lightning  
767 stroke the tower of the mother church and, piercing the organ, it hit and killed a peasant of Terranova.  
768 Thank goodness that the harvesting was almost finished; so damages to campaigns were few].

769

770 *The flood on 1882: a large landslide threatens the collapse of the Castelpagano village*

771 It was on May 30<sup>th</sup>, 1882 when the mayor Orazio De Matteis, pharmacist by profession, during the  
772 Council of the Town of Castelpagano wished «*che si portasse un grandissimo riparo all'enorme*  
773 *sprofondamento cagionato dalle acque del così detto Pidocchioso, o vallone della Terra, il quale scorre*  
774 *rasente le mura del paese, nel lato meridionale, e minaccia buona parte della case che gli sovrastano,*  
775 *e che si vedono chi più chi meno aperte, e con esse anche la chiesa madre, in cui ormai è divenuto*  
776 *pericoloso l'accesso, vedendosi nella volta diverse fenditure, come a tutti è noto. Che all'oggetto egli,*  
777 *di concerto con la Giunta municipale, ha fatto elevare una perizia delle operazioni necessarie ed urgenti*  
778 *dall'Architetto Sig. Vincenzo Finelli, da Colle Sannita, che già esibisce, e dalla quale risulta ascendere*  
779 *l'importo a Lire diecimila, compresa la strada Piano del Muscio»* [in the realization of a great defense  
780 work to counteract the enormous sinking caused by the waters of the so-called Pidocchioso, or Terra  
781 valley, which runs hugging the walls of the village, in the southern side, and threatens a large part of  
782 houses above it, which are seen more or less open, and with them also the mother church, which has  
783 now become dangerous to access due to large cracks affecting the roof, as everyone knows. For this  
784 aim, in agreement with the Municipal Council, he required an expert opinion about the necessary and  
785 urgent actions by the Architect Mr. Vincenzo Finelli, from Colle Sannita, which already performs, and  
786 which results in ascending the amount to ten thousand Lire, including the Piano del Muscio road]. After  
787 considering «*che realmente la parte del paese che guarda il mezzogiorno versa in gravissimo pericolo*  
788 *per sì tristi effetti delle piene del cennato torrente, vedendosi in franoso movimento una lunga*  
789 *estensione di suolo in cui si trovano edificati tanti fabbricati, i quali presto o tardi andranno a cadere,*  
790 *se sollecitamente non si apprestano i rimedi dell'arte»*[that really the part of the village that looks at  
791 the South is at very serious danger because of such sad effects of the floods of the mentioned stream,  
792 seeing involved in mass movement a long extent of soil in which so many buildings are built, which  
793 sooner or later will going to fall, if art remedies are not promptly realized], however, the Council  
794 believed that with municipal finances such enormous expenditure could not face and they resolved to  
795 send «*la menzionata perizia»* [the mentioned expert opinion] together with the «*copia del presente*  
796 *verbale all'egregio Capo della Provincia, Signor Commendatore Giorgetti<sup>4</sup>, augurandosi che nell'alta*  
797 *sua saggezza, compenetrato, come già ne è, delle critiche e disperate posizioni di questo infelice paese*

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<sup>4</sup>Giorgetti Dr. Diego was Prefect of the Benevento Province in two periods of time: July 29<sup>th</sup>, 1878-November 25<sup>th</sup>, 1883 and April 1<sup>st</sup>, 1886-October 1<sup>st</sup>, 1889.

798 ... non che dell'assoluta deficienza di mezzi, per sostenere la spesa di che trattasi, si degni esaudire i  
799 voti comuni, e di sequenza provocare (sic) da chi di ragione i necessari provvedimenti pel sussidio in  
800 parola» [copy of these minutes to the Head of the Province, Mr. Commendatore Giorgetti, hoping that  
801 in his high wisdom, interpenetrated, as he is, of the critical and desperate positions of this wretched  
802 country ... as well as the absolute lack of means, to bear that expense of that question, he worthy  
803 himself to fulfill the common votes, and in consequence provoking (sic) by insiders the necessary  
804 measures for the subsidy in question].

805

#### 806 *The flood on August 1884*

807 On August 1884 the harnessing works on the Terra creek and the repairing of the Piano del Muscio  
808 street were ongoing, but in the minutes the exact date is not reported, when another flood destroyed  
809 the works on construction sites and so the City Council charged the blame on the incompetence of  
810 the contracting firm and the poor quality of the materials employed. In a minute by three years later,  
811 on October 10<sup>th</sup>, 1887<sup>5</sup>, one can read, in fact, that the Mayor Giovanni Nista asked the Council: «*che*  
812 *venga eseguita una nuova verifica circa le opere di riparazione fatte nel torrente Pidocchioso nel 1884*  
813 *e distrutte dall'alluvione in Agosto detto anno, poiché è a ritenersi esservi stata imperizia d'arte sia per*  
814 *manca di fundamenta, sia per la cattiva malta, come è stato giudicato da persone competenti»*  
815 [that a new verification is performed about the repair works done in the Pidocchioso creek in 1884 and  
816 destroyed by the flood in August that year, since it is considered to have been inexperience of art both  
817 for lack of foundation bad cementitious grout, as it was judged by competent persons].

818

#### 819 *The thunderstorm on September 1889*

820 September 1<sup>st</sup>-September 5<sup>th</sup>: haze in Benevento; September 6<sup>th</sup>: thunderstorms in continuous  
821 succession for 8 hours, together with heavy rain, lightning spreading and outstanding exceptional hail  
822 devastating Benevento, Buonalbergo, and Campolattaro; some casualties caused by lightning occurred  
823 at Morcone. September 1<sup>st</sup> Decade: Benevento: «*In questa decade si sono avuti fenomeni*  
824 *estremamente eccezionali. Dopo una continua caligine della 1a pentade, il giorno 6 si volse a continue*  
825 *scariche elettriche dalle 6 antim. Alle 14:30 I temporali si succedevano senza interruzione l'uno dopo*  
826 *l'altro, arrecando pioggia dirotta, caddero fulmini sugli alberi e sui fabbricati. Grandine devastatrice*  
827 *non mai veduta, della grandezza di grossi noci; di forma sferica, prismatica ecc. Danni rilevanti. La*  
828 *stessa sorte toccò a Buonalbergo ed a Campolattaro. A Morcone vi furono vittime umane per fulmini*  
829 *ed incendi di varie biche di paglia»<sup>6</sup>* [In this decade, extremely exceptional phenomena occurred. After  
830 a continuous haze during the first pentad, the day September 6<sup>th</sup> turned to continuous electrical  
831 discharges from 6 AM to 14:30 the thunderstorms succeeded without interruption, one after the other,  
832 causing pouring rain, lightning fell on trees and buildings. Devastating hail never seen before, large  
833 walnuts in size; spherical, prismatic etc. in shape. Significant damage. The same fate befell Buonalbergo  
834 and Campolattaro. Some casualties caused by both lightning and fires of straw heaps occurred at  
835 Morcone].

836

#### 837 *The intense rainfall and floods on November 1889*

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<sup>5</sup>Folder n. 31, Register of original council resolutions, October 10<sup>th</sup>, 1887. (in Italian)

<sup>6</sup>Rivista Meteorico-Agraria, Ufficio Centrale di Meteorologia e Geodinamica, Roma, year 10, 403. (in Italian)

838 «*Pioggia continua, inondazione dei fiumi con allagamenti delle campagne e danni ai seminati in*  
839 *Benevento e in Morcone. Novembre 3a Decade: Benevento – Dopo tanti bellissimi giorni, seguirono*  
840 *piovosi il 26-28, i quali produssero straripamento dei fiumi ed allagamento alle campagne con danno*  
841 *ai seminati; Morcone – La dirotta e copiosa pioggia del 28 ha recato grave danno alle campagne per*  
842 *lo straripamento dei fiumi e dei torrenti; Avellino – La pioggia torrenziale (mm 95) del mattino del 28*  
843 *ha danneggiato i seminati in pendio. Neve al monte nella notte del 29»<sup>7</sup> [Continuous rain, flooding of*  
844 *rivers causing damage to countryside and fields sown in Benevento and in Morcone. Nov. 3<sup>rd</sup> Decade:*  
845 *Benevento - After so many beautiful days, rainy were the days from November 26<sup>th</sup> to November 28<sup>th</sup>,*  
846 *which produced the overflowing of rivers and flooding the countryside damaging sown fields; Morcone*  
847 *- The pouring and conspicuous rain on November 28<sup>th</sup> produced serious damage to the campaigns*  
848 *due to the overflowing of rivers and streams; Avellino - The torrential rain (95 mm) fell in the morning*  
849 *of November 28<sup>th</sup> has damaged the sown fields on slope. Snow to the mountain in the night of*  
850 *November 29<sup>th</sup>].*

851

852 *The continuous rainfall and floods on March 1890*

853 March 16<sup>th</sup>-March 21<sup>st</sup>: «*Pioggie continue, straripamento dei fiumi, impedimento dei lavori campestri in*  
854 *Benevento e in Morcone; frane e sospensione dei lavori campestri in Avellino. Marzo 2a Decade:*  
855 *Benevento – La pioggia, sebbene non abbia arrecato danno positivo alla campagna tranne qualche*  
856 *straripamento dei fiumi...; Morcone – Cinque giorni con pioggia (mm 171,7). Il 20 spesso neve sui monti.*  
857 *Per pessimo tempo sono stati sospesi tutti i lavori campestri; Avellino – Pioggie continue dal 16 a tutto*  
858 *il 21 [...] Le piogge danneggiarono i terreni che si smuovono e franano in più luoghi»<sup>8</sup> [Continuous*  
859 *rains, overflowing of rivers, prevention of field works in Benevento in Morcone; landslides and*  
860 *suspension of work in the fields in Avellino. March 2<sup>nd</sup> Decade: Benevento - The rain, though it has not*  
861 *done damage to the country except for some flooding of rivers ...; Morcone - Five days with rain (171.7*  
862 *mm). On March 20<sup>th</sup> often snow on the mountains occurred. Due to bad weather all the work in the*  
863 *fields was suspended; Avellino – Continuous rains from March 16<sup>th</sup> to March 21<sup>st</sup> [...] The rains damaged*  
864 *the soils that are subjected to landsliding in various places].*

865

866 *The continuous rainfall on November-December 1890*

867 Nov. 26<sup>th</sup> to 30<sup>th</sup>: «*pioggie continue; Dicembre 2: pioggia continua ed intensa, inondazione dei fiumi,*  
868 *danni ai ponti e ai seminati in Benevento; allagamenti diffusi nella piana di Morcone; inondazioni nella*  
869 *vallata di Montecassino. Novembre 3a Decade: La semina del frumento, non ancora terminata, viene*  
870 *interrotta ancora dalle continue piogge. Dicembre 1a Decade: Benevento – Nel 2 si ebbero 91 mm di*  
871 *acqua in 22 ore di seguito, in causa della quale avvennero le inondazioni che produssero danni rilevanti*  
872 *ai ponti e ai seminati nella valle del Calore; Morcone – Quattro giorni con pioggia (mm 212). [...] Per le*  
873 *continue piogge si è allagato qualche tratto del piano»<sup>9</sup> [Continuous rains; Dec. 2<sup>nd</sup>: continuous and*  
874 *intense rain, rivers flooding, damage to bridges and sown in Benevento; widespread flooding in the*  
875 *Morcone plain; flooding in Monte Cassino valley. November 3<sup>rd</sup> Decade: The sowing of wheat, not yet*

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<sup>7</sup>Rivista Meteorico-Agraria, Ufficio Centrale di Meteorologia e Geodinamica, Roma, year 10, 531. (in Italian)

<sup>8</sup>Rivista Meteorico-Agraria, Ufficio Centrale di Meteorologia e Geodinamica, Roma, year 11, 125. Marzo 2a Decade. (in Italian)

<sup>9</sup>Rivista Meteorico-Agraria, Ufficio Centrale di Meteorologia e Geodinamica, Roma, year 11, 540-541. (in Italian)

876 completed, is still interrupted by the continuous rains. December 1<sup>st</sup> Decade: Benevento – On  
877 December 2<sup>nd</sup>, 91 mm of water fell in 22 hours straight, because of which floods occurred that produced  
878 significant damage to bridges and sown in the Calore valley; Morcone - Four days with rain (212 mm).  
879 [...] Due to continuous rain some sections of the plan were flooded].

880

881 *The Pescolle creek flood on 1891*

882 It is difficult to establish the exact date of this flood, that has been thought to occur in 1891, because  
883 in the Council minutes it is reported in that year, month and day, the contribution paid in favor of  
884 Giuseppe and Salvatore Nista after the work carried out on their behalf by the mason Salvatore Vetere,  
885 as shown below. However, it is more likely, that it occurred in the previous year, or maybe even two  
886 years ago, forming at one with the flood of 1889, as in 1891, at the time of the meeting of the Council,  
887 the minutes talk about works already been completed.

888 On July 26<sup>th</sup>, 1891, the Mayor John Nista made «*dar lettura di una istanza avanzata dai Sig.ri Giuseppe*  
889 *e Salvatore Nista tendente ad ottenere un sussidio per la spesa da loro fatta nella restaurazione del*  
890 *ponte a fabbrica sul torrente Pescolle, in contrada Casale, il quale, mentre serve ai Sig.ri Nista da incile*  
891 *per condurre l'acqua al loro molino, serve ancora al pubblico, per accedere al Capoluogo del*  
892 *Mandamento, ad altri molini, al bosco Comunale di S. Angelo, ed a tante altre proprietà particolari, in*  
893 *ispecie quando la gonfiezza dei torrenti impedisce di guararlo a piedi»<sup>10</sup>. [give read off an instance by  
894 Messrs Giuseppe and Salvatore Nista aimed at obtaining a subsidy for the expense made from them  
895 for the restoration of the stony bridge over the Pescolle creek, in the Casale district, which, while serving  
896 to Messrs Nista to bring water to their mill, still serves also the public, to gain access to the Capital of  
897 the District, to other mills, to the Communal forest of S. Angelo, and many other particular properties,  
898 especially when the swelling of the rivers prevents wade walk].*

899 The works had been commissioned to the mason Salvatore Vetere, who had requested L. 402.55 for  
900 repairs «*oltre i legnami occorsi per la forma di detto ponte, i quali, poco dopo terminata l'opera, furono*  
901 *tutti portati via dalle alluvioni».* [in addition to the timbers needed for shaping that bridge, which,  
902 shortly after the work finished, were all swept away by floods]

903

904 *1894: the large landslide on the Terra creek*

905 The calamities for the inhabited area of Castelpagano, now called "old village", were not over. In fact  
906 on 1894, November 25<sup>th</sup> the mayor Antonio Di Pinto alarmed the Council saying «*una grande murgia*  
907 *franata nel torrente detto della Terra ... avendo formato una diga nel letto del torrente in parola,*  
908 *impediva il passaggio delle acque e minacciava in tal modo la rovina de' fabbricati limitrofi posti sulla*  
909 *sponda sinistra, in terreno eminentemente franoso»<sup>11</sup> [a large mass collapsed into the so called Terra  
910 creek ... having formed a dam in the bed of the creek prevented the water to flow and thereby  
911 threatened the ruin of neighboring buildings, just located on the left bank, on landsliding soils].*

912 Given the urgency of action the council «*diede incarico allo spacca-monti Pagliuca Vito fu Nicola»*  
913 [gave assignment to the mountain-smasher Pagliuca Vito fu Nicola] to break and move out that large  
914 rock. The mayor concluded that «*Al seguito dei lavori ivi eseguiti, si è tolto ogni pericolo, e nel*

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<sup>10</sup>Folder n. 31, Extracts from the council's deliberations record, 1891. (in Italian)

<sup>11</sup>Ricchetti (2004) places instead the event occurrence on 1882 and attributes it, in addition to the erosion «*del torrente Fossi che vi passava sotto*» [by the under passing Fossi creek] also to the «*terremoto dell'anno 1882*» [1882 earthquake].



915 *contempo si è venuto ad elevare il letto del torrente, sicché le acque scorrendo non più a cascata ma*  
916 *placidamente, non potranno più scalzare la terra e produrre ulteriori franamenti». [After completion of*  
917 *the works, all the dangers were removed and at the same time the stream bed has been raised, so that*  
918 *the water flowing not on cascade, but quietly, can no longer undermine the land producing further*  
919 *landslides], and the Council «considerato che l'opera lunga e difficoltosa del Pagliuca è riuscita*  
920 *egregiamente, tanto da meritare l'approvazione della intera cittadinanza» [considering that the long*  
921 *and difficult work of Pagliuca was perfectly successful, as to deserve the approval of the entire citizenry]*  
922 *unanimously decreed the remuneration of L. 150.00.*

923

924 *Floods and landslides on January 1895*

925 «*Gennaio 1a Decade: Benevento – Decade eccezionale. Il 1° giorno vi fu pioggia nella notte*  
926 *antecedente; i giorni 2 e 3 brina e gelo, il 4 brina, gelo e nevicata, il 5 temporale con pioggia, massima*  
927 *temperatura al mattino, il 6 temporale con pioggia e grandine, il 7 temporale con pioggia, l'8 temporale*  
928 *con pioggia e grandine, la notte dell'8 al 9 vari temporali con pioggia diretta e grandine. Nella*  
929 *medesima notte vi fu grande inondazione nell'agro di Benevento per effetto delle nevi sciolte nonché*  
930 *delle frane, con qualche vittima umana; Guardia Sanframondi – Il 4-10 pioggia (mm 153,5). Il 5-7, 9 e*  
931 *10 neve; in media cm 40; il 5, 6 e 8 temporali con grandine...Il fiume Calore, stante le acue copiose, ha*  
932 *straripato senza fare però molti danni; la piena è giunta alla stazione di Telese»<sup>12</sup>. [January 1<sup>st</sup> Decade:*  
933 *Benevento - exceptional Decade. On January 1<sup>st</sup> rain occurred in the preceding night; on January 2<sup>nd</sup>*  
934 *and 3<sup>rd</sup> rime and frost, on January 4<sup>th</sup> rime, frost and snowfall, on Jan. 5<sup>th</sup> storm with rain, maximum*  
935 *temperature recorded in the morning, on January 6<sup>th</sup> storm with rain and hail, on January 7<sup>th</sup>*  
936 *thunderstorm with rain, on Jan. 8<sup>th</sup>, thunderstorm with rain and hail, on the night between January 8<sup>th</sup>*  
937 *and January 9<sup>th</sup> several storms with heavy rain and hail. On the same night a significant flood in the*  
938 *countryside of Benevento occurred as a result of snow melting and in addition also landslides occurred,*  
939 *causing some casualties; Guardia Sanframondi – From January 4<sup>th</sup> to January 10<sup>th</sup> rainfall (153.5 mm).*  
940 *From January 5<sup>th</sup> to January 7<sup>th</sup>, January 9<sup>th</sup> and January 10<sup>th</sup> snow; 40 cm on average; on January 5<sup>th</sup>,*  
941 *January 6<sup>th</sup> and January 8<sup>th</sup> thunderstorms with hail ... The Calore river, given the abundant waters,*  
942 *flooded without causing, however, much damage; the flooding river reached the Telese station].*

943

944 *The flood on October 7<sup>th</sup>, 1899*

945 November 7<sup>th</sup> 1899: the Council presided by the mayor Giovanni Nista «*in seduta pubblica*» [in public  
946 session], deliberated «*in ordine alla ricostruzione dei ponti in legno sul torrente Tammarecchia e su*  
947 *quello delle Pescolle, nelle località denominate Madonna del Carmine, Casale e Monaconi. Che detti*  
948 *ponti, rovinati e travolti dall'alluvione del 7 Ottobre ultimo scorso, si rendono indispensabili, poiché*  
949 *per essi si accede ai limitrofi Comuni di S. Croce del Sannio (Capoluogo del Mandamento), di*  
950 *Cercemaggiore e di Riccia.» [about the reconstruction of wooden bridges over the Tammarecchia and*  
951 *Pescolle creeks, in the localities called Madonna del Carmine, Casale and Monaconi. That these bridges,*  
952 *damaged and overwhelmed by the flood of the last October 7<sup>th</sup>, are indispensable, because they*  
953 *provide access to the neighboring municipalities of Santa Croce del Sannio (Capital of the District),*  
954 *Cercemaggiore and Riccia.].*

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<sup>12</sup>Rivista Meteorico-Agraria, Ufficio Centrale di Meteorologia e Geodinamica, 1 (year 16), 10. (in Italian)

955 The Council considered a «*necessità indispensabile*» [indispensable necessity] the reconstruction of  
956 bridges «*senza dei quali i torrenti suddetti non sono guadabili nei giorni di piena*» [without which the  
957 above mentioned streams are not fordable in the days of flood] and, unanimously, decided of  
958 contributing «*per la somma di L. 100.00*» [for the amount of L. 100.00] since to the rest of the spending  
959 «*contribuiranno volenterosi cittadini, che già si sono quotati per discrete offerte.*»<sup>13</sup> [will contribute  
960 willing citizens, who are already listed for discrete offerings].

961 During the same session, as already mentioned about the landslides that threatened the stability of  
962 the ancient village of Castelpagano, it was determined that «*a tempo opportuno*» [in due time], poplars  
963 and willows were planted along the banks of streams<sup>14</sup>, planting that, being almost winter, was  
964 postponed to the the following spring, when they other impelling public works consequently the flood  
965 damages were approved. In fact, the following year, on June 10<sup>th</sup>, 1900, the Council presided by the  
966 elder Councillor Antonio Pinto, being sick the mayor Giovanni Nista, decided «*in ordine ai restauri*  
967 *definitivi occorrenti al ponte rotto del torrente dei Torti, lungo la rotabile Castelpagano-Colle.*» [about  
968 the final restorations needed by the broken bridge of the Torti stream, along the Castelpagano-Colle  
969 road.]. The Chairman of the assembly exhibited «*un dettaglio redatto dai muratori Carolla Giovanni e*  
970 *Vetere Salvatore, da cui risulta che la spesa relativa ascende a L. 346,30, e ciò perché la calce e l'arena*  
971 *risultano acquistate*» [a written detail by masons Carolla Giovanni and Vetere Salvatore, showing that  
972 the spending amount ascends to L. 346.30, because the lime and the sand are purchased]. The Council,  
973 considering the aforementioned masons «*notoriamente idonei*» [notoriously suited], unanimously  
974 resolved «*che i cennati restauri del ponte sui Torti si eseguano in economia, a cura e responsabilità dei*  
975 *muratori Vetere e Carolla, e sotto la vigilanza quotidiana del Consiglieri Comunali, i quali per turno*  
976 *assisteranno ai lavori.*»<sup>15</sup> [that the mentioned restoration works of the bridge on Torti are executed in  
977 economics, edited and under responsibilities of masons Vetere and Carolla and masons, and under  
978 the daily supervision of the Municipal Councilors, who in turn will assist in the work].

979 For sure, the flood on 1899 was very devastating, since in the Council of November 3<sup>rd</sup>, 1900 it was still  
980 debated, when Antonio Di Pinto, again mayor, believed necessary to ask for «*un sussidio governativo*  
981 *nella misura del 50% per i restauri a farsi alle cennate opere*» [a government subsidy covering 50% of  
982 spending for the restorations that have to be done to the aforementioned works], that is the  
983 Castelpagano-Colle Sannita road, along which, as previously said, the bridge over the Torti stream had  
984 been seriously damaged. But it was necessary to appoint an engineer «*che dovrà compilare*  
985 *urgentemente i progetti delle opere danneggiate dalle alluvioni dell'ultimo trimestre 1899; e ciò*  
986 *affinché il Comune non perda il diritto di ottenere il sussidio.*» [who must urgently compile the projects  
987 of works damaged by floods on last quarter of 1899; so that the Municipality does not lose the right to  
988 get the subsidy]. It was designated «*l'ingegnere Sig. Paolucci Giovanni fu Francesco, da Colle Sannita,*  
989 *il quale essendo di un paese vicinissimo al nostro, potrà nel più breve tempo compilare i detti*  
990 *progetti.*»<sup>15</sup> [the engineer Mr Paolucci Giovanni fu Francesco, from Colle Sannita, who, coming from a  
991 country very close to ours, will be able to compile those projects in the shortest time].

992

993 *The torrential and continuous rainfall on December 1899*

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<sup>13</sup>Folder n. 31, Extracts from the registry of deliberations, 1899. (in Italian)

<sup>14</sup>Folder n. 31, Extracts from the registry of deliberations: Planting of poplars and willows along the stream banks, 1899. (in Italian)

<sup>15</sup>Folder n. 31, Original council deliberations, 1900. (in Italian)

994 December 12<sup>th</sup> and 13<sup>th</sup>: intense and continuous rains, flooding rivers in Benevento; heavy rainfall in  
995 Avellino and Campobasso «*Dicembre 2a Decade: Benevento – Piovisi i giorni 12-15 e 20; nebbioso il*  
996 *18; misti gli altri. SW forte nel pomeriggio e sera del 12 e 15; nel resto della decade dominarono venti*  
997 *deboli e debolissimi del terzo quadrante. Il 13 straripamento dei fiumi e minima temperatura alla sera.*  
998 *I lavori campestri sono interrotti, causa le continue piogge; S. Agata dei Goti – Pioggia i giorni 12-17 e*  
999 *20 (mm 166). Coperti 5, misti 5, brina l'11 e il 18. Neve ai monti il 12 e 17. Ghiaccio l'11. Temporalì in varie*  
1000 *ore del giorno 12»<sup>16</sup>. [December 2<sup>nd</sup> Decade: Benevento - rainy were the days from December 12<sup>th</sup> to*  
1001 *December 15<sup>th</sup> and the day December 20<sup>th</sup>; foggy on December 18<sup>th</sup>; Mixed were the others. Strong*  
1002 *wind from SW in the afternoon and the evening on December 12<sup>th</sup> and on December 15<sup>th</sup>; in the rest*  
1003 *of the decade weak and very weak winds from the third quadrant dominated. On December 13<sup>rd</sup> floods*  
1004 *of rivers and minimum temperature at night. Due to the continuous rains, the field works are*  
1005 *interrupted; St. Agata dei Goti - Rain from December 12<sup>th</sup> to December 17<sup>th</sup> and on December 20<sup>th</sup> (166*  
1006 *mm). Cloudy was December 5<sup>th</sup> , mixed was Dec. 5<sup>th</sup> , frost on Dec. 11<sup>th</sup> and Dec. 18<sup>th</sup>. Snow on the*  
1007 *mountains on December 12<sup>th</sup> and December 17<sup>th</sup>. Ice on December 11<sup>th</sup> day. Thunderstorms on Dec.*  
1008 *12<sup>th</sup> in various hours].*

1009

#### 1010 *The thunderstorms and floods on January 1900*

1011 January 28<sup>th</sup>: thunderstorm with hail; from January 29<sup>th</sup> to January 31<sup>st</sup>: heavy rainfall, rivers flooding  
1012 campaigns in Benevento; heavy rainfall, landslides in Ariano Irpino; abundant rainfall, widespread  
1013 landslides, torrents floods at Zungoli. «*Gennaio 3a Decade: Benevento – Piovisi i giorni 25, 28-31;*  
1014 *interamente coperti il 21 e 28-31; misti gli altri. Dominò il vento del primo quadrante, che fu forte il 22*  
1015 *e 27. Il 28 nevicata sui monti vicini; temporale con SW fortissimo ed alle 15,15 grandine. Il 30 vi fu*  
1016 *minima temperatura alla sera. Causa le abbondanti piogge vi è stato straripamento dei fiumi con*  
1017 *inondazione delle campagne. Tutti lavori agricoli sono stati sospesi; Ariano Irpino – Giorni con pioggia*  
1018 *sei (mm 145,8). A causa delle nevi e della pioggia cadute nelle decade, sono avvenuti molti*  
1019 *frammenti»<sup>17</sup>. [January 3<sup>rd</sup> Decade: Benevento - rainy the January 25<sup>th</sup>, and from January 28<sup>th</sup> to Jan.*  
1020 *31<sup>st</sup>; cloudy on January 21<sup>st</sup> and from January 28<sup>th</sup> to January 31<sup>st</sup>; mixed the other days. The wind from*  
1021 *the the first quadrant dominated, which was strong on January 22<sup>nd</sup> and on January 27<sup>th</sup>. On January*  
1022 *28<sup>th</sup> snow on the nearby mountains; thunderstorm with very strong wind from SW and hail at 15.15. On*  
1023 *January 30<sup>th</sup> there was minimum temperature at night. Due to the abundant rainfall the campaigns*  
1024 *were flooded by rivers. All agricultural works were suspended; Ariano Irpino - six days with rain (145.8*  
1025 *mm). Because of the snow and rain falls, many landslides occurred in the decade].*

1026

#### 1027 *The flood on September 1921*

1028 Since we have not found further news about the hypothetical flood occurred on 1910, which was  
1029 discussed in the session of December 28<sup>th</sup>, except those reported above referring to the landslide  
1030 affecting the southern side of the Castelpagano village, favoring the decision to subject «*a vincolo*  
1031 *forestale tutti i fondi che si trovano lungo le due sponde del torrente denominato della Terra, dalla*  
1032 *contrada Mandra a San Marco fin oltre il Toppo Telesino» [to forest protection all the territories that*

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<sup>16</sup>Rivista Meteorico-Agraria, Ufficio Centrale di Meteorologia e Geodinamica, Roma, 35 (year 20), 703-705. (in Italian)

<sup>17</sup> Rivista Meteorico-Agraria, Ufficio Centrale di Meteorologia e Geodinamica, Roma, 35 (year 20), 703-705. (in Italian)

1033 are located along the two banks of the so-called Terra creek, from Mandra district to San Marco, until  
1034 beyond the Toppo Telesino] and to proceed with a new planting of poplars and willows, one should  
1035 arrive up to 1921 to find news about another severe flood. That year, 1921, July 24<sup>th</sup>, the Municipal  
1036 Council on the proposal of mayor Nicola De Matteis had approved the purchase by the Cassa Rurale  
1037 [Rural fund], at the price of 225 L., for «*tutto il materiale pietroso esistente innanzi la casa recentemente*  
1038 *costruita dalla stessa*» [all the existing stony material before the house recently built by the same] in  
1039 order to «*provvedere all'imbrecciamento della rotabile che attraversa l'abitato, e propriamente del*  
1040 *tratto Pozzo a Monte, reso veramente in stato intrafficabile*» [provide for paving the road that crosses  
1041 the village, particularly in the tract Pozzo a Monte, really rendered not trafficable]. The rubble was piled  
1042 near the parish church waiting to proceed to the paving, but the work was not carried out because the  
1043 month later a devastating flood occurred in the mid or end of August. It has been reported by the  
1044 council session of, September 10<sup>th</sup>, 1921 in whose agenda the topic being discussed was: «*Urgenti lavori*  
1045 *da eseguirsi per riparazioni alle strade Via Mentana e Pozzo a Monte.*»<sup>18</sup> [Urgent works to be made for  
1046 repairs the Via Mentana and Pozzo a Monte roads.]  
1047 The Mayor referred «*che le acque che provengono dalla parte superiore dell'abitato e che si*  
1048 *raccogliono nella via Mentana e poscia scaricano nell'altra detta Pozzo a Monte, le hanno rese*  
1049 *impraticabili, ed hanno travolto e portato fuori dall'abitato tutto il brecciamme di cui erano ricoperte. Le*  
1050 *cunette debbono essere rifatte in modo da guidare le acque nel Torrente Pidocchioso ove nessun*  
1051 *danno possono arrecare alle strade interne che attraversano l'abitato.*» [that the waters coming from  
1052 the upper part of the village and which gather in the via Mentana and afterwards are discharged in the  
1053 other called Pozzo a Monte, made them impassable, and overwhelmed and taken outside the village  
1054 all the stones of which they were covered. The road ditches have to be redone so driving the water  
1055 toward the Pidocchioso creek, where no damage they can cause to internal roads running through the  
1056 village]. The mayor concluded by proposing to provide for extra works «*col mezzo di una contribuzione*  
1057 *popolare proporzionata obbligatoria per cui dovrebbe essere compilato un analogo Ruolo*  
1058 *(sottintendere: di tassazione)*» [by means of a popular proportionate mandatory contribution for which  
1059 a similar Role (implying: taxation) should be compiled]. Of course, the Council approved.  
1060 The rubbles transported by the flood water accumulated in large quantities near the parish church and  
1061 they were removed on 1922, April. Then with the stones piled near the church, purchased by the «*Cassa*  
1062 *Rurale*» [Rural Fund], the pavement of Pozzo a Monte Street was carried out (modern Umberto I Square  
1063 and Umberto I Street).  
1064  
1065 *The 2<sup>nd</sup> flood on October, 1921: repair of the wooden footbridge over the Tammarecchia creek*  
1066 Also in that year 1921, a couple of months after the occurrence of the just narrated flood, the  
1067 Castelpagano village was hit by a second meteorological event perhaps of similar intensity, as reported  
1068 in the Resolution of the Council of 20<sup>th</sup> November, in which session the mayor Nicola De Matteis told  
1069 to the councilors Rocco Cricca and Alfonso Maselli «*che a seguito di un alluvione dell'ottobre u.s. la*  
1070 *passerella a legno nel Torrente Tammarecchia venne danneggiata e fa mestieri ripararla per renderla*  
1071 *transitabile, onde comunicare col capo luogo del mandamento, e con altri paesi limitrofi, ove questi*  
1072 *naturali svolgono la loro vita commerciale.*» [that, following the October flood, the wooden footbridge

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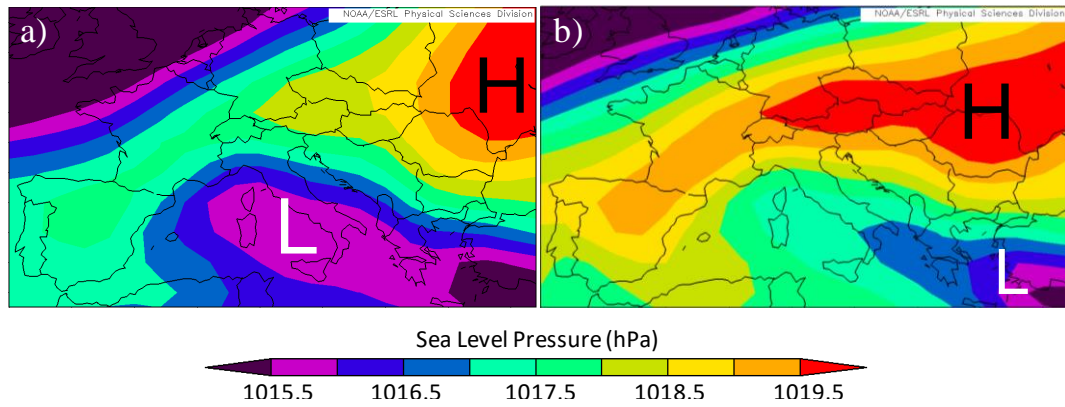
<sup>18</sup>Folder n. 35, *Extracts from the registry of deliberations, 1920-1921*. The old Pozzo a Monte Street corresponds to the modern Umberto I Square and Umberto I Street, both hit by a recent flood occurred on October 19<sup>th</sup>, 2015. (in Italian)

1073 over the Tammarecchia creek was damaged and is necessary to repair it to make it passable, in order  
1074 to communicate with the main town of the district, and with other neighboring countries, where trade  
1075 life take place.] Therefore he invited the Council to provide for payment, and the Council «*portato*  
1076 *attento esame sulla nota stessa*» [after careful examination of the same note] approved the spending.

1 Figures

2

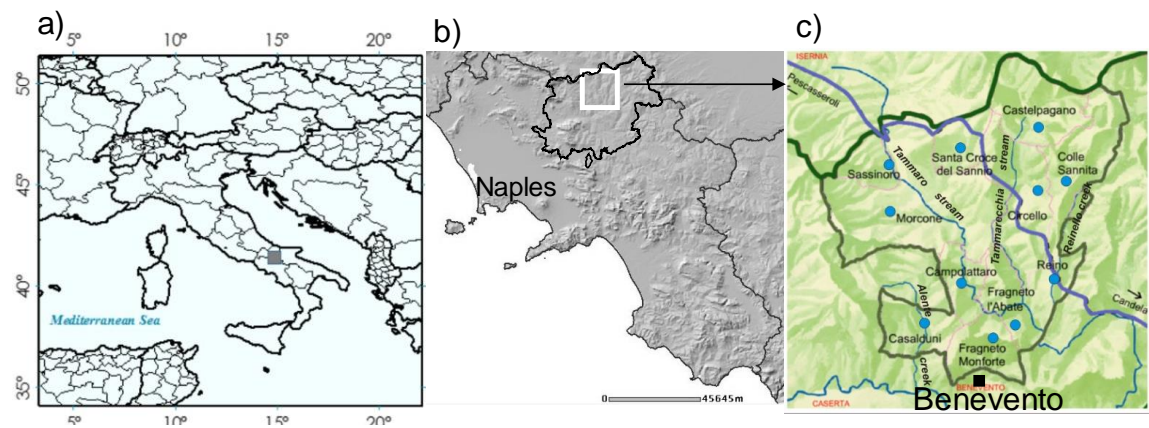
3 Figure 1



4

5

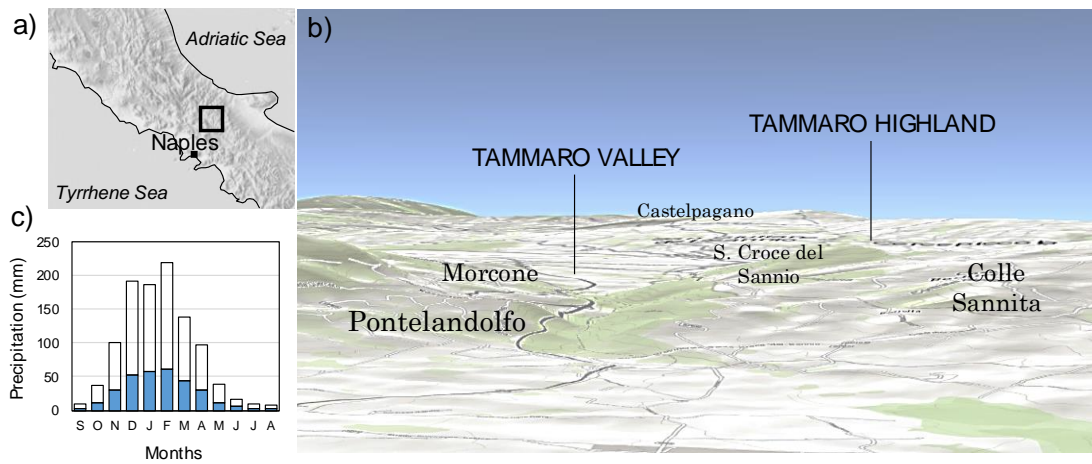
6 Figure 2



7

8

9 Figure 3

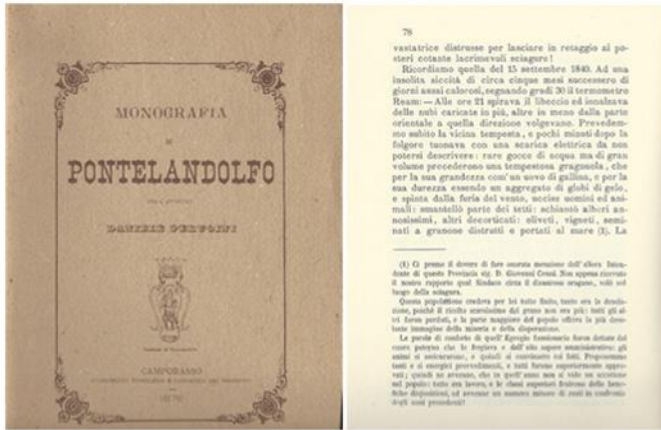


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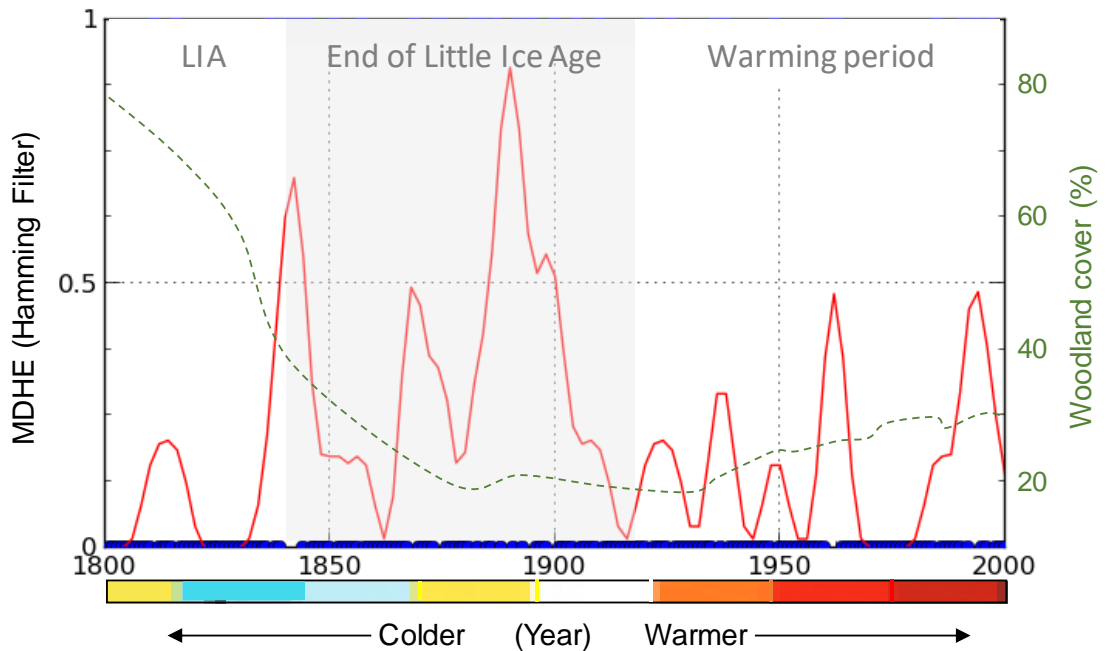
12 Figure 4

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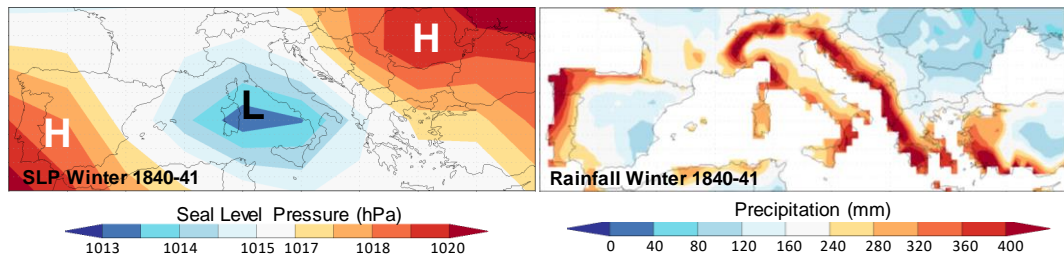
25 Figure 5



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27

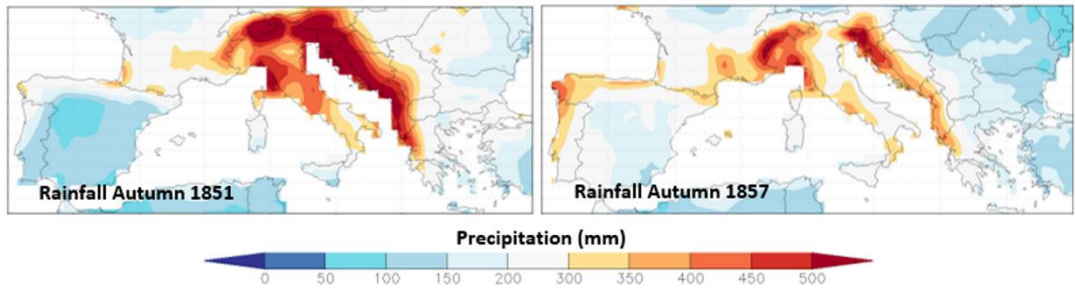
28 Figure 6



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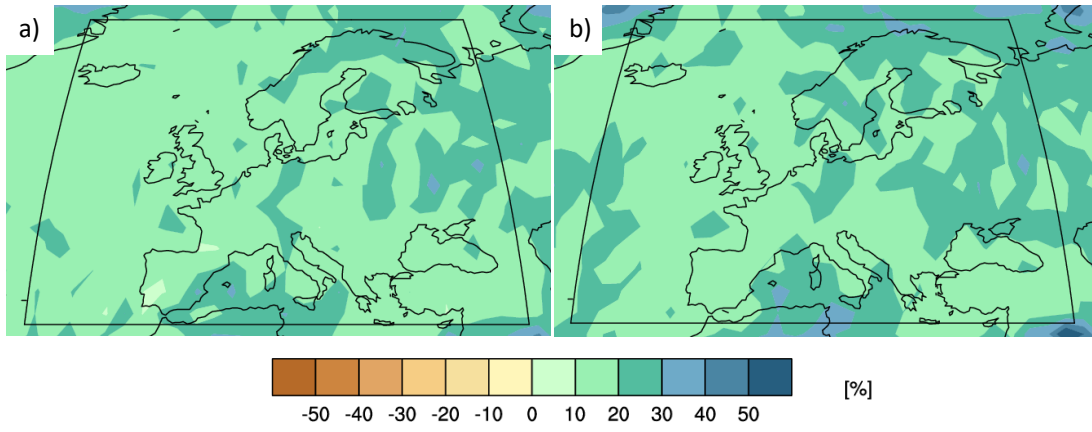
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31 Figure 7



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Figure 8



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