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Preface

"Extreme events induced by weather and climate change: evaluation, forecasting and proactive planning"

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This special issue of Natural Hazards and Earth System Sciences (NHESS) contains eight papers presented as oral or poster contributions in the Natural Hazards NH-1.2 session on "Extreme events induced by weather and climate change: evaluation, forecasting and proactive planning", held at the European Geosciences Union (EGU) General Assembly in Vienna, Austria, on 13–18 April 2008. The aim of the session was to provide an international forum for presenting new results and for discussing innovative ideas and concepts on extreme hydro-meteorological events, including: (i) the assessment of the risk posed by the extreme events, (ii) the expected changes in the frequency and intensity of the events driven by a changing climate and by multiple human-induced causes, (iii) new modelling approaches and original forecasting methods to predict extreme events and their consequences, and (iv) strategies for hazard mitigation and risk reduction, and for a improved adaptation to extreme hydro-meteorological events.

The scope of the session is mirrored in the content of the special issue, which contains papers discussing multiple aspects of extreme hydro-meteorological events, including meteorology, hydrology, and risk assessment and management. In the following, we summarize the content and main results of the eight papers published in the special issue.

Planchon et al. (2009) applied the Hess-Brezowsky classification to identify weather patterns causing heavy winter rainfall in Brittany, France. Identification of rainy air-circulation types was obtained using the objective computational version of the 29-type Hess and Brezowsky Grosswetterlagen system for classifying European synoptic regimes, for the cold season (November–March) of the 1958–2005 period at the weather station of Lorient, and 13 stations located in western and southern Brittany, including a more detailed study for the wet 2000–2001 cold season for three stations in the Scorff watershed. The precipitation proportion (days with cumulated rainfall of at least 20 mm) was calculated by major air-circulation type, and by individual air-circulation subtype, for the studied period. The frequent occurrence of rainy days associated with westerly and southerly circulation types confirmed well-known observations in Western Europe. This result justified the use of the Hess-Brezowsky classification in other areas outside Central Europe. The southern or south-western exposure of the watershed with a hilly inland area enhanced the heavy rainfall generated by the SW and S circulation types, and increased the difference between the rainfall amounts of coastal and inland stations during the wettest days.

Vasiliades et al. (2009) proposed a statistical downscaling model of monthly precipitation to evaluate the impact of climate change on droughts. The model is based on multiple regressions of global circulation model variables with observed precipitation, and on the application of a stochastic time-series model for the simulation of precipitation model residuals. The outputs of the global circulation model CGC-Ma2 for two socio-economic scenarios (SRES A2 and SRES B2) were used. First, a model was calibrated in the Lake Karla watershed, Thessaly, Greece, for the period 1960–1990. Next, the model was validated using observed monthly precipitation measurements for the period 1990–2002 in the same area. Validation revealed that the accuracy and the uncertainty were propagated by the downscaling procedure in the estimation of the Standardized Precipitation Index (SPI), a meteorological drought index.

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Monthly precipitation and SPI were estimated for two future periods, 2020–2050 and 2070–2100. Results indicate that climate change will have a major impact on droughts. Also, the uncertainty associated with the future predictions is large and increases as the time scale of SPI increases.

Gouveia et al. (2009) used the Normalized Difference Vegetation Index (NDVI) and the Soil Water Index (SWI) to monitor the spatial extent, severity and persistence of drought episodes in Portugal. The analysis focused on droughts which occurred during the period 1996–2005. The severity of a drought was determined by evaluating the cumulative impact of drought conditions on the vegetation. During the 1999 and the 2005 drought episodes, negative anomalies of NDVI were observed over large sectors of southern Portugal for periods of up to nine (out of eleven) months of the vegetative cycle. On the contrary, the 2002 drought episode was characterised by negative anomalies in northern Portugal, and for a shorter period (eight out of eleven months) of the vegetative cycle. The impact of soil moisture on vegetation dynamics was evaluated by analysing monthly anomalies of the SWI, and by studying the annual cycle of SWI vs. NDVI. In the 1999 drought episode, the shortage of water in the soil persisted until spring, whereas in the 2005 drought episode the deficit in greenness was already clear at the end of the summer. The impact of dry periods on vegetation was observed in both arable land and forest, with arable land showing a higher sensitivity to the shortage of water.

Georgescu et al. (2009) studied a severe blizzard event in southern Romania to evaluate forecasting and modelling procedures. The event occurred on 2–4 January 2008, and followed a yearlong period of southerly circulation that produced warm weather, with the record-high maximum temperature registered during this period. The event was not modelled correctly by the operational numerical forecasts and cross-comparison numerical simulations were performed to analyse the role of the coupler/coupling models, and to compare two approaches for reducing process-scale uncertainties, namely: (i) forecast range optimization, and (ii) ensemble forecasting. The modelling results confirmed the importance of the physical parameterization, and the relevance of the model horizontal resolution. The results indicated that the quality of the transmitted large-scale information and the choice of an appropriate time scale of the event's physics are essential for capturing the event. Experiments to compare ensemble forecasting versus resolution increase revealed an improved accuracy of the ensemble forecasting approach when applied to correct the minimum skill of the deterministic forecast.

Oprea and Bell (2009) analysed the meteorological conditions during a tornado outbreak which occurred on 7 May 2005 in southern Romania, when three tornadoes were observed around Bucharest. The area affected by wind damage extended to about 150 km. Based on the extent of the damage, one tornado was classified as a F1 type on the Fujita scale, and the other two tornadoes were classified as F0, on the same scale. A vigorous upper level trough provided the large scale forcing required for generating and sustaining the tornados. The squall line developed in the warm sector of a low-pressure field, ahead of the cold front. Data from the Bucharest C-band Doppler radar and a S-band radar were used in the analysis. The combined effects of synoptic and meso-scale circulations were analysed jointly with data provided by C-band and S-band radars, and the ECMWF and ALADIN model outputs.

Petrucci and Polemio (2009) proposed an approach to classify "damaging hydro-geologic events" (DHEs), defined as landslide and flood events caused by heavy or prolonged rainfall. The proposed methodology considered: (i) the meteorological conditions preceding the damaging rainfall event, (ii) the season when the event occurred, (iii) the return period of the maximum daily rainfall that resulted in the damaging event, (iv) the geographical region affected by the event, (v) the type of damaging phenomena, and (vi) the type and extent of the damage. The methodology was tested using time series of DHEs in Calabria, southern Italy, during the period 1921–2005. A total of thirteen DHEs that resulted in landslides and floods, and caused severe damage and multiple causalities, were analysed. Results of the analysis revealed that the most severe damage was caused by persistent rainfall events associated with low-pressure fields in two distinct areas W of Calabria. The analysis also revealed a decreasing frequency of the DHEs in the investigated period, with no extremely severe event in the last fifty years.

Llasat et al. (2009) studied the perception of floods and droughts in Catalonia, Spain, during the period 1982–2006. Newspaper articles were used as a source of information and a computer database was prepared to store the historical data. The number of newspaper articles per event was compared to quantitative (measured) information to identify biases that could lead to erroneous descriptions of the events. The Standardized Precipitation Index (SPI) index was used for drought analysis, and a GIS database with information on flood events in Catalonia during the period 1900–2009 was used for flood analysis. Analysis of the responses to a questionnaire on the impact of natural hazards in two selected areas was exploited to determine the perception of droughts and floods in rural and urban areas. A better correlation was found between the historical information on droughts and water scarcity and the SPI index, than between the historical flood database and the information on floods reported in the newspapers. A positive trend was observed for the non-catastrophic floods. The trend was explained with a decrease of the perception threshold, an increase of the population density in flood-prone areas, and by land use changes.

Seidel et al. (2009) used historical information to reconstruct the meteorological conditions and to simulate flood discharge for the December 1882 flooding event in the Neckar catchment, in Baden-Württemberg, Germany. Historical data obtained from different sources were used for hydrological runoff modelling. To estimate the rainfall pattern associated with the December 1882 event, the sparse historical rainfall information was modified using the precipitation pattern of a recent event. The results of the runoff simulation were compared to the historical data, and to one-dimensional hydraulic simulations prepared using the HEC-RAS hydrological modelling software. Results indicate that the hydro-meteorological conditions of the 1882 flood would lead to a 100-year flood today, and that the run-off characteristics of a 100-year flood have not changed significantly since 1882.

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