Historical Flood Trends in Europe

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HISTORICAL FLOOD TRENDS IN EUROPE

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Knowledge of the past is an important ingredient of any recipe for accurately predicting the future. If one desires to know how flood characteristics might change if the Earth continues its post-Little Ice Age warming, for example, it would be advisable to determine how these flood properties may have changed during prior periods of warming and/or cooling in Earth's history. Hence, we here review several studies of this nature based on data collected in Europe.

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> *And that perspective clearly shows that even greater floods occurred repeatedly during the Little Ice Age, which was the coldest period of the current interglacial.*

FRANCE

On the 8th and 9th of September 2002, extreme flooding of the Gardon River in southern France occurred as approximately half an average year's rainfall was received in approximately twenty hours, which flooding claimed the lives of a number of people and caused much damage to towns and villages situated adjacent to its channel. The event elicited much coverage in the press; and, in the words of Sheffer *et al*. (2003a)[1], "this flood is now considered by the media and professionals to be 'the largest flood on record'," which record extends all the way back to 1890.

Coincidently, Sheffer *et al*. were in the midst of a study of prior floods of the Gardon River when the "big one" hit; and they had data spanning a much longer time period against which to compare its magnitude. Based on that data as presented in their paper, they reported that "the extraordinary flood of September 2002 was not the largest by any means," noting that "similar, and even larger floods have occurred several times in the recent past," with three of the five greatest floods they had identified to that point in time occurring over the period AD 1400-1800 during the Little Ice Age. Commenting on these facts, Sheffer *et al*. stated that "using a longer time scale than human collective memory, paleoflood studies can put in perspective the occurrences of the extreme floods that hit Europe and other parts of the world during the summer of 2002." And that

[1] http://www.co2science.org/articles/V6/N15/C2.php.

perspective clearly shows that even *greater* floods occurred *repeatedly* during the Little Ice Age, which was *the coldest period of the current interglacial*.

Working in the same region five years later, Sheffer *et al*. (2008)[2] analyzed geomorphic, sedimentologic and hydrologic data associated with both historical and late Holocene floods from two caves and two alcoves of a 1600-meter-long stretch of the Gardon River, which analysis they hoped would provide a longer and better-defined perspective on the subject. And so it did, as they discovered that "at least five floods of a larger magnitude than the 2002 flood occurred over the last 500 years," all of which took place, as they describe it, "during the Little Ice Age." In addition, they note that "the Little Ice Age has been related to increased flood frequency in France (Guilbert, 1994; Coeur, 2003; Sheffer, 2003; Sheffer *et al*., 2003a,b; Sheffer, 2005), and in Spain (Benito *et al*., 1996; Barriendos and Martin Vide, 1998; Benito *et al*., 2003; Thorndycraft and Benito, 2006a,b)."

Also working in France were Renard *et al*. (2008)[3], who employed four different procedures for assessing field significance and regional consistency with respect to trend detection in both high-flow and low-flow hydrological regimes of French rivers, using daily discharge data obtained from 195 gauging stations having a minimum record length of 40 years. In doing so, they determined that "at the scale of the entire country, the search for a generalized change in extreme hydrological events through field significance assessment remained largely inconclusive." In addition, they discovered that at the smaller scale of hydro-climatic regions, there were also no significant results for most such areas.

Introducing their study of the subject, Wilhelm *et al*. (2012)[4] write that "mountain-river floods triggered by extreme precipitation events can cause substantial human and economic losses (Gaume *et al*., 2009)," and they say that "global warming is expected to lead to an increase in the frequency and/or intensity of such events (IPCC, 2007), especially in the Mediterranean region (Giorgi and Lionello, 2008)." However, they caution that "reconstructions of geological records of intense events are an *essential tool* for extending documentary records beyond existing observational data and thereby building a *better understanding* of how local and regional flood hazard patterns evolve in response to changes in climate [italics added for emphasis]."

In an effort to obtain this "better understanding," Wilhelm *et al*. analyzed the sediments of Lake Allos, a 1-km-long by 700-m-wide high-altitude lake in the French Alps (44°14'N, 6°42'35"E), by means of both seismic survey and lake-bed coring, carrying out numerous grain size, geochemical and pollen analyses of the sediment cores they obtained in conjunction with a temporal context derived using several radionuclide dating techniques. In doing so, the thirteen researchers, all hailing from France, report that their investigations revealed the presence of some 160 graded sediment layers over the last 1400 years; and they indicate that comparisons of the most recent of these layers with records of historic floods suggest that the sediment layers are indeed representative of significant floods that were "the result of intense meso-scale precipitation events." Of special interest to the discussion at hand is their finding of "a low

2 http://www.co2science.org/articles/V11/N41/C2.php.
3 http://www.co2science.org/articles/V11/N50/C2.php.
4 http://www.co2science.org/articles/V15/N43/C3.php.

flood frequency during the Medieval Warm Period and more frequent and more intense events during the Little Ice Age," which meshes nicely with the results of an analysis of a Spanish lake sediment archive that allowed Moreno *et al*. (2008) to infer that "intense precipitation events occurred more frequently during the Little Ice Age than they did during the Medieval Warm Period."

Wilhelm *et al*. additionally state that "the Medieval Warm Period was marked by very low hydrological activity in large rivers such as the Rhone (Arnaud *et al*., 2005; Debret *et al*., 2010), the Moyenne Durance (Miramont *et al*., 1998), and the Tagus (Benito *et al*., 2003), and in mountain streams such as the Taravilla lake inlet (Moreno *et al*., 2008)." But of the Little Ice Age, they say that "research has shown higher flood activity in large rivers in southern Europe, notably in France (Miramont *et al*., 1998; Arnaud *et al*., 2005; Debret *et al*., 2010), Italy (Belotti *et al*., 2004; Giraudi, 2005) and Spain (Benito *et al*., 2003), and in smaller catchments (e.g., in Spain, Moreno *et al*., 2008)."

In concluding their report, Wilhelm *et al*. say their study shows that "sediment sequences from high altitude lakes can provide reliable records of flood-frequency and intensity-patterns related to extreme precipitation events," closing with the warning that "such information is required to determine the possible impact of the current phase of global warming." And when this warning is heeded, it is clearly seen that the climate-model-inspired claim that global warming will lead to "an increase in the frequency and/or intensity of such events" - would appear to be just the *opposite* of what is suggested by Wilhelm *et al*.'s *real-world study* and the real-world studies of the other scientists they cite.

In one final, and somewhat different, study from France, Pirazzoli (2000)[5] analyzed tide-gauge and meteorological data over the period 1951-1997 for the northern portion of the Atlantic coast of France, discovering that the number of atmospheric depressions and strong surge winds in this region "are becoming less frequent." The data also revealed that "ongoing trends of climate variability show a decrease in the frequency and hence the gravity of coastal flooding."

GERMANY

Focusing on the region of southwest Germany, Burger *et al*. (2007)[6] reviewed what is known about flooding in this region over the past three centuries. According to the six scientists, the extreme flood of the Neckar River (southwest Germany) in October 1824 was "the largest flood during the last 300 years in most parts of the Neckar catchment." In fact, they say "it was the highest flood *ever recorded* [italics added] in most parts of the Neckar catchment and also affected the Upper Rhine, the Mosel and Saar." In addition, they report that the historical floods of 1845 and 1882 "were among the most extreme floods in the Rhine catchment in the 19th century," which they describe as truly "catastrophic events." And speaking of the flood of 1845, they say it "showed a particular impact in the Middle and Lower Rhine and in this region *it was higher than the flood of 1824* [italics added]." Finally, the year 1882 actually saw *two* extreme floods, one at the end of November and one at the end of December. Of the first one,

5 http://www.co2science.org/articles/V4/N13/C3.php.
6 http://www.co2science.org/articles/V10/N38/C1.php.

Burger *et al*. say that "in Koblenz, where the Mosel flows into the Rhine, the flood of November 1882 was the fourth-highest of the recorded floods, after 1784, 1651 and 1920," with the much-hyped late-20th-century floods of 1993, 1995, 1998 and 2002 *not even meriting a mention*.

In the opening paragraph of their paper, Czymzik *et al*. (2010)[7] write that "assumptions about an increase in extreme flood events due to an intensified hydrological cycle caused by global warming are still under discussion and must be better verified," while noting that some historical flood records indicate that "flood frequencies were higher during colder periods (Knox, 1993; Glaser and Stangl, 2004), challenging the hypothesis of a correlation between the frequency of extreme floods and a warmer climate." Thus, they decided to further explore the relationship between level of warmth and degree of flooding as it may have manifested itself in southern Germany over the past 450 years.

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Working in Lake Ammersee in southern Germany (48°00'N, 11°07'E), which is fed primarily by the River Ammer, Czymzik *et al*. retrieved two sediment cores from the deepest part of the lake in June of 2007 that they analyzed via what they describe as "a novel methodological approach that combines microfacies analyses, high-resolution element scanning (μ-XRF), stable isotope data from bulk carbonate samples (δ^{13}Ccarb, δ^{18}Ocarb), and X-ray diffraction (XRD) analyses (Brauer *et al*., 2009)." Based on these measurements, the six scientists determined that the flood frequency distribution over the entire 450-year time series "is not stationary but reveals maxima for colder periods of the Little Ice Age when solar activity was reduced," while reporting that "similar observations have been made in historical flood time series of the River Main, located approximately 200 km north of Ammersee (Glaser and Stangl, 2004), pointing to a wider regional significance of this finding."

[7] http://www.co2science.org/articles/V14/N6/C2.php.

In the introduction to their empirical study of the hydrology of German rivers, Bormann *et al*. (2011)[8] write that "following several severe floods in Germany during the past two decades, [the] mass media as well as scientists have debated the relative contributions of climate and/or anthropogenic processes to those floods." Driven by a desire to help resolve this climate-change impact debate, the three researchers utilized long time-series of stage and discharge data obtained from 78 river gauges in Germany, searching for trends in flood frequency, peak discharge, peak stage and stage-discharge relationships, where all variables investigated had to have a temporal history on the order of at least half a century.

In doing so, the three researchers first established the nature of Germany's *temperature history*, noting that Schonwiese (1999) identified a homogenous positive trend of 0.5-1.0°C over the course of the 20th century, which was subsequently confirmed by Gerstengarbe and Werner (2008) and Bormann (2010). Then, in terms of *land use change* between 1951 and 1989, they report that "agricultural area in Germany decreased from 57.8% to 53.7%, while forested areas remained almost constant." During this same time period, they report that "impervious areas increased sharply from 7.4% to 12.3%," and they say that "this trend has continued since 1989," with impervious areas further increasing from 11.2% to 13.1%, forest areas increasing from 29.3% to 30.1%, and agricultural area decreasing from 54.7% to 52.5%. And as a consequence of the *net increase in impervious surfaces*, they say that "runoff generation can be expected to increase and infiltration and groundwater recharge decrease," which would be expected to lead to *increases* in river flow and a potential for more frequent and extreme floods. However, they report that "most stations analyzed on the German rivers did not show statistically significant trends in *any* of the metrics analyzed [italics added]."

In light of these several observations -- plus the fact that "most decadal-scale climate-change impacts on flooding (Petrow and Merz, 2009) are small compared to historic peaks in flood occurrence (Mudelsee *et al*., 2006)" -- Bormann *et al*. conclude their report by stating that these significant facts "should be emphasized in the recent discussion on the effect of climate change on flooding." And if this is done, there is no other conclusion to be drawn but that the warming experienced in Germany over the past century has *not* led to unprecedented flooding throughout the country. In fact, it has not led to *any* increase in flooding.

UNITED KINGDOM

Reynard *et al*. (2001)[9] used a continuous flow simulation model to assess the impacts of potential climate and land use changes on flood regimes of the UK's Thames and Severn Rivers; and, as is generally typical of a *model* study, it predicted modest *increases* in the magnitudes of 50-year floods on these rivers when the climate was forced to change as predicted for various global warming scenarios. However, when the modelers allowed forest cover to rise concomitantly, they found that this land use change "acts in the opposite direction to the climate changes and under some scenarios is large enough to fully compensate for the shifts due to climate." To better determine what might actually happen in the *real* world, therefore, it is important to consider how the forested areas of the rivers' catchments might change in the future; and two things come into play here. First, if forests are deemed to be important carbon

[8] http://www.co2science.org/articles/V14/N29/C1.php.
[9] http://www.co2science.org/articles/V4/N19/C3.php.

sinks for which countries may get sequestration credits, and if nations begin to employ them as such, the UK government may well promote the development of new forests on much of the land in question. Second, as the air's CO_2 content continues to rise, there will be a great *natural* impetus for forests to expand their ranges and grow in areas where grasses now dominate the landscape. Consequently, forests may well expand their presence on the river catchments in question and neutralize any *predicted* increases in flood activity in a future high-CO_2 world.

Turning to a *real*-world study, Macklin *et al*. (2005)[10] developed what they described as "the first probability-based, long-term record of flooding in Europe, which spans the entire Holocene and uses a large and unique database of ^{14}C-dated British flood deposits," after which they compared their reconstructed flood history "with high-resolution proxy-climate records from the North Atlantic region, northwest Europe and the British Isles to critically test the link between climate change and flooding." As a result of this multifaceted endeavor, they determined that "the majority of the largest and most widespread recorded floods in Great Britain [had] occurred during cool, moist periods," and that "comparison of the British Holocene palaeoflood series ... with climate reconstructions from tree-ring patterns of subfossil bog oaks in northwest Europe also suggests that a similar relationship between climate and flooding in Great Britain existed during the Holocene, with floods being more frequent and larger during relatively cold, wet periods." In addition, they say that "an association between flooding episodes in Great Britain and periods of high or increasing cosmogenic ^{14}C production suggests that centennial-scale solar activity may be a key control of non-random changes in the magnitude and recurrence frequencies of floods."

An association between flooding episodes in Great Britain and periods of high or increasing cosmogenic ^{14}C production suggests that centennial-scale solar activity may be a key control of non-random changes in the magnitude and recurrence frequencies of floods.

Noting that "recent flood events have led to speculation that climate change is influencing the high-flow regimes of UK catchments," and that "projections suggest that flooding may increase in [the] future as a result of human-induced warming," Hannaford and Marsh (2008)[11] used the UK "benchmark network" of 87 "near-natural catchments" identified by Bradford and Marsh (2003) to conduct "a UK-wide appraisal of trends in high-flow regimes unaffected by human disturbances." This work revealed, in their words, that "significant positive trends were observed in all high-flow indicators ... over the 30-40 years prior to 2003, primarily in the maritime-influenced, upland catchments in the north and west of the UK." *However*, they say "there is little compelling evidence for high-flow trends in lowland areas in the south and east." They also found that "in western areas, high-flow indicators are correlated with the North

10 http://www.co2science.org/articles/V9/N48/C3.php.
11 http://www.co2science.org/articles/V12/N3/C2.php.

Atlantic Oscillation Index (NAOI)," so that "recent trends may therefore reflect an influence of multi-decadal variability related to the NAOI." In addition, they state that longer river flow records from five additional catchments they studied "provide little compelling evidence for long-term (>50 year) trends but show evidence of pronounced multi-decadal fluctuations." Lastly, they add that "in comparison with other indicators, there were fewer trends in flood magnitude," and that "trends in peaks-over-threshold frequency and extended-duration maxima at a gauging station were not necessarily associated with increasing annual maximum instantaneous flow." All things considered, therefore, Hannaford and Marsh concluded that "considerable caution should be exercised in extrapolating from any future increases in runoff or high-flow frequency to an increasing vulnerability to extreme flood events."

SPAIN

"Starting from historical document sources, early instrumental data (basically, rainfall and surface pressure) and the most recent meteorological information," as they describe it, Llasat *et al*. (2005)[12] analyzed "the temporal evolution of floods in NE Spain since the 14th century," focusing particularly on the river Segre in Lleida, the river Llobregat in El Prat, and the river Ter in Girona. This work indicated there was "an increase of flood events for the periods 1580-1620, 1760-1800 and 1830-1870," and they report that "these periods are coherent with chronologies of maximum advance in several alpine glaciers." In addition, it can be calculated from their tabulated data that, for the aggregate of the three river basins noted above, the mean number of what Llasat *et al*. call *catastrophic floods* per century for the 14th through 19th centuries was 3.55 ± 0.22, while the corresponding number for the 20th century was only 1.33 ± 0.33.

In concluding their paper, the four Spanish researchers say "we may assert that, having analyzed responses inherent to the Little Ice Age and due to the low occurrence of frequent flood events or events of exceptional magnitude in the 20th century, the latter did not present an excessively problematic scenario." However, having introduced their paper with descriptions of the devastating effects of the September 1962 flash flood in Catalonia (over 800 deaths), the August 1996 flash flood in the Spanish Pyrenees (87 deaths), as well as the floods of September 1992 that produced much loss of life and material damage in France and Italy, they hastened to add that the more recent "damage suffered and a *perception* [italics added] of increasing vulnerability is something very much alive in public opinion and in economic balance sheets."

Shifting to the area of southeast Spain, Benito *et al*. (2010)[13] reconstructed flood frequencies of the Upper Guadalentin River using "geomorphological evidence, combined with one-dimensional hydraulic modeling and supported by records from documentary sources at Lorca in the lower Guadalentin catchment." The combined palaeoflood and documentary records indicate that past floods were clustered during particular time periods: AD 950-1200 (10), AD 1648-1672 (10), AD 1769-1802 (9), AD 1830-1840 (6), and AD 1877-1900 (10), where the first time interval coincides with the Medieval Warm Period and the latter four time intervals all fall within the confines of the Little Ice Age; and by calculating mean rates of flood occurrence over each of the five intervals, a value of 0.40 floods per decade during the Medieval Warm Period

12 http://www.co2science.org/articles/V9/N51/C3.php.
13 http://www.co2science.org/articles/V13/N19/C2.php.

and an average value of 4.31 floods per decade over the four parts of the Little Ice Age can be determined, which latter value is *more than ten times greater* than the mean flood frequency experienced during the Medieval Warm Period.

Writing as background for their work, Barredo *et al*. (2012)[14] say that "economic impacts from flood disasters have been increasing over recent decades," but they add that "despite the fact that the underlying causes of such increase are often attributed to a changing climate, scientific evidence points to increasing exposure and vulnerability as the main factors responsible for the increase in losses," citing the studies of Pielke and Landsea (1998), Crompton and McAneney (2008), Pielke *et al*. (2008), Barredo (2009, 2010), and Neumayer and Barthel (2011). Ever curious, however - and possibly looking for exceptions - Barredo *et al*. set out to examine "the time history of insured losses from floods in Spain between 1971 and 2008," striving to see "whether any discernible residual signal remains after adjusting the data for the increase in the number and value of insured assets over this period of time." So what did they learn?

The "most salient feature" of Barredo *et al*.'s findings, as they describe it, was "the absence of a significant positive trend in the adjusted insured flood losses in Spain," which suggests, in their words, that "the increasing trend in the original losses is explained by socio-economic factors, such as the increases in exposed insured properties, value of exposed assets and insurance penetration." And they add that "there is no residual signal that remains after adjusting for these factors," so that "the analysis rules out a discernible influence of anthropogenic climate change on insured losses," which they say "is consistent with the lack of a positive trend in hydrologic floods in Spain in the last 40 years."

SWITZERLAND

Schmocker-Fackel and Naef (2010a)[15] investigated how flooding in Switzerland may or may not have responded to the post-Little Ice Age warming of the past century and a half, especially in light of the extreme flooding that occurred there in 1999, 2005 and 2007. To do so, they "analyzed streamflow data from 83 stations with a record length of up to 105 years, complemented with data from historical floods dating back to 1850." Results indicated, according to the two researchers, that "in Switzerland, periods with frequent floods have alternated with quieter periods during the last 150 years," and that "since 1900, flood-rich periods in northern Switzerland corresponded to quiet periods in southern Switzerland and vice versa." They also note that although "three of the four largest large-scale flood events in northern Switzerland have all occurred within the last ten years," they report that "a similar accumulation of large floods has already been observed in the second half of the 19th century," adding that "studies about changes in precipitation frequencies in Switzerland come to similar conclusions," citing the work of Bader and Bantle (2004).

Expanding the temporal view of flooding in Switzerland back a full five centuries, the same duo of authors collected and analyzed historical flood data from fourteen catchments located in northern Switzerland (Schmocker-Fackel and Naef, 2010b[16]) in a contemporaneous publication.

[14] http://www.co2science.org/articles/V16/N4/C1.php.
[15] http://www.co2science.org/articles/V13/N11/C1.php.
[16] http://www.co2science.org/articles/V13/N52/C2.php.

Results of this second work revealed four periods of frequent flooding lasting between 30 and 100 years each (1560-1590, 1740-1790, 1820-1940 and since 1970); and Schmocker-Fackel and Naef report that the first three periods of intervening *low* flood frequency (1500-1560, 1590-1740 and 1790-1810) were found to correspond to periods of low solar activity. However, they add that "after 1810 no relationship between solar activity and flood frequency was found, nor could a relationship be established between reconstructed North Atlantic Oscillation indices or reconstructed Swiss temperatures." In addition, they determined that "the current period of increased flood frequencies has not yet exceeded those observed in the past." And they write that "a comparison with the flood patterns of other European rivers suggests that flood frequencies are not in phase over Europe."

In light of their several diverse findings, Schmocker-Fackel and Naef conclude that "the current period with more floods in northern Switzerland, which started in the mid 1970s, might continue for some decades," even under conditions of "natural climatic variation."

Introducing their study of the subject, Stewart *et al*. (2011)[17] note that "regional climate models project that future climate warming in Central Europe will bring more intense summer-autumn heavy precipitation and floods as the atmospheric concentration of water vapor increases and cyclones intensify," citing the studies of Arnell and Liu (2001), Christensen and Christensen (2003) and Kundzewicz *et al*. (2005). Then, in an exercise designed to assess the reasonableness of these projections, Stewart *et al*. derived "a complete record of paleofloods, regional glacier length changes (and associated climate phases) and regional glacier advances and retreats (and associated climate transitions) ... from the varved sediments of Lake Silvaplana (ca. 1450 BC-AD 420; Upper Engadine, Switzerland)," while indicating that "these records provide insight into the behavior of floods (i.e. frequency) under a wide range of climate conditions."

Based on their analysis, the five researchers report there was "an increase in the frequency of paleofloods during cool and/or wet climates and windows of cooler June-July-August temperatures" and that the frequency of flooding "was reduced during warm and/or dry climates." Reiterating the fact that "the findings of this study suggest that the frequency of extreme summer-autumn precipitation events (i.e. flood events) and the associated atmospheric pattern in the Eastern Swiss Alps was not enhanced during warmer (or drier) periods," Stewart *et al*. acknowledge that "evidence could not be found that summer-autumn floods would increase in the Eastern Swiss Alps in a warmer climate of the 21st century," in contrast to the projections of the regional climate models that have suggested otherwise.

MULTIPLE COUNTRIES

Starkel (2002)[18] reviewed what is known about the relationship between extreme weather events and the thermal climate of Europe during the Holocene. This review clearly demonstrated that more extreme fluvial activity was typically associated with *cooler* time intervals. In recovering from one such period (the Younger Dryas), for example, temperatures in Germany and Switzerland rose by 3-5°C over several decades; and "this fast shift," in Starkel's words, "caused a rapid expansion of forest communities, [a] rise in the upper treeline and

17 http://www.co2science.org/articles/V15/N20/C1.php.
18 http://www.co2science.org/articles/V5/N29/C2.php.

higher density of vegetation cover," which led to a "drastic" reduction in sediment delivery from slopes to river channels.

Mudelsee *et al*. (2003)[19] analyzed historical documents from the 11th century to 1850, plus subsequent water stage and daily runoff records from then until 2002, for two of the largest rivers in central Europe: the Elbe and Oder Rivers. In doing so, they discovered that for the prior 80 to 150 years, which climate alarmists typically describe as a period of unprecedented global warming, there was actually "a decrease in winter flood occurrence in both rivers, while summer floods show[ed] no trend, consistent with trends in extreme precipitation occurrence."

Shortly thereafter, Mudelsee *et al*. (2004)[20] wrote that "extreme river floods have had devastating effects in central Europe in recent years," citing as examples the Elbe flood of August 2002, which caused 36 deaths and inflicted damages totaling over 15 billion U.S. dollars, and the Oder flood of July 1997, which caused 114 deaths and inflicted approximately 5 billion dollars in damages. And they noted that *concern* had been expressed in this regard "in the Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change," wherein it was stated that "current anthropogenic changes in atmospheric composition will add to this risk."

Unconvinced about this contention, the four researchers reevaluated the quality of data and methods of reconstruction that had previously produced flood histories of the middle parts of the Elbe and Oder rivers back to AD 1021 and 1269, respectively; and in doing so, they found, for both the Elbe and Oder rivers, "no significant trends in summer flood risk in the twentieth century," but "significant *downward* [italics added] trends in winter flood risk," which latter phenomenon -- described by them as "a reduced winter flood risk during the instrumental period" -- they specifically described as "a response to regional warming." Hence, their study provided no support whatsoever for the IPCC "concern" that CO_2-induced warming would add to the risk of river flooding in Europe. If anything, their findings suggested just the *opposite*.

> *Consequently, after removing the influence of the stated socio-economic factors, the European Commission researcher says "there remains no evident signal suggesting any influence of anthropogenic climate change on the trend of flood losses in Europe during the assessed period."*

Most recently, based on information on flood losses obtained from the Emergency Events Database and the Natural Hazards Assessment Network, Barredo (2009)[21] developed a 1970-2006 history of *normalized* monetary flood losses in Europe -- including the member states of the European Union along with Norway, Switzerland, Croatia and the former Yugoslav Republic of Macedonia -- by calculating the value of losses that would

[19] http://www.co2science.org/articles/V6/N41/C2.php.
[20] http://www.co2science.org/articles/V8/N1/C2.php.
[21] http://www.co2science.org/articles/V12/N25/C2.php.

have occurred if the floods of the past had taken place under the current socio-economic conditions of the continent, while further removing inter-country price differences by adjusting the losses for purchasing power parities. This work revealed, in the analyst's words, that "there is no evidence of a clear positive trend in normalized flood losses in Europe," and that "changes in population, inflation and per capita real wealth are the main factors contributing to the increase of the original raw losses." Consequently, after removing the influence of the stated socio-economic factors, the European Commission researcher says "there remains no evident signal suggesting any influence of anthropogenic climate change on the trend of flood losses in Europe during the assessed period."

Writing as background for their work, Buntgen *et al*. (2010)[22] correctly indicate that instrumental station measurements, which systematically cover only the last 100-150 years, "hinder any proper assessment of the statistical likelihood of return period, duration and magnitude of climatic extremes," stating that "a palaeoclimatic perspective is therefore indispensable to place modern trends and events in a pre-industrial context (Battipaglia *et al*., 2010), to disentangle effects of human greenhouse gas emission from natural forcing and internal oscillation (Hegerl *et al*., 2011), and to constrain climate model simulations and feedbacks of the global carbon cycle back in time (Frank *et al*., 2010)." In an effort to satisfy these requirements and help facilitate the accomplishment of the associated goals, Buntgen *et al*., as they describe it, "introduce and analyze 11,873 annually resolved and absolutely dated ring width measurement series from living and historical fir (Abies alba Mill.) trees sampled across France, Switzerland, Germany and the Czech Republic, which continuously span the AD 962-2007 period," and which "allow Central European hydroclimatic springtime extremes of the industrial era to be placed against a 1000 year-long backdrop of natural variations." And what did their analysis show?

In the words of the nine researchers, their data revealed "a fairly uniform distribution of hydroclimatic extremes throughout the Medieval Climate Anomaly, Little Ice Age and Recent Global Warming." Such finding, as stated by the authors, "may question the common belief that frequency and severity of such events closely relates to climate mean states," which conclusion represents a rebuke of the claim that global warming will lead to more frequent and severe floods and droughts.

OTHER EUROPEAN COUNTRIES

Norway

Nesje *et al*. (2001)[23] analyzed a sediment core from a lake in southern Norway in an attempt to determine the frequency and magnitude of prior floods in that region. The last thousand years of the record revealed "a period of little flood activity around the Medieval period (AD 1000-1400)," which was followed by a period of extensive flood activity that was associated with the "post-Medieval climate deterioration characterized by lower air temperature, thicker and more long-lasting snow cover, and more frequent storms associated with the 'Little Ice Age'." Hence, this particular study suggests that the post-Little Ice Age warming the Earth has experienced for the last century or two -- and which could well continue for some time to come -- should be

22 http://www.co2science.org/articles/V15/N9/C1.php.
23 http://www.co2science.org/articles/V4/N32/C2.php.

leading this portion of the planet into a period of less extensive flooding as opposed to the more extensive flooding that is typically predicted by climate alarmists to occur most everywhere on Earth in response to warming.

Finland

According to Korhonen and Kuusisto (2010)[24], "annual mean temperatures in Finland increased by about 0.7°C during the 20th century," citing Jylha *et al*. (2004), while noting that under such a warming regime, "both droughts and floods are expected to intensify." In a study designed to explore the soundness of this contention, the two Finnish researchers analyzed long-term trends and variability in the discharge regimes of both regulated and unregulated rivers and lake outlets in Finland up to the year 2004, using data supplied by the Finnish Environment Institute.

This analysis revealed that as "winters and springs became milder during the 20th century ... the peak of spring flow has become 1-8 days earlier per decade at over one-third of all studied sites." *However*, they say that "the magnitudes of spring high flow have not changed." On the other hand, low flows, in their words, "have increased at about half of the unregulated sites due to an increase in both winter and summer discharges." Nevertheless, they indicate that "statistically significant overall changes have not been observed in mean annual discharge." Thus, in contrast to typical global warming projections, at the *high* end where *flooding* may occur, there has been *no change* in the magnitude of flows that can lead to that unwelcome phenomenon for the region examined. And at the *low* end, where *droughts* may occur, there has actually been an *increase* in flow magnitude; and that increase either acts to *prevent* or leads to *less frequent* and/or *less severe* episodes of this other unwelcome phenomenon.

Slovakia

Working in the Myjava Hill Land of Slovakia, which is situated in the western part of the country near its border with the Czech Republic, Stankoviansky (2003)[25] employed topographical maps and aerial photographs, field geomorphic investigation, and the study of historical documents, including those from local municipal and church sources, to determine the spatial distribution of gully landforms and the temporal history of their creation. These diverse efforts led to his discovery that "the central part of the area, settled between the second half of the 16th and the beginning of the 19th centuries, was affected by gully formation in two periods, the first between the end of the 16th century and the 1730s and the second roughly between the 1780s and 1840s." Stankoviansky determined that these gullies were formed "during periods of extensive forest clearance and expansion of farmland," but he reports that "the triggering mechanism of gullying was *extreme rainfalls during the Little Ice Age* [italics added]." More specifically, he writes that "the gullies were formed relatively quickly by repeated incision of ephemeral flows concentrated during extreme rainfall events, which were clustered in periods that correspond with known climatic fluctuations during the Little Ice Age." Subsequently, from the mid-19th century to the present, he reports "there has been a decrease in gully growth because of the afforestation of gullies and ***especially*** *climatic improvements since the termination of the Little Ice Age* [bold and italics added]."

[24] http://www.co2science.org/articles/V14/N9/C1.php.
[25] http://www.co2science.org/articles/V12/N12/C2.php.

Sweden

Lindstrom and Bergstrom (2004)[26] analyzed runoff and flood data from more than 60 discharge stations scattered throughout Sweden, some of which provided information stretching as far back in time as the early to mid-1800s, when Sweden and the world were still experiencing the cold of the Little Ice Age. This analysis led them to discover that the last 20 years of the past century were indeed unusually wet, with a runoff anomaly of +8% compared with the century average. But they also found that "the runoff in the 1920s was comparable to that of the two latest decades," and that "the few observation series available from the 1800s show that the runoff was even higher than recently." In addition, they determined that "flood peaks in old data [were] probably underestimated," which "makes it difficult to conclude that there has really been a significant increase in average flood levels." Also, they say that "no increased frequency of floods with a return period of 10 years or more, could be determined."

With respect to the generality of their findings, Lindstrom and Bergstrom concluded that conditions in Sweden "are consistent with results reported from nearby countries: e.g. Forland *et al*. (2000), Bering Ovesen *et al*. (2000), Klavins *et al*. (2002) and Hyvarinen (2003)," and that, "in general, it has been difficult to show any convincing evidence of an increasing magnitude of floods (e.g. Roald, 1999) in the near region, as is the case in other parts of the world (e.g. Robson *et al*., 1998; Lins and Slack, 1999; Douglas *et al*., 2000; McCabe and Wolock, 2002; Zhang *et al*., 2001)."

Poland

Cyberski *et al*. (2006)[27] used documentary sources of information (written documents and "flood boards") to develop a reconstruction of winter flooding of the Vistula River in Poland all the way back to AD 988. This work indicated, in their words, that winter floods "have exhibited a decreasing frequency of snowmelt and ice-jam floods in the warming climate over much of the Vistula basin." In addition, they report that the work of Pfister (2005) indicates that most of Central Europe has also become less *drought*-prone in winter during the 20th century. Consequently, it would appear that 20th-century global warming has been accompanied by reductions in both floods *and* droughts in much of Central Europe, which is just the *opposite* of model-based projections on *both* counts.

Italy

Diodato *et al*. (2008)[28] undertook a detailed analysis of "the Calore River Basin (South Italy) erosive rainfall using data from 425-year-long series of both observations (1922-2004) and proxy-based reconstructions (1580-1921)." This work revealed pronounced inter-decadal variations, "with multi-decadal erosivity reflecting the mixed population of thermo-convective and cyclonic rainstorms with large anomalies," and they note that "the so-called Little Ice Age (16th to mid-19th centuries) was identified as the stormiest period, with mixed rainstorm types and high frequency of floods and erosive rainfall."

[26] http://www.co2science.org/articles/V7/N26/C2.php.
[27] http://www.co2science.org/articles/V11/N45/C3.php.
[28] http://www.co2science.org/articles/V12/N3/C3.php.

In concluding their paper, the three researchers write that "in recent years, climate change (generally assumed as synonymous with global warming) has become a global concern and is widely reported in the media." And with respect to the concern that both droughts and floods will become both more frequent and more severe as the planet warms, they say *their* study indicates that "climate in the Calore River Basin has been largely characterized by naturally occurring weather anomalies in past centuries (long before industrial CO_2 emissions), not only in recent years," and that there has been a "relevant smoothing" of such events during the modern era.

In summary, and in spite of climate-alarmist claims to the contrary, there do not appear to have been any increases in either floods or properly-adjusted flood damages throughout all of Europe over the past few decades, which climate alarmists contend was the warmest of the past thousand or more years. In fact, real-world data indicate that in many instances, just the *opposite* has occurred.

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