Space-Time Dynamics of Extreme Floods

S P A T E

Newsletter

Edition 9

Coordinator: Prof. Dr. Andreas Schumann

Ruhr-University Bochum
Institute of Hydrology, Water Resources
Management and Environmental
Engineering
D – 44801 Bochum

Phone: +49 (0)234 / 3224693

Fax: +49 (0)234 / 3214153

E-Mail: andreas.schumann@rub.de

www.spate.ruhr-uni-bochum.de

SPATE: back live in action!

Dear colleagues and followers of the SPATE research unit,

Finally! After more than two years of pandemic-related restrictions and meetings exclusively online, the time finally came in April: our seventh project meeting took place at Leibniz University in Hanover. And it was a complete success! Many exciting presentations reported on the current work in SPATE and we planned our final spurt for the last year of SPATE, which starts in July. You can expect a lot more from us! But as with so many meetings, an important aspect was the many conversations and exchanges alongside the official programme. That's how cooperation is formed and that's why we are proud that the joint work in the project group has increased incredibly. There have never been so many joint papers as in the first half of this year, and this shows that almost five years of work have now culminated in a joint result of which we can be more than proud. We are therefore particularly pleased to be able to present one of these cooperation projects in more detail in this issue: project 3 and 6 investigated, if small and large flood have the same drivers of change. An important contribution on how extreme floods are different from normal floods, the main research goal of our project. But the worldwide scientific community is also starting to meet again. And our SPATE members have made diligent use of this. We are particularly proud of our huge symposium at the IAHS Assembly 2022 in Montpellier in May 2022, which provided a large stage for seven contributions from SPATE over two and a half days with more than 40 presentations. And these were more than well received by the audience! The medals and awards given to the members of SPATE, not only in Montpellier, are more than proof of the excellence of our work.

Finally, we would like to draw your attention to a particularly important date for us: on **23 March 2023**, our final symposium will take place at the TU Vienna. Right in front of the EGU. Feel free to drop by and find out what we have been researching on extreme floods in our research group. More information will follow soon.

On behalf of the whole SPATE-project, with kind regards,

Svenja Fischer and Andreas Schumann

Members of the SPATE-project

Dr. Svenja Fischer, Prof. Dr. Andreas Schumann
Subproject 1 (Ruhr-University Bochum)

Prof. Dr. Bodo Ahrens, Mostafa Hamouda
Subproject 2 (Goethe-University Frankfurt)

Dr. Sergiy Vorogushyn, Prof. Dr. Bruno Merz, Dr. Björn Guse, Elena Macdonald, Luzie Wietzke
Subproject 3 (GFZ Potsdam)

Prof. Dr. Ralf Merz, Dr. Larisa Tarasova
Subproject 4 (UFZ Halle/Saale)

Prof. Dr. András Bárdossy, Dr. Jochen Seidel, Faizan Anwar
Subproject 5 (University of Stuttgart)

Prof. Dr. Günter Blöschl, Dr. Miriam Bertola, David Lun
Subproject 6 (Technical University of Vienna)

Prof. Dr. Uwe Haberlandt, Dr. Anne Bartens, Ross Pidoto, Luisa Thiele
Subproject 7 (Leibniz University Hannover)

Members of the research unit SPATE at the SPATE-Meeting in Hannover, April 2022.

Drivers of changes in European floods

Recent studies have shown evidence of increasing and decreasing trends for average floods and flood quantiles across Europe. Attempts to attribute detected changes have mostly focused on the average flood behavior, without distinguishing small and large floods, and have not resulted in a clear picture about the contribution of the underlying drivers. In a joint study of sub-projects 3 and 6, a new framework for attributing flood changes to potential drivers, as a function of return period in a regional context was developed and applied to European flood series. The idea, the design of the framework and of the analysis, as well as the interpretation of the results has been carried out within this collaboration.

The method focuses on flood quantiles in order to explicitly model the relationships between small and large floods (e.g. the 2-year and the 100-year flood) and potential drivers of flood change and to separate the effects of drivers on selected flood quantiles. The approach is based on non-stationary flood frequency approach to attribute observed flood changes to potential drivers, used as covariates of the parameters of the regional probability distribution of floods. Extreme precipitation, antecedent soil moisture and snowmelt are the potential drivers considered. The relative contribution of the different drivers to flood changes is quantified through the elasticity of flood quantiles with respect to each driver.

The attribution model is applied to European flood and covariate data and aims at attributing the observed flood trend patterns to specific drivers for different return periods at the regional scale. Flood discharge records from 2370 hydrometric stations in Europe are analysed over the period 1960–2010. Extreme precipitation, antecedent soil moisture and snowmelt are the potential drivers of flood change considered. Results show that, in northwestern Europe, extreme precipitation mainly contributes to changes in both the median (T=2) and 100-year flood (T=100), while the contributions of antecedent soil moisture are of secondary importance. In southern Europe, both antecedent soil moisture and extreme precipitation contribute to flood changes, and their relative importance depends on the return period. Antecedent soil moisture is the main contributor to changes in the median flood, while the contributions of the two drivers to changes in larger floods (T>10 years) are comparable. In eastern Europe, snowmelt drives changes in both small and large floods.

More details can be found in the publication of Bertola et al. (2021).
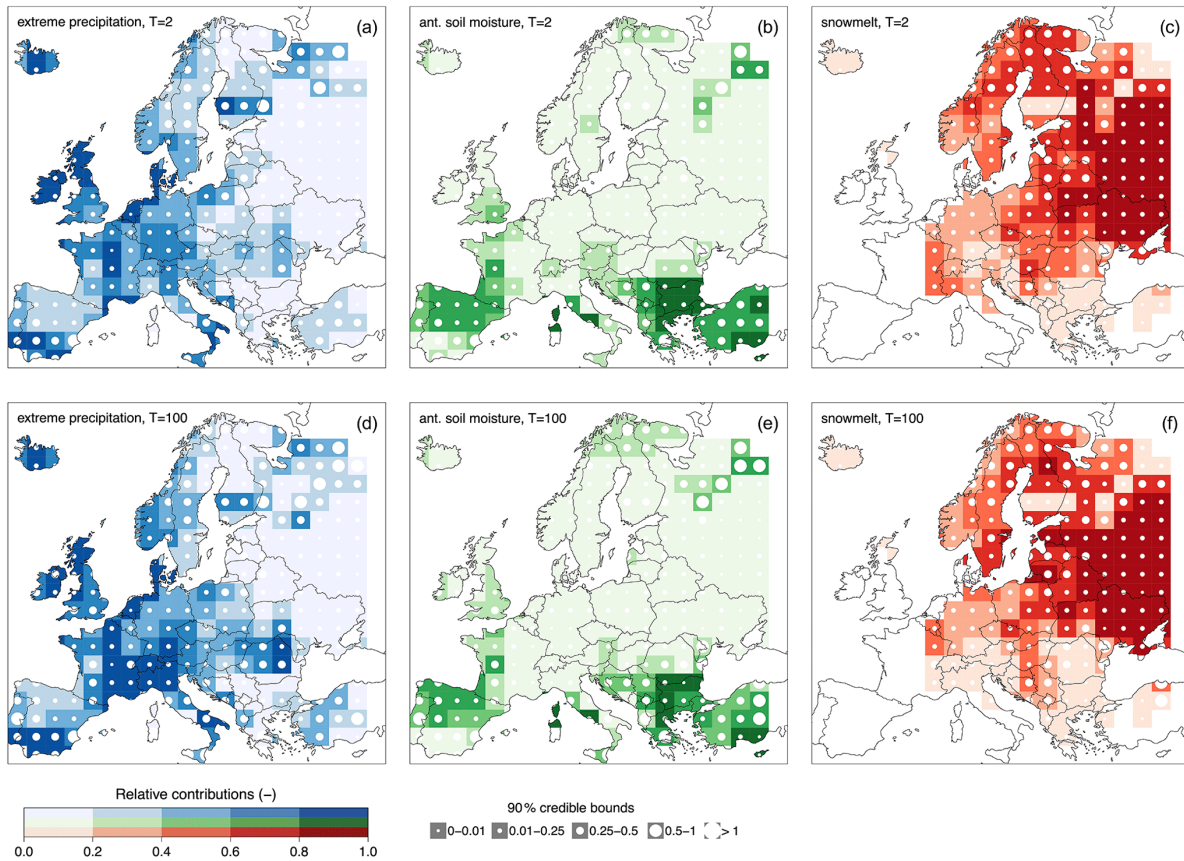
Figure from Bertola et al. (2021). Relative contributions of extreme precipitation (a, d), antecedent soil moisture (b, e) and snowmelt (c, f) to changes in the median flood (T=2) and the 100-year flood (T=100).

Reference:

Bertola, M., Viglione, A., Vorogushyn, S., Lun, D., Merz, B., and Blöschl, G.: Do small and large floods have the same drivers of change? A regional attribution analysis in Europe, Hydrol. Earth Syst. Sci., 25, 1347–1364, https://doi.org/10.5194/hess-25-1347-2021, 2021.

Björn Guse (SP3), together with Miriam Glendell, was elected as New chair of EGU Subdivision Catchment Hydrology.

Larisa Tarasova (SP4) has received the Best Dissertation Award 2021 from German Hydrological Society and AGU 2021 Editors' Citation for Excellence in Refereeing for Water Resources Research.

Safae Aala (SP4) has received Best Master Thesis Award 2021 from TH Köln.

Publications

1) Publications in journals

Published since last newsletter:

Ahrens, B., Leps, N. (both SP2) (2021): Sensitivity of Convection Permitting Simulations to Lateral Boundary Conditions in Idealised Experiments. Journal of Advances in Modeling Earth Systems. 13(12) http://doi.org/10.1029/2021MS002519

Basso, S. (SP4), Botter, G., Merz, R. (SP4), Miniussi, A. (2021): PHEV! The PHysically-based Extreme Value distribution of river flows, Environ. Res. Lett. 16 (12), art. 124065

Farrag, M., Brill, F., Nguyen, D., Sairam, N., Schröter, K., Kreibich, H., Merz, B. (SP3): de Bruijn, K. M., Vorogushyn, S. (SP3) (2022): On the role of floodplain storage and hydrodynamic interactions in flood risk estimation. - Hydrological Sciences Journal - Journal des Sciences Hydrologiques, 67, 4, 508-534. https://doi.org/10.1080/02626667.2022.2030058

Fischer, S., and Schumann, A., (both SP1) (2022): Handling of the Stochastic Uncertainty of Flood Statistics in Regionalisation Approaches. Hydrological Sciences Journal. https://doi.org/10.1080/02626667.2022

Giani, G., Tarasova, L. (SP4), Woods, R.A., Rico-Ramirez, M.A., (2022): An objective time-series-analysis method for rainfall-runoff event identification, Water Resour. Res. 58 (2), e2021WR031283

Haberlandt, U. (SP7), Krämer, S., Bárdossy, A. (SP5), Bartens, A. (SP7), Birkholz, P., Eisele, M., Fuchs, L., Herrmann, O.-C., Kuchenbecker, A., Maßmann, S., Pidoto, R. (SP7), Müller, T., Seidel, J. (SP5), Sympher, K. (2022): Kontinuierliche synthetische Niederschläge für stadthydrologische Bemessungen in Deutschland – Hydrologie & Wasserbewirtschaftung, 66, (3), 106-121. DOI: 10.5675/HyWa_2022.3_1

Krug, A. (SP2), Aemisegger, F., Sprenger, M., Ahrens, B. (SP2) (2022): What intensifies Vb-cyclone precipitation in Central Europe? Climate Dynamics. https://doi.org/10.1007/s00382-022-06256-7

Macdonald, E. (SP3), Merz, B. (SP3), Guse, B. (SP3), Wietzke, L.M. (SP3), Ullrich, S. (SP3), Kemter, M., Ahrens, B. (SP2), Vorogushyn, S. (SP3) (2022): Event and Catchment Controls of Heavy Tail Behavior of Floods. Water Resources Research. DOI: 10.1029/2021WR031260

Mishra, A., Mukherjee, S., Merz, B. (SP3): Singh, V. P., Wright, D. B., Villarini, G., Paul, S., Kumar, D. N., Khedun, C. P., Niyogi, D., Schumann, G., Stedinger, J. R. (2022): An Overview of Flood Concepts, Challenges, and Future Directions. - Journal of Hydrologic Engineering, 27, 6. https://doi.org/10.1061/(ASCE)HE.1943-5584.0002164

Mushtaq, S., Miniussi, A., Merz, R. (SP4), Basso, S. (SP4) (2022): Reliable estimation of high floods: a method to select the most suitable ordinary distribution in the Metastatistical Extreme Value framework, Adv. Water Resour. 161,104127

Schnurr, A., and Fischer, S. (SP1) (2022): Generalized ordinal patterns allowing for ties and their applications in hydrology. Computational Statistics & Data Analyses 171, https://doi.org/10.1016/j.csda.2022.107472.

Schnurr, A., Fischer, S. (SP1) (2022): An Ordinal Procedure to Detect Change Points in the Dependence Structure between Non-Stationary Time Series. Eng. Proc. 2022, 18, 14. https://doi.org/10.3390/engproc2022018014

Accepted:

Merz, B. (SP3), Basso, S. (SP4), Fischer, S. (SP1), Lun, D. (SP6), Blöschl, G. (SP6), Merz, R. (SP4), Guse, B. (SP3), Viglione, A. (Meractor-fellow), Vorogushyn, S. (SP3), Macdonald, E. (SP3), Wietzke, L. (SP3) and Schumann, A. (SP1) (2022): Understanding heavy tails of flood peak distributions. Water Resources Research.

Merz, R. (SP4), Miniussi, A., Basso S. (SP4), Petersen, K.-J., Tarasova, L. (SP4) (2022): More complex is not necessarily better in large scale hydrological modelling - A model complexity experiment across the contiguous United States. Bulletin of the American Meteorological Society.

Pre-Prints:

Pidoto, R. (SP7), Bezak, N., Müller-Thomy, H., Shehu, B., Callau-Beyer, A. C., Zabret, K., & Haberlandt, U. (SP7) (2022): Comparison of rainfall generators with regionalisation for the estimation of rainfall erosivity at ungauged sites. Earth Surface Dynamics Discussions, 1-21

Talks

1) Invited talks:

Tarasova, L. (SP4) Process-Based Characterization and Typology of Runoff Events, Award Lecture for Best Dissertation in Hydrology, Tag der Hydrologie, Munich, Germany, 2022

Tarasova, L. (SP4), Gnann, S., Yang, S., Hartmann, A., Wagener, T. Current practices in catchment characterization: data sources, aggregation approaches, derived descriptors and their value, EGU General Assembly 2022, Vienna, Austria (EGU Highlight)

2) Other talks at conferences

Ahrens, B., Leps, N. (both SP2). On the Challenge of Convection Permitting Precipitation Simulations: Results from Idealised Experiments. EGU General Assembly 2022, Vienna, Austria, 23-27 May 2022

Basso, S. (SP4), Merz, R. (SP4), Miniussi, A. Risky rivers: physioclimatic controls of basins' penchant for extreme floods, IAHS 2022, Montpellier, France, 30 May-03 June 2022

Basso, S. (SP4), Botter, G., Merz, R. (SP4), Miniussi, A. The Physically-Based Extreme Value (PHEV) distribution of river discharges, EGU General Assembly 2022, Vienna, Austria, 23-27 May 2022

Bertola, M. (SP6), Castellarin, A., Valtancoli, E., Viglione, A. (Mercator fellow), and Blöschl, G. (SP6): Probabilistic regional envelope curves in Europe, EGU General Assembly 2022, Vienna, Austria, 23–27 May 2022

Bezak, N., Pidoto, R. (SP7), Müller-Thomy, H., Shehu, B., Callau-Beyer, A., Zabret, K., and Haberlandt, U. (SP7). Investigation of the applicability of rainfall generators for the estimation of the rainfall erosivity for ungauged locations, EGU General Assembly 2022, Vienna, Austria, 23–27 May 2022

Fischer, S. (SP1): Multivariate statistische Bestimmung von Hochwasserszenarien unter Berücksichtigung von Nebenflusseinflüssen und Hochwassertypen. Tag der Hydrologie 2022, Munich, Germany, 22-23 March 2022

Fischer, S. (SP1): Multivariate statistical assessment of flood scenarios in large river basins under consideration of tributary impacts and flood types. IAHS Assembly 2022, Montpellier, France, 30 May-03 June 2022

Fischer, S. (SP1): Consideration of sample size uncertainty for the regionalization of type-specific flood frequency analyses. IAHS Assembly 2022, Montpellier, France, 30 May-03 June 2022

Haberlandt, U. (SP7) and Thiele, L.-B. (SP7): Investigation of the maximisation potential of large floods by spatio-temporal simulation of rainfall, IAHS Assembly 2022, Montpellier, France, 30 May-03 June 2022

Hamouda, M., B. Ahrens. On the Convective Precipitation Contribution during Vb-events. EGU General Assembly 2022, Vienna, Austria, 23-27 May 2022

Lun, D. (SP6), Viglione, A. (Mercator fellow), Bertola, M. (SP6), Komma, J., Parajka, J., Valent, P., and Blöschl, G. (SP6): Characteristics and process controls of statistical flood moments in Europe - a data-based analysis, IAHS Assembly 2022, Montpellier, France, 30 May-03 June 2022

Merz, B. (SP3): Disastrous flooding in July 2021 in Germany – Event analysis and consequences for risk assessment approaches. IAHS Assembly 2022, Montpellier, France, 30 May-03 June 2022

Merz, R. (SP4), Tarasova, L. (SP4), Basso, S. (SP4) The German flood cooking book: ingredients and regional flavors of floods. IAHS Assembly 2022, Montpellier, France, 30 May-03 June 2022

Pesce, M., Viglione, A. (Mercator), von Hardenberg, J., Tarasova, L. (SP4), Basso, S. (SP4) and Merz, R. (SP4) hydroPASS: a newly developed R package to go through the regional calibration of distributed catchment models, EGU General Assembly 2022, Vienna, Austria, 23-27 May 2022 (EGU Highlight)

Pidoto, R. (SP7) and Haberlandt, U. (SP7): A multi-scale space-time hybrid weather generator, EGU General Assembly 2022, Vienna, Austria, 23–27 May 2022

Thiele, L.-B. (SP7), Pidoto, R. (SP7), and Haberlandt, U. (SP7): Calibration framework for derived flood frequency analysis driving a rainfall-runoff model with stochastically generated rainfall data, EGU General Assembly 2022, Vienna, Austria, 23–27 May 2022

S. Vorogushyn (SP3): Statistical and hydraulic analysis of flood hazard in the Ahr valley, Germany considering historical floods. IAHS Assembly 2022, Montpellier, France, 30 May-03 June 2022

Wang, H., Yang, S., Merz, R., (SP4), Basso, S. (SP4) The role of spatial rainfall variability for the emergence of heavy tails in streamflow distributions, EGU General Assembly 2022, Vienna, Austria, 23-27 May 2022

3) Talks at faculty seminars:

Fischer, S. (SP1): Hochwasserstatistik – Extreme Naturereignisse besser verstehen. Ringvorlesung „Statistik in den Anwendungen". Otto-von-Guericke Universität Magdeburg, Mai 2022.

4) Poster

Bertola, M. (SP6), Viglione, A. (Mercator fellow), Lun, D. (SP6), and Blöschl, G. (SP6): Investigating flood change mechanisms through a probabilistic flood change model. AGU Fall Meeting 2021.

Bertola, M. (SP6), Viglione, A. (Mercator fellow), Lun, D. (SP6), and Blöschl, G. (SP6): Investigating flood change mechanisms in Europe through a probabilistic flood change model. IAHS Assembly 2022, Montpellier, France, 30 May-03 June 2022

Thiele, L.-B. (SP7), Pidoto, R. (SP7), and Haberlandt, U. (SP7): Uncertainty propagation in derived flood frequency analysis driving a rainfall-runoff model with stochastically generated climate input data. IAHS Assembly 2022, Montpellier, France, 30 May-03 June 2022

Wietzke, L. (SP3), Merz, B. (SP3), Guse, B. (SP3), Macdonald, E. (SP3), Vorogushyn, S. (SP3) (2022): Einfluss von Niederschlagsregime und Saisonalität auf die Upper Tails von Extremniederschlagsverteilungen. Tag der Hydrologie 2022, Munich, Germany, 22-23 March 2022

Theses

Amelie Hoff (SP2) (2021): Hydro-Climatic Causes of Widespread Floods in Central Europe: On Rain-on-Snow and Vb-Cyclone Events. PhD thesis defended on 28 January 2022, Goethe-University Frankfurt, Germany.

Christian Czaky (2022) Information exchange from marginal seas to Vb-precipitation in MedCORDEX simulations. Master Thesis, Goethe-University Frankfurt, Germany.

Workshops, Conferences

Session HS2.2.1 Incorporating novel data and hydrological process understanding into catchment models across spatio-temporal scales (Conveners: S. Stisen, L. Samaniego, S. Khatami, S. Gharari, B. Guse (SP3))

Session HS2.4.3 Space-time dynamics of floods: processes, controls, and risk, EGU General Assembly 2022, Vienna, Austria, 23-27 May 2022 (Conveners: Farmer, W., Medeiro, L., Vorogushyn, S. (SP3), Tarasova, L. (SP4), Sairam, N.)

Session HS3.1 Hydroinformatics: data analytics, machine learning, systems analysis, optimization, EGU General Assembly 2022, Vienna, Austria, 23-27 May 2022 (Conveners: D. Solomatine, A. Elshorbagy, G. El Serafy, D. Han, Nil. Dogulu, S. Fischer (SP1), W. Knoben, A. Annis, M. Mazzoleni)

Session S2: Floods: Processes, Forecasts, Probabilities, Impact Assessments and Management. IAHS General Assembly 2022, Montpellier, France (Conveners: S. Fischer (SP1), Andreas Schumann (SP1), Elena Volpi, Günter Blöschl (SP6), Alberto Viglione (Mercator-fellow), Christopher White, Marcelo Uriburu)

Visits

Larisa Tarasova (SP4) has visited the Department of Earth and Environmental Engineering, Columbia University in the City of New York, NY, USA from January to July 2022.