Riederalp 2018 Workshop on Exposure, vulnerability and resilience of human societies to climate- and weather-related disasters from the Holocene to the Anthropocene

Riederalp, Switzerland, March 20-24, 2018

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Workshop Program

Abstracts Volume

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Workshop on Exposure, Vulnerability and Resilience of Human Societies to Climate- and Weather-Related Disasters from the Holocene to the Anthropocene

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WORKSHOP PROGRAM

(Right-hand column indicates the page of the abstract in the Abstracts Volume below)

	Tuesday, March 20	
Afternoon	**Participants arrive in Riederalp**	
18:30	Icebreaker, followed by supper (around 19:30)	
	Wednesday, March 21	
08:30-09:00	M. Stoffel, F. Ludlow, J. Manning: Welcome by the organizers and meeting objectives.	
	SESSION 1: Concepts, databases and floods	
09:00-09:20	*Rüdiger Glaser, University of Freiburg, Germany* Conceptualisation of Climate Vulnerability and Resilience Through the Ages	
09:20-09:40	*Michael Kahle, University of Freiburg, Germany* Historical and Modern Hermeneutic Information on Climate, Vulnerability and Resilience	
09:40-10:00	*Juan Antonio Ballesteros-Cánovas, University of Geneva, Switzerland* Historical archives reveal recurrent extreme floods that have affected Kashmiri societies over the last millennium	
10:00-10:20	*Libor Elleder, Czech Hydrometeorological Institute, Czech Republic* Flood frequency analysis and vulnerability of human society	
10:20-11:00	Coffee, tea, refreshments	
11:00-11:20	*Gregor Zenhäusern, University Institute for Research on the History of the Alpine Area, Brig, Switzerland* Natural disaster prevention and management in the Valais Alps in the past	
11:20-11:40	*Scott St. George, University of Minnesota, United States* The societal value of historical and paleoflood research in Manitoba, Canada	
11:40-12:00	*Peter Stucki, University of Berne, Switzerland* Historical reconstruction and numerical simulation of an extreme flood in 1868	
12:00-12:30	*Discussions and preparations for the breakout sessions*	
12:30-17:00	Free afternoon for outdoor or indoor activities	
17:30-19:15	**SESSION 2 : OUTBREAK SESSIONS**	
19:30	Evening meal	

	Thursday, March 22
	SESSION 3: Climate change, climate risks and droughts: their impacts on societies
09:00-09:20	*Joseph Manning, Yale University, USA* Risks and Responses to climate change in the ancient world: the case of ancient Egypt
09:20-09:40	*Mario Rohrer, MeteoDat GmbH and University of Geneva, Switzerland* Importance of climate variations on 'Pauperism' in Switzerland and Germany during the mid-19th century
09:40-10:00	*Albert Hafner, University of Berne, Switzerland* Collapse, resilience and mobility in prehistoric agrarian societies. Can we prove relations to weather and climate?
10:00-10:20	*Christian Franzke, University of Hamburg, Germany* Impacts of a Changing Climate on society and economy
10:20-11:00	Coffee, tea, refreshments
11:00-11:20	*Liang Emlyn Yang, Christian-Albrecht University Kiel, Germany* Resilience of the human-water interrelationship at the Southern Silk Road: Evolution of the Northern Catchment of Erhai Lake, China (1382-1912)
11:30-11:40	*Yong Zhang, Chinese Academy of Sciences, Beijing, China* A 2000-yr moisture history in the western Qilian Mountains of northwestern China: Evidence from tree rings
11:40-12:00	*Francis Ludlow, Trinity College Dublin, Ireland* Extreme Weather as a Trigger of Violence and Conflict in Medieval Ireland
12:00-12:20	*Nathan Morrow, Tulane University, Unites States* Armed conflict and environmental protection; GEF insights for security and sustainability
12:30-17:00	Free afternoon for outdoor or indoor activities
17:15-19:00	**SESSION 4: OUTBREAK SESSION**
19:45	Special Conference Dinner (information will be provided during the Workshop...)

	Friday, March 23
	SESSION 5: Natural disasters: assessment, risk and socio-anthropological dimensions
09:30-09:50	*Astrid Wigidal, Germany* The social construction of disaster risk and vulnerability and resilience in the face of hazards in the Greater Everglades ecosystem
09:50-10:10	*Jamie McCaughey, Nanyang Technical University, Singapore* Socio-economic consequences of post-disaster reconstruction in hazard-exposed areas
10:10-10:30	*Dmitry Petrakov, Moscow State University, Russian Federation* Climate change, weather extremes and related hazards in the Caucasus in the early 21st century
10:30-10:50	*Muhammad Sajjad, City University of Hong Kong, Hong Kong (SAR)* Past is key to Future: A Bottom-Up, Place-based approach for Spatial Risk Assessment to support Risk-Informed Planning and Management
10:50-11:30	Coffee, tea, refreshments
	SESSION 6: Volcanic cooling and other weather anomalies and their impact on societies
11:30-11:50	*Sébastien Guillet, University of Geneva, Switzerland* New insights on the climatic and societal impacts of the unidentified 535 CE and 1257 Samalas eruptions in Medieval Europe
11:50-12:10	*Al Matthews, Trinity College Dublin, Ireland* Explosive Volcanism as a Driver of North Atlantic Marine Productivity, Fisheries and Markets, 1400-1850 CE
12:10-12:30	*Nicolas Maughan, Aix-Marseille University, France* Climatic Effects and Agricultural Impacts of the 1815 Tambora Eruption: a European Overview from the Mediterranean to Central Europe
12:30-17:00	Free afternoon for outdoor or indoor activities
17:30-19:00	**SESSION 7: OUTBREAK SESSIONS**
19:30	Evening meal
	Saturday, March 24
	SESSION 8: Final plenary, wrap-up, future work
09:00-10:30	Reports from the breakout sessions
10:30-11:00	Coffee, tea, refreshments
11:00-11:30	The way forward, future work and coordination of decisions taken
11:30-11:45	M. Stoffel, F. Ludlow, J. Manning: Closing remarks from the organizers, farewell
12:00	Close of the meeting
Afternoon	**Participants depart from Riederalp**

VOLUME OF ABSTRACTS

List in order of appearance of the contributions as given in the Workshop Program above

Conceptualisation of Climate Vulnerability and Resilience Through the Ages

Rüdiger Glaser

University of Freiburg, Germany
ruediger.glaser@geographie.uni-freiburg.de

Based on long-term 1000 years reconstructions of climatic variations in Central Europe and their impacts on societies and their coping and adaptation measures, a conceptual framework combining vulnerability and resilience concepts on different climatic, temporal, spatial and social scales is introduced. For selected case studies (marker years) representing the middle ages, the early modern age, the enlightenment, the industrialization and the modern period pathways (chain of cause and effects) are represented, which are triggered by climatic stressors and weather extremes likewise droughts, chilly winters, storm surges and floods. Within these pathways the specific vulnerability of the societies is identified, but also how they coped and adapted to these climatic stressors and how strategies had been developed and how far good or bad governance contributed leading to resilience.
The case studies reveal how vulnerability and resilience had been and still are context dependent through the ages and how their internal dynamic can be understood. The study is based on a number of research projects, in which vulnerability and resilience had been analyzed in historical and modern contexts likewise the Projects DRIeR and Clim´Ability.

The data used for this study is stored within the collaborative research environment (CRE) tambora.org, which is visible and free accessible for interested scientific community, stakeholders and the public.
www.tambora.org

http://www.geographie.uni-freiburg.de/ipg/fdb-projekte?lfdnr=9961&sprache=D&jahr=2017
http://www.geographie.uni-freiburg.de/ipg/fdb-projekte?lfdnr=9858&sprache=D&jahr=2017

Historical and Modern Hermeneutic Information on Climate, Vulnerability and Resilience

Michael Kahle

University of Freiburg, Germany
michael.kahle@geographie.uni-freiburg.de

The project tambora.org emerged from HISKLID, a database focused on historical climatology. Including events regarding weather, phenology and environment as well as impacts and coping strategies of societies, as a Collaborative Research Environment (CRE) tambora.org goes further. As web-based tool it optimizes the workflow in the field of climate and environmental history starting with collecting and reviewing sources such as town chronicles, travel reports, diaries and newspapers. The often handwritten documents are transcribed and, if necessary, translated. The extracted quotes get coded regarding chronology, location and observation. Therefore, a set of hierarchical parameters, indices covering rankable observations and the handling of measurements in ancient and modern units was developed. Well accepted standards ensure comparable data across all projects and guarantees the easy reuse inside and outside the CRE. A comprehensive data collection published inside the

tambora.org data series makes the work visible and citable via DOI. Data can be used in external tools via API or file export.

An increasing number of projects contributing information to tambora.org covering hazards (floods, droughts, cold waves, storms, wild fires, ...), societal and economic impacts (damages, harvest, prices, hunger, migration,...) and institutional reactions (subsidies, charity, warnings, ...) meanwhile leading to more than 350000 events. Further development covers areas like crowd sourcing and citizen science, data mining of recent incidents, mapping of coherences as impact chains, engagement in Pages working groups (Flood, Historical Climatology) for data standardization, extending export formats (i.e. LiPD) and extension of visualization feasibilities.

Historical Archives Reveal Recurrent Extreme Floods that have Affected Kashmiri Societies over the Last Millennium

Juan Antonio Ballesteros-Cánovas

University of Geneva, Switzerland
Juan.Ballesteros@unige.ch

Recent climate-induced extreme events in the Himalayan region have highlighted the large vulnerability of its population. A paradigmatic case is the Kashmir valley, drained by the Jhelum River, and located in northwestern India. This region has recently experienced extreme flood disasters in September 2014 and March 2015 as well as drought conditions in 2017, causing substantial economic losses, fatalities. The event also weakened the region further and gave rise to renewed geopolitical issues. Interestingly, water resources in this valley are managed by the Indus Water Treaty, signed in 1960 between India and Pakistan. This agreement imposes a special management status on the watershed. In this communication, we present a tree-ring based and historical flood reconstruction showing evidence that extreme flood events have frequently occurred in the past. We perform a multiproxy approach based on historical archives, tree-ring records and existing flow measurements in the valley. Then, we apply paleohydrology techniques to reconstruct the magnitude of past flood events and investigate if this information could modify the flood hazard assessment that is so far based exclusively on flow measurements. Historical sources include old records from archives belonging to the Irrigation and Flood Control Department and both Indian and British National Libraries, among others. Our records show as the entire Kashmir valley has severely suffered from extreme flood events in the past, affecting populations and agriculture, thereby triggering socio-economical changes in the region. We also show that the treaty was signed during a period lacking major disasters, which now has consequences on the management of floods. Our study is expected to contribute to a more appropriate definition of risk-based flood scenarios based on real information as well as to improve the tolerance for risk-taking of the Kashmiris societies.

Flood Frequency Analysis and Vulnerability of Human Society

Libor Elleder

Czech Hydrometeorological Institute
elleder@chmi.cz

The presented contribution reflects on the time-series of estimated peak discharges of the Vltava River in Prague in time span of 1118 – 2015. Based on the above data series, a thorough analysis focused on the periods of high frequency of flood events occurrence has been already published. Nevertheless, considering a vulnerability of human society, a different aspect appears to be of key importance. In this contribution, the above time series was used to analyse the time intervals between subsequent extreme peak discharges (Q_{10}, Q_{20}, Q_{50} a Q_{100}). Return period of individual extreme events is in certain connection with the above time interval. Maximal or minimal time span between flood events is actually an important ground for taking the possible future extreme event in consideration by human society. The ability of flood protection is associated with personal awareness and experience with flood extreme, and with willingness to take the future possible extreme into account at all. The flood period and its likely association with solar inertial motion are indicated. In this context, we can speculate, how the next period of "flood unrest" is getting underway.

Natural Disaster Prevention and Management in the Valais Alps in the Past

Gregor Zenhäusern

University Institute for Research on the History of the Alpine Area, Brig, Switzerland
zenhaeusern@stockalperstiftung.ch

As part of various scientific projects «The University Institute for Research on the History of the Alpine Area» in Brig has created a database on the past climate and natural disasters in the Valais Alps (Switzerland). The rich historical source material, collected in different archives of the region, emphasises in particular the vulnerability of the rural communities to weather and climate. Furthermore, it highlights people's considerable efforts towards and measures taken on flood prevention and road maintenance despite the lack of a functioning government administration with regular financial resources during the Ancien Régime. An effective protection against the elements only became possible through the establishment of the «Department of Bridges and Roads» at the beginning of the 19th century with official state budget funds for river engineering and avalanche barriers. Thus, it can be shown that a certain helplessness towards meteorological and para-meteorological phenomena (e.g. droughts or long humid periods) threatening the traditional livelihood prevailed in the pre-industrial society. Natural disasters were often traditionally and religiously interpreted as punishment by God. These interpretations, however, required adequate defence strategies which could be found in the Rituale Romanum (1614), such as for example extraordinary processions of devotion or even ritual ceremonies (evocation of glaciers).

The Societal Value of Historical and Paleoflood Research in Manitoba, Canada

Scott St. George

University of Minnesota, United States
stgeorge@umn.edu

Southern Manitoba is one of the most flood-prone regions in Canada, with the Red River of the North being the cause of most significant floods. The realization that the then-recent 1950 flood disaster was dwarfed by the historical 1826 flood led Canadian government officials to set an unusually high design standard for the Red River floodway, a 48-km long diversion built in the 1960s to protect the provincial capital of Winnipeg. And after paleoflood research confirmed new evidence of the 1826 flood, that event was cited as the main justification for expanding the Red River floodway, a $668 billion CAN infrastructure project that began in 2010. Without these insights from historical and paleoflood research, it's almost certain flood risk estimates would have been unrealistically low and Winnipeg would have adopted a lesser level of flood protection. Because widespread Euro-American settlement in the Pembina Territory (the present-day Red River basin within the United States) did not occur until the 1870s, there are no historical accounts that indicate whether the 1826 flood was also so severe in North Dakota or Minnesota. As a result, the 1997 flood, which was nearly 1.5 times larger than any other previous flood in the US gage record, overwhelmed the dikes protecting Grand Forks and East Grand Forks. By having a deeper understanding of the history of flooding, communities are better able to anticipate future floods, make sound decisions about flood protection and migration, and protect people and their property more effectively.

Historical Reconstruction and Numerical Simulation of an Extreme Flood in 1868

Peter Stucki

University of Berne, Switzerland
peter.stucki@giub.unibe.ch

Risk assessments of natural hazards require highly resolved information in space and time. For extreme, i.e., very rare events, such information has only been available for a few decades. Recently developed atmospheric reanalyses products reach back to the 19th century, an era that was hitherto the province of environmental historians. Reanalyses products allow numerical meteorological analyses of extreme events on large, i.e. synoptic scales.

In an interdisciplinary approach, we make use of both historian and meteorological methods to assess the most destructive flood event in southern Switzerland in centuries, the Lago Maggiore flood in autumn 1868. We use documentary sources to reconstruct the intensity and spatial extent of flood damages, and a collection of meteorological observations to describe the climatic and meteorological precursors of the 1868 flood. This information is then compared to a high-resolution numerical weather simulation obtained from dynamical downscaling of a global reanalyses dataset. In particular, the weather simulation allows to assess the relevant meteorological features such as a synoptic-scale PV streamer, or the role of the freezing level. In a last step of the

model chain, a hydrological model can be used to reproduce the record flood levels of Lago Maggiore. The hydro-meteorological model chain, validated with historical sources and recent analog cases, may help to draw more robust conclusions for prevention measures, and it may put typical prevention measures like re-forestation or waterflow regulations into perspective.

Risks and Responses to Climate Change in the Ancient World: The Case of Ancient Egypt

Joseph Manning

Yale University, United States
joseph.manning@yale.edu

Explosive volcanic eruptions are a primary driver of abrupt short-term climatic changes. State-of-the-art revisions to polar ice-core chronologies now allow us to track the impacts of a sequence of major and closely-recurring volcanic eruptions on the great Ptolemaic kingdom centred in Egypt, between 305-30 BCE. This was a formidable Mediterranean cultural and economic power in the efflorescent Hellenistic era of the first four centuries BCE, a period bracketed by Alexander the Great on one end and Cleopatra on the other, and known for its considerable advancement in science and material culture. In this presentation we show a link between major volcanic eruptions that register through elevated sulphate deposition in the polar ice, and a suppression of the agriculturally-critical Nile summer flood, identifiable in annual Nilometer measurements from Rhoda, Cairo, between 641 and 1469 CE. This likely relates to a volcanic perturbation of the East African monsoon, responsible for the rainfall in the Ethiopian highlands that drives the annual summer flood, and the effect can also be identified in ancient papyri that indicate the quality of the Nile flood in the first several centuries BCE. Volcanic eruptions in this period are also shown to correspond in timing with the initiation of a series of hitherto poorly understood internal revolts against Ptolemaic rule in Egypt, while also corresponding in timing to the cessation of major interstate conflicts (the nine “Syrian Wars”, running 274-96 BCE) between the Ptolemaic kingdom and their powerful Near Eastern rival, the Seleukid empire. Subsistence crises driven by volcanically-induced suppression of the Nile flood are likely to have played a key causal role in these events, an understanding that helps to advance our knowledge of the major historical events of the Hellenistic era, which set the scene for the incorporation of the eastern Mediterranean into the Roman Empire. Our findings also suggest the potential of integrating human and natural archives to identify causal links between climate change and human history, while highlighting the vulnerability of the region to future eruptions.

Importance of Climate Variations on 'Pauperism' in Switzerland and Germany During the Mid-19th Century

Mario Rohrer

MeteoDat GmbH and University of Geneva, Switzerland
rohrer@meteodat.ch

What we can learn from this mid-19th century's humanitarian debacle for today's food security and livelihood's exposure/resilience against climate change and climate variation

Potato late blight is caused by *Phytophtera infestans*, an organism having characteristics between algae and fungi. Warm and humid weather favors this disease and can lead to yield losses of 20 to 40% or even total loss of the potato yield. It's widely known that this potato disease lead to the Great Irish Famine (1845-47) which was a humanitarian catastrophe with about one million fatalities and the same number of emigrants. It's less known that in Switzerland and Germany also, potato late blight demanded many victims and impelled thousands of poor families to emigration. Of course, it's impossible to explain Switzerland's and Germany's 'Pauperism' - and the related political events - in a mono-causal way. But, there is evidence that climatic variations - as the warm humid phase in large parts of Europe of the 1840ies - can influence the proliferation of plant diseases and thus exacerbate a hunger crisis. The socio-economic phase of 'Pauperism' is often cited to start in 1816 - the year without summer - and is culminating with the 'potato crisis' in the 1840ies, leading 1847 to Berlin's 'potato revolution'. The phase of 'Pauperism' in Switzerland and Germany shows in an exemplary way how climate variation and change can prepare the ground for a food crisis, social unrest and emigration. But, this particularly if other preconditions are fulfilled, as bad governance, uneven socio-economic conditions with an unbalanced nutrition of broad social classes, but also predominant agricultural monocultures, a limited biodiversity of crops, and a small genetic pool of cultivated plants.

Collapse, Resilience and Mobility in Prehistoric Agrarian Societies. Can We Prove Relations to Weather and Climate?

Albert Hafner

University of Berne, Switzerland
albert.hafner@iaw.unibe.ch

Based on the intensive research of wetland settlements in lakes and bogs of the Alpine Space I will present examples of collapsing settlement activities, which may be related, to weather and climate. Mainly rising lake levels are seen as a factor of collapse for settlements near lakeshores. Well-researched sites with complete information on size, development and chronology may deliver the best examples. Archaeology – and mainly prehistoric archaeology – is a science, which is used to work with large times scales. Contributions to climate change research offer chances to get involved in a research topic that is of societal relevance. If archaeologists can show that during

long periods of the Holocene human societies have been vulnerable and were forced to be adaptive to new environmental situations this may also change the view of our own, quite static societies of the 21st century.

Impacts of a Changing Climate on Society and Economy

Christian Franzke

University of Hamburg, Germany
christian.franzke@uni-hamburg.de

Weather and climate extremes cause huge economic damages and harm many
lives each year. There is evidence that some types of weather and climate extremes, like heat waves and flooding, have already increased or intensified over the last few decades, and climate projections reveal a further intensification for many types of weather and climate extremes in many regions though the uncertainties still remain large. While there is evidence for increases in economic losses it is uncertain whether this is due to an increase in the number and intensity of extreme events or can be attributed to socio-economic changes. However, there is agreement that the increasingly complex and internationally distributed supply chains of global companies make them more vulnerable to extreme weather events. It is also thought that global warming will adversely affect the global food supply chain and especially developing countries. In my presentation I will discuss how weather and climate extremes impact our economies and how we can mitigate their impacts using financial and insurance products.

Resilience of the Human-Water Interrelationship at the Southern Silk Road: Evolution of the Northern Catchment of Erhai Lake, China (1382-1912)

Liang Emlyn Yang

Christian-Albrecht University Kiel, Germany
lyang@gshdl.uni-kiel.de

This study focuses on the northern catchment of the Erhai Lake that lies in the heart of the ancient Southern Silk Road (also known as the Tea-Horse Roads) in southwest China. The water environment of this region was complex and evolved with significant human impacts, especially after the large population immigrated in from 1382 under the policy of military tillage. This leaded to raising pressures on both the limited land and water resources in this region, challenging the resilience of the human-water interrelationships. This paper investigated the changes how local people addressed the conflicts of utilizing limited water for people, livestock and irrigation till 20th century when the Republic of China was established. Statistical analysis, spatial analysis and correlation analysis were adopted, and the historical data of water disasters, water conservancy projects, agriculture, diseases were collected to support a detailed examination on the evolution process of the human-water interrelationship in the study area. The results indicate that: (1) the evolution of both the natural river system and the hydro-chemical

environment involved a close interaction with human activities ; (2) local people constructed various water conservancy engineering and changed their farming structures in coping with the water problems, which however, contributed in turn to the break out and spread of the schistosomiasis japonica; (3) the sustainable development of human-water relationship was maintained and enhanced by effective water management and environment governance, while in some periods the relationship was intense by biased policy measures. These findings emphasized that social policy and human activities could significantly influence the resilience of the catchment water system, but the influences may be identified only over a long period.

A 2000-yr Moisture History in the Western Qilian Mountains of Northwestern China: Evidence from Tree Rings

Yong Zhang

Chinese Academy of Sciences, Beijing, China
zhangyong@igsnrr.ac.cn

The understanding of the relationship between climatic change and social activities in ancient China mainly depend on high-resolution climatic-proxy series for the past two thousands, however, lots of climatic series were conducted in eastern China, more than 1000 years high-resolution climatic proxies are scarce in western China, especially in the area nomads inhabited. Here, we present an 1775-year (AD 241–2015) reconstruction of May–June self-calibrating Palmer Drought Severity Index (scPDSI) in the western Qilian Mountains of northwestern China that is based on nearly two millennia-long ring-width chronologies derived from long-lived Qilian Juniper trees (*Juniperus przewalskii Kom.*). The reconstruction demonstrated twelve severe wet periods: AD 241-268, AD 282-313, AD 529-543, AD 806-809, AD 965-995, AD 1195-1209, AD 1214-128, AD 1223-1242, AD 1353-1403, AD 1564-1596, AD 1606-1612, AD 1741-1807, and twelve severe dry periods: AD 365-376, AD 459-506, AD 693-724, AD 732-763, AD 806-909, AD 1114-1125, AD 1135-1145, AD 1153-1161, AD 1262-1283, AD 1462-1515, AD 1660-1720, AD 1953-1967. Some of wet periods corresponded to a high incidence of the social rising events in ancient China, while wars between nomadic and farming groups were waged during dry periods in general. In the meantime, results of the multi-tape method analysis and wavelet analysis further confirmed the relationship between regional hydroclimate variability, solar activity forcing, and westerly disturbances.

Extreme Weather as a Trigger of Violence and Conflict in Medieval Ireland

Francis Ludlow

Trinity College Dublin, Ireland
ludlowf@tcd.ie

Ireland's many centuries of well-documented medieval history allow us to examine the evolving influence of climate on society over long time periods, especially when combined with the continued development of

palaeoclimatic reconstructions of growing chronological and geographical scope. In this presentation, I examine the association between extreme weather registered in European tree-rings and the incidence of major societal stresses drawn from an exhaustive survey of medieval Irish chronicles, in which harvest failure, famine, and disease are recorded in detail. These chronicles also record the violent killings of societal elites with great reliability on a continuous annual basis, in addition to a broad spectrum of further conflict types, including cattle raids, slave raids, mass killings, large-scale land and naval battles, and the implementation of scorched earth tactics and other environmentally-destructive conflict. The outcome of this study firmly implicates extreme weather anomalies as a significant catalyst for major societal stresses, conflict and violence in medieval Ireland, but also shows that medieval Irish society was not a passive "victim" of such weather conditions, with a range of coping mechanisms available to rapidly restore order.

Armed Conflict and Environmental Protection; GEF Insights for Security and Sustainability

Nathan Morrow

Tulane University, United States
nmorrow@tulane.edu

The Global Environment Facility (GEF) is the largest multilateral funder of environmental protection projects. Here we find, through tiered multiscale meta-evaluative analysis of GEF's online project database, insecurity and conflict result in widespread and severe negative outcomes. Since 1992, over one third of GEF's global portfolio (>$4bn USD) was invested in countries enduring armed conflict. Sub-national geospatial analysis found 73% of districts with land degradation projects in Africa were conflict-affected. Project-level analysis revealed pragmatic environmental security approaches promoting sustainable development-related governance and empowerment, rather than perfunctory reactions to perceived resource scarcity, resulted in cooperation, improved human security and conflict resolution as a foundation for achieving environmental protection goals. Nonetheless, project implementation suffered security-related delays of crucial technical and logistical support or extreme circumstances where stakeholders were threatened or murdered. Threat identification and risk mitigation are essential to operationalize environmental security concepts but not yet adequately integrated into environmental protection projects.

The Social Construction of Disaster Risk and Vulnerability and Resilience in the Face of Hazards in the Greater Everglades Ecosystem

Astrid Wigidal

Germany
astrid.wigidal@gmail.com

In my presentation, the area of exposure is the Greater Everglades Ecosystem constituting much of central and south Florida. My focus lies on the region's particular socio-hydrological cycle, which natural hazards are part of the cycle, affect it, and how it is and will be impacted by the effects of climate change. In order to understand root causes, dynamic pressures leading to unsafe conditions, my temporal frame begins at the onset of modern development in the mid-19th century and focuses on the perceptions and severe alterations of the region's water regime, demographic and land-use changes, and the subsequent construction of risk leading to many disastrous events. On a few examples of the large number of natural disasters that occurred throughout the past 150 years in the Greater Everglades Ecosystem, I illustrate vulnerability and resilience, ways of coping and its limits in the face of particular natural hazard events.

Socio-Economic Consequences of Post-Disaster Reconstruction in Hazard-Exposed Areas

Jamie McCaughey

Nanyang Technical University, Singapore
jmccaughey@ntu.edu.sg

With coastal populations growing and sea levels rising, reconstruction decisions after coastal disasters are increasingly consequential determinants of future societal vulnerability and thus the sustainability of development. The humanitarian sector tends to favour rebuilding in-place to avoid the social disruptions of mass relocation, yet evidence on what affected people want is mixed. Using the case of post-tsunami Banda Aceh, Indonesia, we investigate whether a policy to rebuild in-place in the disaster-affected area suits an urban population that was previously unaware of the hazard. We show that following the tsunami, a substantial proportion of the population prefers to live farther from the coast. This has caused a new price premium for inland properties and socio-economic sorting of poorer households into coastal areas. These findings show that offering reconstruction aid predominantly within a hazard-exposed area can inadvertently transfer disaster risk to the poor.

Climate Change, Weather Extremes and Related Hazards in the Caucasus in the Early 21st Century

Dmitry Petrakov

Moscow State University, Russian Federation
dpetrakov@gmail.com

In many regions of the world climate change impact on frequency and magnitude of weather extremes and natural hazards. At the same time human societies became more vulnerable to hazards due to increasing land use activity and growing population. This is true for the Caucasus, highly glaciated mountains with altitude up to 5642 m asl., stretched in Russia, Georgia and Azerbaijan. During recent decades they registered rapid increase of June-September mean air temperature. It has resulted in predominantly negative glacier mass balance and accelerating glacier area loss, disappearing of ice apron and termini retreat overall in the Caucasus. Disappearing cryosphere impacts on downstream communities through changing runoff and various hazards including glacier related debris flows, ice-rock and snow avalanches. Overlaying of cryospheric change and weather extremes caused several situations without historical precedents in the region. We analyze major climate, cryosphere and weather-related disasters happened in the Caucasus since early 21st century, identify their triggers and assess their influence on local communities. In most of cases historical communities were less prone to local-scale hazards comparatively to modern communities, but regional cooling in 14th century was among triggers of state Alania decline.

Past is Key to Future: A Bottom-Up, Place-Based Approach for Spatial Risk Assessment to Support Risk-Informed Planning and Management

Muhammad Sajjad

City University of Hong Kong, Hong Kong (SAR)
mah.sajjad@my.cityu.edu.hk

Coastal communities are facing risks to extreme events such as tropical cyclones (TCs), storm surges and flood causing heavy rains. Risk-informed management is key to resilient communities and sustainability of hazard-prone areas. This paper, using TCs hazard as an example, proposes the adoption of a bottom-up, place-based framework for a realistic risk modeling. We introduce an inclusive Typhoon Risk Index based on an integration of place-based destructive potential of a typhoon, vulnerability, and resilience adaptability of coastal communities. The best-track historical time series dataset of TCs from China Meteorological Administration (CMA) for the period 1949-2015 is used as data inventory to evaluate the inter-decadal trends and regime shifts (if any) in the frequency of landfalling TCs and their destructive potential. The study introduces a coupled approach based on spatial distributional models in geographic information systems to map and modeling the risk-hotspots. Furthermore, we assess the resilience adaptability status of identified hotspots of highest destructive potential based on place-based resilience indicators under five potential components of resilience (social, ecological, economic, institutional, and safety dimension). The study identifies a decreasing regime shift in the frequency of landfalling typhoons whereas, an

increase in the destructive potential is observed during the study period. This indicates the intensification of landfalling TCs during recent years in China's coastal region indicating greater life-threating impacts.

Moreover, the results show that more than 60% coastal counties are exposed to typhoon risk in coastal China with above 25% under the highest category of risk. The areas under highest risk harbor more than 50 million people including more than 7 million non-adults (0-14 years) and approximately 2.5 million elderly people (above 65 years). The Pearl-River-Delta region of Guangdong province in southern China is identified (statistically significant) as the hotspot of highest typhoon risk, with a population share of above 35 million and a gross domestic product (GDP) of 120 million, followed by Fujian and Zhejiang provinces in eastern China. The results show that the hotspots of highest risk lack in ecological and safety dimension of resilience. The place-based results from our approach are more applicable and relevant to a risk-informed policy/decision making and management in the coastal regions of China, particularly from a disaster-risk-reduction (DRR) perspective. The evaluation of resilience adaptability can also facilitate making coastal regions resilient in future through improving the weak sectors. The study also provides a set of useful tools within the proposed framework to facilitate the identification of risk/vulnerability hotspots in any given region of the world, particularly in developing countries where data availability is a major constraint for such analysis.

New Insights on the Climatic and Societal impacts of the Unidentified 535 CE and 1257 Samalas Eruptions in Medieval Europe

Sébastien Guillet

University of Geneva, Switzerland
Sebastien.Guillet@unige.ch

Sometimes during the years of 536 CE and 1258 CE, a mysterious cloud appeared over Europe, bringing unusually cold and wet weather lasting several months. Crop and grape harvests failed, while subsistence crisis, famine and pandemics prevailed in several areas of Europe. There is now a large consensus among climate scientists on the fact that the cause of all the disturbances that afflicted Europe may be two volcanic eruptions, which filled Earth's atmosphere with a considerable amount of ash and aerosols. The first event likely occurred in 535 CE but the volcano responsible for the eruption still remains to be identified. The second eruption happened in 1257 CE at Samalas volcano in Indonesia.

In this contribution, we review, using historical and tree-ring records from Europe, the effects that may have had these eruption on medieval societies. We suggest that the climatic impacts induced by the unidentified 535 CE and 1257 eruptions cannot alone account for the crisis that struck Europe in 536 and 1257. Other factors such as governance structure, disturbances in crop supply and distribution, military conflicts must also be considered.

Explosive Volcanism as a Driver of North Atlantic Marine Productivity, Fisheries and Markets, 1400-1850 CE

Al Matthews

Trinity College Dublin, Ireland
matthewa@tcd.ie

Research that twins data from human (written) archives with data from natural environmental archives represents a rapidly advancing frontier in understanding the ecosystem and linked societal impacts of climatic change. The study of explosive volcanic eruptions, capable of inducing severe short-term climatic anomalies, provides a proving ground in which to develop the methodologies required to combine these disparate sources of evidence, and for showcasing the insights that can be achieved. Volcanic influences on the oceans are becoming increasingly understood, through advances in marine palaeoenvironmental proxies and more sophisticated Earth system modelling. At the same time, growing concern exists over the impacts of present and projected climatic changes on marine ecosystems and important higher trophic level species (Cod, Herring) exploited by commercial fisheries. Here we examine the impact of major explosive volcanism on North Atlantic sea-surface-temperatures (SSTs) using the Norwegian Earth System Model, and on North Sea Herring (1600-1860 CE) and Grand Banks Cod (1675-1827 CE) populations, using rigorously reconstructed catch volumes from contemporary documentation. We show that volcanic eruptions, identifiable through elevated sulfate levels in polar ice cores, impacted ocean temperatures and triggered population booms in both species during the first post-eruption decade. We also show this response to be consistent with expected increases in plankton productivity (a key food source for Cod and Herring) under lower SSTs in the North Sea and higher SSTs in the Grand Banks, respectively. We complement our historical analyses with Cod and Herring population modelling, similarly predicting a population boom in the first decade following a positive ecosystem disturbance (e.g., increased food availability for Cod and Herring, promoting increased survivorship). Lastly, we employ historical Herring price data to examine market responses post-eruption, observing an increase in prices in the first two post-eruption years, thus indicating an increased demand for Herring as a substitute for terrestrial agriculture likely to have been impacted by volcanic climatic anomalies. Our results will help improve fish population projections for the North Atlantic after the next big eruption.

Climatic Effects and Agricultural Impacts of the 1815 Tambora Eruption: a European Overview from the Mediterranean to Central Europe

Nicolas Maughan

Aix-Marseille University, France
nicolas.maughan@gmail.com

The eruption of Mount Tambora in Indonesia in 1815 was one of the most powerful of its kind in recorded history and it had substantial effects on global climate. Consecutive severe climatic anomalies influenced crop growth and contributed to poor harvests of important crops and for some led to “the last great subsistence crisis in the

Western world". The aim of this paper is, on the one hand, to present -for the first time- a detailed analysis of Tambora's environmental effects on Mediterranean agro-ecosystems, and on the other hand to provide an overview of its agricultural impacts in Europe based on a comparison between three different geographical areas.

We first investigate the climatic effects of the eruption (the post-eruption weather perturbations) and their impacts on harvest of main crops, subsistence crisis and human life in the Southeastern France for an area covering approximately 50.000 km^2* for the subsequent years of 1816/1817 but also throughout the next decade until 1825. Climatic effects are evaluated thanks to available long-term homogenized series of daily instrumental observations (air temperature, precipitations and mean pressures) from various regional meteorological stations, and mean French series in the short term (1805-1825) and long term (1800-2010). Environmental data derived from specific documentary sources related to crop yields, grain prices (e.g. agricultural surveys) and food availability were used for the analysis of adverse agricultural consequences. Then, results from Mediterranean France are compared with recently produced data from two other Central European regions, with different climatic conditions: the Switzerland and the Czech Lands. The resilience of societies (and their food system) to these extreme climatic disturbances, in light of their respective political and socio-economic context and past experiences at that time, is discussed.