



## Panta Rhei – Drought in the Anthropocene

Report of the 2017 workshop in Freiburg, Germany



### **Acknowledgements**

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## Introduction

This document reports on the 2<sup>nd</sup> edition of the annual Drought in the Anthropocene workshop, which was held in Freiburg, Germany, between the 9<sup>th</sup> and 11<sup>th</sup> of October 2017. The workshop brought together an interdisciplinary group of international scientists with a common research interest – the impacts of humans on drought and vice versa.

The Drought in the Anthropocene working group is part of a wider research initiative connected to the new scientific decade “Panta Rhei – everything flows” initiated by the International Association of Hydrological Sciences (IAHS). The overall purpose of the Panta Rhei Drought in the Anthropocene working group is to gain a better understanding of the feedbacks between drought and human society at different scales. The specific research questions the group aims to answer are:

- How are people enhancing/alleviating hydrological drought events?
- How are people responding to drought event by changing water use and management practices and infrastructure?
- How do these feedback processes result in aggravated or alleviated drought conditions?

The current workshop is a follow up to the first workshop hosted in Birmingham, UK, in 2016. During this Birmingham 2016 workshop, various research projects were initiated (overview and status in Annex 1). The aim of the 2017 Freiburg workshop was to update the (new) group members on the status and progress of these projects as well as to facilitate the opportunity to define new research projects. Specifically, the objectives were:

- Strengthen the existing network by bringing together a group of early-career and established scientists, new and existing Panta Rhei members;
- Provide a review of the state of the art for Drought in the Anthropocene research;
- Update the working group on progress made with ongoing projects defined during the 2016 workshop in Birmingham;
- Identify key challenges and opportunities for future drought research in the Anthropocene;
- Define new research projects and collaborations based on these challenges and opportunities.

## Workshop participants

One of the goals was to strengthen existing network and enlarge the current research network by bringing together drought researchers from different disciplines and geographical settings.

- The number of participants more than doubled compared to the compared to last year’s workshop (38, listed in Annex 2).
- Good gender balance in the group (20 male, 18 female)
- Participants came from the hosting country Germany (Baden-Württemberg and other regions), various other European countries (The Netherlands, Belgium, UK, Germany, France, Italy and Sweden) and from outside Europe (Nigeria).
- The majority of the group consisted of early career researchers (Master student, PhD, Postdoc, early-career lecturer), complemented by a number of experienced senior scientists.
- Workshop participant came from different disciplines, ranging from hydrology to social science to legal science
- The group consisted of people doing both fundamental and applied research.



*Group picture of Pantarhei workshop participants*

### **Structure of the workshop**

The workshop was structured in the following way.

- General introduction to the state of drought research in the Anthropocene
- Thematic presentations and discussion on specific topics aligned with the specific research questions of the Drought in the Anthropocene working group
  1. Influence of humans on hydrological drought at the local scale
  2. Influence of humans on hydrological drought at the large scale
  3. Drought impacts on people & drought risk
  4. Response of people to drought
- Definition and planning of new research projects

In addition, there was an icebreaker to give the (new) participants the chance to introduce themselves to each other in an informal way. A poster session was hosted to facilitate detailed sharing of individual research among the group members. Social events, such as dinners in the evening and an excursion to Breisach were carried out to further strengthen the connection within the group. The complete agenda of the meeting can be found in Annex 3.

## General introduction

After a word of welcome by workshop organizers Veit Blauhut (Freiburg University) and Anne Van Loon (University of Birmingham), a general introductory keynote lecture was given by Henny van Lanen (Wageningen University). The keynote lecture provided a state of the art of drought research in the Anthropocene. In his presentation, Henny van Lanen showcased that up to now most hydrological research focusses on natural processes; aiming to better understand how climate and catchment properties modify the precipitation signal when it propagates through the hydrological cycle. However, anthropogenic influences cannot be ignored in a human-modified world and more recently, different studies try to include the human dimension into drought research. There are a lot of opportunities for more drought research in the Anthropocene which might have to start by rethinking the definition of drought. Overall, this introduction provided a knowledge basis for the rest of the meeting that was focused on more specific thematic topics.



*Word of welcome by Veit Blauhut*

## Thematic sessions

This section summarizes the four thematic sessions and presents the key challenges identified within each session. The thematic sessions started with a presentation of an invited keynote speaker that provided an overview of the state of the art and key challenges within the specific research theme. Afterwards, everyone had the opportunity to present one slide on a topic related to the session. Following was a group discussion related to the topic of the session.



*Different keynote speakers: Gemma Coxon (left), Niko Wanders (middle) and Jürgen Vogt (right).*

### 1. Influence of humans on hydrological drought at the local scale

The keynote lecture of this session was given by Gemma Coxon (Bristol University). She highlighted the absence of human influences in many of the commonly used catchment-scale hydrological models. Future research should aim to do this as many of the real-world catchments are not free of human influences. There are opportunities to learn from other research communities, such as large-scale modeling, as well as from other disciplines that already integrate these processes in their modeling structures.

After the keynote lecture, an update on the Drought in the Anthropocene synthesis project was given by Sally Rangecroft (University of Birmingham). For the case studies considered in the Synthesis project

, groundwater abstractions were found to intensify streamflow drought whereas reservoirs could both intensify and mitigate hydrological drought conditions downstream. Results are promising but more case studies are needed as well as a better spatial coverage in some areas of the world for which less data is available (e.g. Africa, Asia). In the discussion slides, Jean-Philippe exemplified for France that human influences go further back in time (19<sup>th</sup> century) and Simon Parry presented the different sources of data available for the UK.

The group discussion was carried out in a “snowballing” format. For the first round, the group was divided into pairs that discussed key challenges of analyzing human influences on the catchments scale. In the following rounds, groups merged together to form groups of increased sizes. In the end, results of the group discussion were shared and discussed in plenary. The following key challenges were identified.

#### Key challenges

- To generalize lessons learned from case studies to the larger scale
- Biases when scaling up results from local (case study) research
- The collection of meta-data
  - How much data is needed?
  - How to collect metadata scarce regions?
- The long reference period needed for drought research (30+ years)
  - Human systems change more rapidly
  - New data does not have such long reference periods
- Most study focus on the hydrological cycle. How to broaden our view and include the perspectives of stakeholders such as water users and water managers?



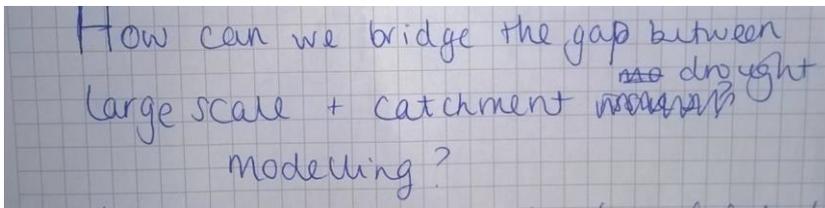
*“Snowballing” group discussion; from small (left) to large groups (right)*

## 2. Influence of humans on hydrological drought at the large scale

Niko Wanders (Utrecht University) gave the keynote lecture on the state of the art of research to human influences in large-scale hydrological models. Nowadays, several large-scale models exist that incorporate human influences. However, more research and data is needed, especially when using models to a finer resolution with the goal of making them locally relevant. To fill the lacing data gap, there is a big opportunity for the use of satellite data.

After the keynote lecture, Anne Van Loon presented a comparison between large-scale modeling output and observations and discusses possibilities to bridge the gap between large and local scale studies. Another possibility to bridge the gap between large and local studies was presented by Erik Tijdeman (Freiburg University), who showed a screening method to identify catchments that have drought characteristics that deviate from those expected under natural condition.

The following group discussion was again started in smaller sub-groups. Everyone could write one question related to the session on a piece of paper. These questions were then given around among the subgroup members that provided their answers and opinions on the stated questions. In the end, a few questions were discussed plenary while the rest of the questions were posted on poster boards and discussed during the poster session.



*Example of a question*

#### **Key challenges**

- Link between large and local scale models or observation
  - How to learn from each other?
  - How to make large-scale models locally relevant?
- Making better use of satellite data
- Use of multi-model ensembles – where do they agree and disagree and why?
- Dealing with non-stationarities
  - Inter-annual changes
  - Differences in timescales
  - Modeling of non-stationary processes
- The use of large-scale models for decision making
- Validation large-scale models with stakeholders
- Combining of detailed hydrological models with conceptual vulnerability models

### **3. Drought impacts on people & drought risk**

Jürgen Vogt presented the state of the art of drought impact and vulnerability research carried out at the Joint Research Center (JRC). The goal of the JRC is to produce large-scale drought vulnerability maps using various vulnerability factors in order to inform policy makers. Their global products are validated with local users and can predict where problems of drought are likely to happen in the near-future.

Following was a presentation by Veit Blauhut who shared the results from a global drought risk analyses review to address the current challenges of drought risk research. Key findings are the triple

complexity of drought risk analysis: the inseparable linkage between hazard, vulnerability and impact information and the need to assess these in order to investigate drought risk appropriately.

For the discussion, the workshop participants were divided over three groups: local, regional and international scale, to discuss on the level specific challenges. Subsequently, the results of the thematic discussion were further discussed in plenary and revealed some of the key challenges of a vulnerability assessment and risk analyses at different scales.

#### Key challenges:

- **Investigate data (spatial and temporal resolution), especially impact & vulnerability information, elaborate citizen science**
- **Make drought impacts visible to public and stakeholder of all levels**
- **Guidance on data usage & suitability: what are suitable drought indices and vulnerability factors with regard to different impact categories**
- **Common overall DRA approach(es?) but impact category specific analyses:**
  - **How can a nested approach for different scales look like?**
- **Communicating drought risk: how to “sell” risk analyses to stakeholders with regard to their specific information needs**
- **Science – Policy interfacing: get politicians interested. Foster an implementation of Drought Risk Management to national/ international legislation, foster integrated river basins management**

#### Response of people to drought

Bethel introduced the session with a story on mismanagement in northern **Niger**. Following, Sylvia Kruse took over and opened the floor for a very different view on drought management: the legislative aspects. Victoria Calliet and Peter Zoth from Heidelberg University gave some highly interesting insight to water management strategies and implementation into the legal framework in California, Spain and Germany.

They identified that a variety of different strategies to mitigate the impacts of drought are present, and a variety of drought management plans could be used for guidance. Nevertheless, mostly the political commitment is missing and therefore a legislative implementation missing.

Group discussion: split into three thematic groups I) risk awareness, II) Implementation & Enforcement / Management tools, & III) science policy interfacing, following the major questions of: ??

I do not have the notes on this anymore ;(, have to ask the rest!

#### Data Session

Discussion on data sources & data sharing.

**Data sources:** satellite data (see Google Earth Engine), human influence data, citizen science data, social media data, historical data

**Data sharing:** Panta Rhei map, large sample Panta Rhei group (Gemma), online labs like SWITCH-ON (<http://www.switch-on-vwsl.eu/>), and basin-info for catchment info and meta-data

Feldfunktion geändert

### Defining new research projects

Various key challenges and opportunities for future research were identified during the discussions of each thematic session. The last session of the workshop aimed to translate these challenges into concrete research topics. Everyone wrote on a post-it note one specific question or topic to work on in the future. These notes were then grouped based on their topical similarity. Workshop participants with the same future research interest then sat together to come up with new research projects suitable for a student dissertation (Table 1). These projects were then shared in plenary, where every participant could indicate interest in future involvement. All projects will be advertised as student project topics at the universities of the workshop participants.



*Post-it notes with future research interests grouped by topic*

Other:

- strengthen links between working groups by being member of more than one working group
- share data & do collaborative projects on SWITCH-ON platform
- next meeting: 2018 workshop in the Netherlands, smaller meetings at AGU & EGU
- website launch: <https://iahs.info/Commissions--W-Groups/Working-Groups/Panta-Rhei/Working-Groups/Drought-in-the-Anthropocene/>

Feldfunktion geändert

### Concluding remarks

The Panta Rhei – Drought in the Anthropocene workshop managed to bring together a mix of early-career and experienced scientists from different disciplines. An update on progress made since the previous workshop clearly showed the value and potential of the working group (Annex 1). These projects will be further developed the coming year. In addition, the current workshop identified a whole range of new challenges and corresponding research projects (Table 1). These projects will be presented as student projects among the different research institutes of the workshop participants. In the end, this will establish new research collaborations between institutes and fosters a better understanding of drought in the Anthropocene.

What is about the “Whats missing in Panta Rhei” part. We had discussion on that as well!

Table 1: future student project topics and interested/involved group members

	Topic	Core group	Further involved
Reconstruction	Human impact on low flows and floods (1900-2010)	Lena, Niko, Sigrid	
	Building of a narrative of the drought impacts for the major droughts (e.g. 1893, 1921, 1947-49) in central Europe	Mathilde, Jean-Philippe	Veit, Simon
	Modelling of historic drought events in Eastern Europe	Mathilde, Jean-Philippe	Veit, Simon
Vulnerability & risk	Comparative analysis of vulnerability and risk across sectors and scales	Gustavo, Veit	Marthe
	Seasonal drought impact forecasting	Henny	Jurgen, Niko, Veit, Marthe, Lena, Simon, Sony
	How to translate risk to policymakers?	Veit	Doris, Pieter
	Value of large-scale risk assessment for locally-specific vulnerability	Gustavo	Veit, Anne, Bethel, Marthe
Socio-hydrology	Thresholds for dryness that triggers drought response	Pieter	Giuliano
	Upstream-downstream comparison of human influences: a literature review	Marthe	Anne, Bea, Pieter, Henny
	Survey: why and how do people respond to drought	Veit, Alexandra	Marthe, Bethel
	Cost-benefits analysis of drought responses	Veit	Bethel, Marthe
	How are droughts communicated in social media?	Anne	Henny, Veit
Water quality	Water quality around the globe: which water quality parameters are affected where?	Bethel	Jan, Jennifer, Jost, Michael
	Water quality at the catchment scale: which water quality parameters are impacted by drought?	Anne (Danny)	Jan, Jennifer, Jost, Bethel, Michael, Gemma, Veit
Attribution	Model inter-comparison among virtual models, hydrological models with human influences and water management models with hydrology	Gemma	Sally, Anne, Erik, Niko, Giuliano, Buruk, Bethel, Pieter, Doris
	Finding hotspots of climate-induced & human-induced drought	Anne	Erik, Buruk, Bethel, Bea, Niko, Pieter, Jean-Philippe, Lena, Joshka, Sally
	Benefits of humans aggravating drought	Anne	Veit, Bethel

Scales	Comparing large-scale hydrological models with case studies	Anne	Niko, Gemma, Henny, Lena, Erik, Joshka, Verena
	Applying the observation-modeling framework on the large scale to identify human-induced hotspots	Anne	Sally, Niko, Henny, and many others
	When where and why do humans affect streamflow	Gemma, Niko, Jean-Philippe, Erik	Henny, Lena, Anne, Doris, Jost, Simon, Verena
	Evaluate different approaches for comparing natural and human-influenced hydrological time series	Sally, Gemma, Anne	

### Annex 1: ongoing and new research projects

Topic	Lead	Contributing	Status
Synthesis project	Sally	All	collection of case studies, writing a draft paper
Review paper on human dimension & drought in large-scale models & satellite data	Marjolein	Amir, Niko, Giuliano, Pieter, Erik	Draft paper
Questionnaire on responses & drought policies	Alexandra & Veit		Draft questionnaire developed - will be adapted
Investigate "ideal" model including humans	Niko	Amir, Giuliano, Gemma, Marjolein, Anne, Pieter	On hold
Bridging the gap: comparing case study results with large-scale models	Anne	Amir, Sally, Niko	Analysis ongoing and presented at conference
reservoirs & drought: learning from different approaches (opinion paper)	Giuliano	Sally, Niko, Linda, Anne, Pieter, Amir	Adapting paper for different journal
A case study to the effect of reservoirs/abstraction on big lakes	Pieter	Amir, Anne, Wouter, Giuliano, Niko, Koen, Eric	Change of Leadership
Use virtual modeling to test groundwater policies	Doris	Anne, Erik, Gemma, Veit, Peter, Mark	Change of Leadership
Check irrigation with satellite data	Linda	Niko, Veit, Marjolein, Anne, Amir, Doris Fabian, Alexandra ...	On hold. Someone interested to lead?
Evaluation of approaches for comparing natural and human-influenced hydrological	Gemma	Sally, Anne	Moved to student project
Interlinkages between hydropower operation and droughts in data scarce regions	Alexandra		New project (started 2017)

## Annex 2: list of participants

Alexandra Nauditt	Cologne University of Applied Sciences, Germany
Anne van Loon	University of Birmingham, UK
Beatriz Quesada Montano	University of Uppsala, Finland
Benedikt Heudorfer	University of Freiburg, Germany
Bethel Ugochukwu Ukazu	University of Nigeria, Nigeria
Buruk Kitachew Wossenyeleh	University of Leuven, Belgium
Doris Wendt	University of Birmingham, UK
Erik Tijdeman	University of Freiburg, Germany
Ezra Haaf	University of Göteborg, Sweden
Gemma Coxon	University of Bristol, UK
Gustavo Naumann	Joint Research Centre, Italy
Henny van Lanen	University of Wageningen, The Netherlands
Inge de Graaf	University of Freiburg, Germany
Jan Greiwe	University of Freiburg, Germany
Jean-Philippe Vidal	IRSTEA, France
Jennifer Lizeth Bocanegra Díaz	Cologne University of Applied Sciences, Germany
Joschka Thurner	Cologne University of Applied Sciences, Germany
Jürgen Vogt	Joint Research Centre, Italy
Kerstin Stahl	University of Freiburg, Germany
Lena Merette Tallaksen	University of Oslo, Norway
Marthe Wens	University of Amsterdam, the Netherlands
Mathilde Erfurt	University of Freiburg, Germany
Niko Wanders	University of Wageningen, the Netherlands
Pieter van Oel	University of Wageningen, the Netherlands
Sally Rancecroft	University of Birmingham, UK
Samuel Sutanto	University of Wageningen, the Netherlands
Sigrid Bakke	University of Oslo, Norway
Simon Parry	CEH, UK
Veit Blauhut	University of Freiburg, Germany
Verena Maurer	University of Heidelberg, Germany
Victoria Caillet	University of Heidelberg, Germany
Wibke Müller	University of Heidelberg, Germany
Peter Zoth	University of Heidelberg, Germany
Irene Kohn	University of Freiburg, Germany
Michael Stölzle	University of Freiburg, Germany
Marit van Tiel	University of Freiburg, Germany
Michael Kraft	University of Heidelberg, Germany
Jost Hellwig	University of Freiburg, Germany

## Annex 3: agenda

**Sunday:** 16:30 – Erik’s icebreaker

19:00 – Dinner at Restaurant “Feierling”

### Monday:

9:00 Welcome by Anne & Veit

9:15 Opening- keynote lecture by Henny van Lanen

10:00 coffee

10:30 Block 1a) Influence of people on drought - Hydrology at small/local scale: Key Note by Gemma Coxon, Chairs: Lukas Menzel & Anne van Loon, State of the art (Sally & Giuliano), discussion

12:30 Lunch at local Mensa

13.30 Block 1b) Influence of people on drought - Hydrology at large/global scale: Keynote by Niko Wanders, Chairs: Lukas Menzel & Anne van Loon, State of the art (Anne), discussion

15:30 Coffee

16:00 BOG- discussion

17.00 Snacks and drinks - poster session

19:00 End

19.30 Dinner @ restaurant Paradies

### Tuesday:

8:30 Block 2) Drought impacts on people → Drought risk: reciprocal effect of nature and anthropogenic usage, keynote by Jürgen Vogt, Chairs: Kerstin Stahl and Veit Blauhut; State of the art (Veit & Irene), discussion

10:30 Coffee break

11:00 Block 3) Response of people to drought: drought policy and management, keynote by Teodoro Estrela Monreal, Chair: Sylvia Kruse, State of the art (Veit & Alexandra; Giuliano?), discussion

13:00 Lunch

14:00 Session 1) Data: what do we know, what do we need, how will we share?

15:00 Session 2) “What is missing in the Panta Rhei- Drought in the Anthropocene working group” e.g. water quality, ?space for your thoughts?

16:00 Social event: Historical city of Breisach – Guided tour by Prof. Dr. Tobias Schütz + champagne tasting, dinner afterward

**Wednesday:**

9:00 Break out group discussions on the way forward

10:30 coffee

11.00 Paving the way forward

12.00 Wrap up and closure