Catena 130 (2015) 1–2

Contents lists available at ScienceDirect

Catena

journal homepage: www.elsevier.com/locate/catena

Preface

Past hydrological extreme events in a changing climate

Keywords:
Palaeohydrology
Fluvial records
Palaeofloods
Historical floods
Climate change

Fluvial records contain evidence of past hydrological changes in terms of water/sediment fluxes and extreme hydrological events (floods), which can be linked to Earth's climate variability. Sedimentological records of hydrological extremes can be complemented with historical documentary information and botanical records. In recent years, fluvial and palaeoflood records supported with excellent chronological data have become available for many rivers worldwide (Gregory et al., 2006), but still regional and global palaeohydrological reconstructions and syntheses have yet to be fully developed. Related to the interpretation of alluvial records, a major recent achievement has been the development of new combined analysis of large radiometrically dated fluvial databases, which allow fluvial activity periods to be more precisely defined and to be characterized in terms of forcing hydrological conditions (Macklin et al., 2006). The approach also serves for comparison of records of fluvial activity in different countries, regions and sites with a range of climate proxies and, for the more recent record, land-use change indicators. The meta-analyses demonstrate the value of the growing spatial coverage and increasing chronological precision of fluvial archives for reconstructing past hydrological events, as well as for understanding river response to environmental/climate change in the past and the future.

This special issue brings together a range of papers that reconstruct regional fluvial chronologies of extreme events based on multiple proxies and documentary information, which evaluate the relationship between river hydrology, climate and atmospheric circulation variability. The research presented in this volume was drawn together within the framework of the INQUA Project 1220 on *Hydrological EXtreme Events in Changing Climate* (HEX Events), and the 1st Workshop on HEX Events held at Utrecht University on November 29th–30th, 2012.

The papers in this special issue on "*Past Hydrological Extreme Events in a Changing Climate* (HEX)" fall into three categories:

1. Regional reconstruction of extreme events

Fluvial palaeohydrology aims at reconstructing long-term river regime and the identification of the causes and mechanism of short-term hydrological changes. Regional analysis of extreme hydrological events in different parts of the world can be used to establish inter-basin and inter-regional chronologies of extreme events in relation with climate variability and environmental changes during the Late Pleistocene and Holocene. A major part of the HEX project was devoted to the compilation and analysis of published and unpublished ^{14}C and OSL dates from Holocene fluvial sedimentary sequences. Three papers present results of compiled databases for: (1) Mediterranean region based on dated flood units from the Iberian Peninsula, Southern France, Southern Italy, north-east Morocco, central Tunisia and Eastern Mediterranean (Benito et al., 2015–in this issue); (2) Northeast Italy comprising catchments draining the southern rim of the Eastern Alps (Rossato et al., 2015–in this issue), and (3) The East European Plain comprising data primarily from the central part of Russia (Panin and Matlakhova, 2015–in this issue). These regional chronologies identify centennial to multi-centennial length flooding episodes, which are synchronous within similar hydroclimatic regions and also show a connection with large scale atmospheric circulation mode and other climatic drivers (e.g. solar irradiance).

This type of analysis is only possible for regions with large numbers of radiometrically dated flood units. In other regions, the research has instead been focused on producing local chronologies of fluvial records. A case study of fluvial aggradation at the lower Algeti River (Transcaucasian region) shows its high sensitivity with respect to climate — and human driven vegetation-changes similar to other semi-arid landscapes of the Mediterranean region (von Suchodoletz et al., 2015–in this issue).

2. Methodological guidelines

A major part of the HEX project and its workshop was devoted to stimulate productive discussions amongst the fluvial research community in order to develop methodological guidelines that can be used worldwide to compile fluvial records of extreme events with good dating control. The discussions centred on using meta-analysis of large databases of ^{14}C and OSL dated flood units, as a way for inter-regional and continental comparison of periods with higher/lower frequency and magnitude of extremes with other proxies of climate change. In this special issue, the paper by Jones et al. (2015–in this issue) on "Meta-analysis of Holocene fluvial sedimentary archives: a methodological primer" presents an up-to-date review of this approach and its potential for continental-scale palaeohydrological reconstructions and hydroclimate correlations.

Flood records obtained from sedimentary archives hold enormous promise for extending existing discharge records with application to flood hazard mapping and design of hydraulic structures. In the mountain catchments of the Black Hills, South Dakota, a palaeoflood study based on slackwater flood indicators provide evidence of a highly anomalous flood frequency during the Medieval Climatic Anomaly (A.D. 900–1300), with many flood units containing charcoal from wild fires (Harden et al., 2015–in this issue). These extreme flood events occurred

http://dx.doi.org/10.1016/j.catena.2014.12.001
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during a period of strong regional warming that the authors associated with intense convective storms with moisture source from the Gulf of Mexico, and increased runoff following wildfires and drought conditions.

In lowland and delta systems, reconstruction of flood magnitude based on stage indicators has been difficult due to complications resulting from channel avulsions and the large floodplain widths which suppress elevation differences of stage indicators between normal and rare floods. In the Lower Rhine, historical flood magnitudes of the last 450 years have been reconstructed from grain-size measurements of flood deposits in records obtained from abandoned channel fills and dike breach scour holes (Toonen et al., 2015–in this issue). In the larger floods, after calibrating their ages to known historical events and normalizing grain-size, the coarse tail of the grain-size distribution is used to estimate peak-flood discharges.

3. Integrated research activities

The HEX project was designed to stimulate integrated research activity on extreme hydrological events by groups approaching this from fluvial record and climate record perspectives, with a common objective. A number of the previously cited papers within this special issue fall under this category of integrated research. An intrinsic characteristic of extremes is their capacity to produce significant impacts either on the landscape or on people's memory, which can be transmitted over many generations. However, in the case of some historical extreme the passage of time often results in loss of information and even contradictory records. One of the largest historical floods in central Europe, the millennium flood of July 1342 is revisited by Herget et al. (2015–in this issue). The documentary records are critically analysed for their reliability and how confusion has arisen in previous studies.

The involvement of early-career scientists has been an important part of the HEX project. We acknowledge the financial contribution of INQUA (Project No. 1220P) which made possible the attendance and participation of these young-researchers to the workshop.

Acknowledgements

Sincere thanks are also extended by the guest editors to all those individuals who acted as referees for the papers in this volume, and to Catena Editors Prof. Erik Cammeraat and Prof. Ad de Roo for their comments, guidance and patience during the preparation of this special issue.

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