JCAR ATRACE

Research topic inventory

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Colofon

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Version	Author	Check	Approved
0.9	K.Slager	JCAR partners	Jaap Kwadijk

Summary

On the November 29, 2023 JCAR ATRACE was officially launched during the Benelux Waterday. As part of this day, research or study topics have been identified guided by researchers from JCAR ATRACE in co-creation with competent river basin authorities and other river basin stakeholders. This research and study topic list will be the base for further scoping research studies (knowledge agenda) and study projects within JCAR ATRACE. Each of the competent authorities of the regional river basins will be approached by regional focal points in 2024 in order to further discuss planning and potential research implementation.

Contents

1 Research topic list

In this chapter a full list of research and study topics suggested and discussed at the Benelux Waterday is presented. The topics are mainly grouped now along the lines of the workshop groups and not (yet) along the lines of regional river basins. Further, the list requires a structural assessment. For each region a focal point from JCAR ATRACE is mentioned and this person will contact competent authorities and stakeholders to follow-up in 2024.

The inventory of research topics should be considered non-exhaustive and non-ordered. Topics need to be further discussed, structured and defined in co-creation with the knowledge clients before it can be programmed within JCAR ATRACE. The Scientific Programme Council of JCAR ATRACE will advise on the prioritization of study projects and given available budget time and capacity, the operational management team (OMT) will organise the resources. It is intended to identify and select at least one research topic per region to initiate new study projects in 2024 within JCAR ATRACE.

1.1 Flanders – North-Brabant

The Flemish Environment Agency (VMM) in Flanders, presented their lessons learned and current actions with regards to extreme floods. The concluding messages on flood risk management in Flanders are: 1) cross-border cooperation is crucial, 2) need for setting operational targets on flood and drought risk (also in European context), 3) A Multi-layer flood risk approach is their main principle, 4) prioritize nature-based solutions and 5) utilize opportunities to link to other policy goals.

During the workshop with participants from Flanders and Province of North-Brabant several research topics were proposed (see Table 1). Topics marked with an asterisk (*) have been mentioned also in other workshop groups.

Besides this first list of research topics, the participants expressed their need for (1) a regional roadmap for policy-relevant research development Flanders – North-Brabant, (2) explore the setup of a Benelux working group to facilitate more regular meetings between competent authorities and to connect to JCAR ATRACE researcher and (3) explore long-term

(beyond 5 year) continuation of this research initiative, potentially through joint research financing and programming.

Focal points for this region are Patrick Willems (KU Leuven) and Kymo Slager (Deltares) and they will follow-up with other JCAR ATRACE partners on these ideas with the knowledge clients in 2024.

Table 1 Overview inventory research topics on floods and droughts in Flanders and North-Brabant

ID	Description
1.1*	Weerbaar waterland implementation: risk assessment (incl. comparison between countries), definition goals, integrated waterbalance and modelling in river basin
1.2*	Upstream nature-based solutions: until what level are these effective to mitigate floods and droughts
1.3*	Impact of flooding on environmental pollution (e.g. polluted sediment) in nature2000 areas
1.4*	Insight in cascade in flood preparedness: precipitation, floods forecasting, warning, crisis response; how do regions compare and is an uniform approach desirable?
1.5	Best practices, bottlenecks, upscaling potential of participative processes and area coalitions (Water+Land+Schap); sociological research
1.6*	Systemic processes, institutional-legal barriers, strategic management science (overview on best practices, bottlenecks)
1.7	Joint transboundary crisis management exercise
1.8	Learn from experiences in Flanders on housing climate label / information label floods
1.9	Mapping water extractions in transboundary river basins
1.10	Align maps of Flanders / Netherlands on height maps, rivers, sewage treatment plants, urban overflows, water resources infrastructure
1.11*	Insight of cumulative impacts of measures within river basin

In 2023 KU Leuven and Deltares already started the design of a transboundary stress test approach for floods and droughts in regional river basins in this region. This design study will already directly contribute

as information base to topic 1.1, 1.2, 1.3, 1.7, 1.10 and 1.11. The study is planned to be finalized in 2024.

1.2 Wallonia

SPW Agriculture, Ressources naturelles et Environnement from Wallonia presented a very thorough and interesting overview of the evaluations done, projects and actions executed and under way in Wallonia after the July 2021 floods. SPW ARNE is interested in future collaboration and exchanging knowledge to learn more about 1) best practices with (inter)national partners: Flanders, Netherlands, Germany, Luxembourg, France, 2) development of a hydrological model for an entire cross-border catchment area (e.g. Roer – Gueule), 3) development of a project on artificial intelligence for flood forecasting on 'natural' watercourses (link between weather forecasts and potentially flooded areas). These ideas may also be explored in the form of new Interreg proposals.

Participants from Wallonia discussed the research topics as presented in Table 2. Topics marked with an asterisk (*) have been mentioned also in other workshop groups. Focal point for the region is Benjamin Dewals (Université de Liège) and he will follow-up with other JCAR ATRACE partners on the ideas with the knowledge clients in 2024.

Table 2 Overview inventory research topics on floods and droughts in Wallonia (between brackets reference to topics suggested in the workshop instructions)

ID	Description
2.1	Flood vulnerability of the population and the potential effect of preventive measures (9)
2.2*	Study on the impact of weather extremes on the resilience of critical infrastructures and map the critical infrastructures at river basin level.
2.3*	Tools for estimating (predictive) flood damage to guide action of households (16)
2.4*	Dependence of upstream-downstream stakeholders in water system functioning, future water demand, policies: water quantity and water quality at river basin level. Potential for tool and strategy (12)
2.5*	Search for areas of temporary flooding at basin level (rather than local/regional level)

2.6*	Potential effectiveness of hydromorphic soils in adapting to / managing floods and droughts at river basin level – also in urban areas (11)
2.7*	Study to pollution risk from floods in residential areas
2.8*	Post-crisis analyses of functioning water infrastructure in river and pluvial flooding (10)
2.9*	Required governance to strengthen practical transboundary water management; requires common language and reference (6)
2.10	Requires also renewed attention for mapping canals and piped drainage (14)

1.3 Luxembourg

The Administration de la gestion de l éau in Luxembourg presented a valuable list of lessons learned after the floods of 2021. Important flood risk management aspects were mentioned to improve: 1) evaluate of a flood event, also focusing on the impacts from flooding, such as economic damage, impacted areas, evacuations, etc., 2) satellite images, which do not have high enough resolution for Luxembourgh, 3) major public awareness-raising campaigns are needed, to strengthen individual responsibility/resilience during flood crises and 4) specific platforms for knowledge exchange, such as an annual symposium, would be possible. Key messages from the presentation were: a) it is not just the warning that is important, also the way is it is communicated, b) good collaboration between the various authorities must succeed, based on clear procedures in advance, and c) good flood risk management has several aspects and must be monitored and adapted regularly, if needed.

Participants from Luxembourg discussed the research topics as presented in Table 3. Topics marked with an asterisk (*) have been mentioned also in other workshop groups. Focal point for the region is Laurent Pfister and Davide Zoccatelli (LIST) and they will follow-up with other JCAR ATRACE partners on the ideas with the knowledge clients in 2024.

Table 3 Overview inventory research topics on floods and droughts in Luxembourg (between brackets reference to topics suggested in the workshop instructions)

ID	Description
3.1	Evaluation of an event with a focus on flooding impacts (damages, impacted areas, evacuations) – satellite images often do not have a high enough resolution for Luxembourg
3.2*	Influence of vegetation on flood risk and its effect on floodplain maintenance
3.3*	Clogging on bridges: stability, pressure, change in overflow expansion (10)
3.4*	Crisis communication: regional warning, water level warning, ensembles, uncertainties
3.5*	Criteria for cross-border drought / low water management
3.6	Concept of assessing the impact of drought / low water (in hindsight)
3.7*	Joint climate change scenarios for the regional development and impact modelling
3.8*	Interaction surface-groundwater during low water and minimum flow rates
3.9*	Dealing with extreme, meteorological forecasts and probability of occurrence and influence on discharge values
3.10*	Evaluation of the crisis communication strategy and tools: how to reach the general public with the most crucial information on the situation
3.11*	Major flood awareness raising campaigns and strengthening individual responsibility/resilience during crisis

1.4 North-Rhine Westphalia

Referat IV-6 Hochwasserschutz und Talsperrenmanagement from BMUV in North-Rhine Westfalia brought some important actions under the attention from the ’10-Punkte-Arbeitsplan Hochwasserschutz in Zeiten des Klimawandels’. Some of these actions also relate to transboundary cooperation: 1) introduction of flood forecasting systems for as many water bodies as possible, 2) State-wide flood information and reporting service, 3) Improvement of flood protection on site and 4) Dam safety and management: e.g. reduction of residual risk and disaster control management. In addition, NRW wants to expand the nationwide hydrological database, e.g. cross-border research into historical floods, testing of supplementary methods for extreme events and consideration of climate change impact on flood statistics.

Participants from North-Rhine Westphalia discussed the research topics as presented in Table 4. Topics labeled with an asterisk (*) have been mentioned also in other workshop groups. Focal points for the region are Holger Schüttrumpf and Elena Klopries (RWTH Aachen). They will follow up with other JCAR ATRACE partners on the ideas with the knowledge clients in 2024.

Table 4 Overview inventory research topics on floods and droughts in North-Rhine Westphalia

ID	Description
4.1*	Comparison of best practice examples of water body restoration and their effects on flood retention and droughts
4.2*	Determination of the changes in flood discharges under climate change conditions in transboundary river basins
4.3*	Robustness and applicability of impact-based flood forecasting models (areal flood modelling in transboundary river basins)
4.4	Joint Information (GIS) calamity portal
4.5	What is the influence of land use /cover on runoff and water availability?
4.6	The increase of beaver population and their impacts during floods on flood protection
4.7	Unifying modelling assumptions for transboundary river basin

4.8 Comparison of warning values: Different comparison values are used in The Netherlands, Germany (Northrhine-Westfelia, Rhineland-Palatinate), Luxemburg, Belgium and France leading to confusion in the context of early warning. Therefore, a transfer matrix is required to translate warning values from one country to the other including the national meaning of the individual warning values. Warning values should be regarded in the context of flood hazard maps and flood risk maps.

4.9 Monetary compensation of flood protection measures: Acceptance of flood protection measures is often a critical issue especially in upstream areas protecting downstream areas. Flood retention areas are foreseen in upstream areas where the need is often not seen. Acceptance in upstream and often rural areas is low since for example farmers and forestry have to provide land for retention areas or have to transform landscapes into sponge areas. They have to provide not only land but loose income as well. Therefore, a kind of monetary compensation would be helpful to increase acceptance, to gain time and to transform flood protection into an economic benefit.

4.10 Measures for floods and droughts: Droughts and floods are often treated separately even if measures for floods are often effective for droughts as well. Especially, soil improvement measures can be of benefit for both sides of the hydrological cycle. Therefore, a comprehensive literature study with recommendations of soil improvements is proposed.

4.11 Historical flood events: One of the interesting topics of the 2021 event was that similar events occurred in the past but were neglected in modern flood protection. Therefore, it is important to establish a comprehensive database (including flood marks, flood events, description of floods, etc.) for all relevant rivers to improve the statistical basis. More discussion is required on how to include this information in modern flood risk management. An important question in this context is : Is the 100-year flood really the 100-year flood if historical flood events are considered?

4.12 Flood retention of large dams: A number of dams are situated in the upstream areas of the Maas-river. These dams have a large retention capacity and distributed to the mitigation of flood risks in downstream areas (especially in The Netherlands) in 2021. In addition, these dams contribute to drought and low water mitigation as well. Therefore, it has to be investigated on how to optimise and improve the regulation of the dams to further

	mitigate flood and drought risks. Which is the discharge which can be ensured without any damage in downstream areas. Are further retention areas (e.g. mining pits, natural reserve areas) available? How can the dams be regulated including early warning, weather forecasts? A tool is required which considers the impact of the flood discharges from the dams on downstream areas.
4.13	Dam break scenarios: Dam breaks will have an impact on downstream areas. In 2021, the Steinbach dam in the Erft catchment was very close to failure. It is unclear what will happen in the case of a dam breach of the large dams and which areas are affected. This can be due to floods but due to earthquakes, terrorism as well. Therefore, a rough estimation of possible affected areas is required including the cross-border aspect.
4.14	Improvement of flood hazard maps: Flood hazard maps are the first tool to assess the risk of flooding. Flood risk maps are less used. Therefore, it is the question if flood hazard maps must be improved by additional information (e.g. Water level, passability of bridges, roads, etc.). An important aspect is the extent of flood hazard maps across borders as well. Therefore, topic 7 should be seen in context to topic 1. An additional question is, do we need any additional flood levels (instead of the three levels provided by the EU flood framework). Especially for operative issues some additional (both in between and above the existing flood levels) could be helpful. Flood hazard maps should be also improved for flood defense and operational aspects during flood events.
4.15	New flood statistics: New flood statistics are required on the basis of 2021. This aspect can be seen in context with topic 4.11 as well as in the context of the very high water levels and discharges which were far above the design discharges in 2021. Do we need new approaches, new values, how do we consider retention areas, cross-border aspects, etc.?

1.5 Vechte area

Participants from the Vechte area discussed the research topics as presented in Table 5. Topics labeled with an asterisk (*) have been mentioned also in other workshop groups. Focal points for the region are Angela Klein (Deltares) and Holger Schüttrumpf (RWTH Aachen). They will follow up with other JCAR ATRACE partners on the ideas with the knowledge clients in 2024.

For this area a scoping study among all stakeholders in the region has been commenced in 2023, which will be discussed and finalized in 2024.

Table 5 Overview inventory research topics on floods and droughts in Vechte and GPRW (between brackets reference to topics suggested in the workshop instructions)

ID	Description
5.1	Waterbombe simulation in Vecht river basin and 'Achterhoek' river basins
5.2	Automated cross-border precipitation measurement network to verify radar images
5.3*	Effectiveness of sponge landscapes on flood and drought risks (11)
5.4	Erosion processes during extreme precipitation
5.5	Drought Information System Vecht river basin
5.6*	How effective are flood adaptation measures at house and business level (9)
5.7*	Upstream & downstream dependencies in the functioning of the water systems
5.8	Drought -> coordination and exchange of information on permits for irrigation
5.9	Regional 'verdringingsreeks' for regional river basin: how to achieve this?
5.10	What data exchange is needed to build a cross-border groundwater model?
5.11*	Enhancing of cross-border forecasting models: what is needed for this?
5.12	How can politicians and decision-makers be motivated to work together across borders?

5.13	What can water management look like when individual countries are affected by the encroaching drought disaster?
5.14*	Which governance structures need to be abandoned in order to optimise cross-border cooperation for water management?
5.15*	How can inundation areas be useful in extreme dry periods?
5.16*	What adaptive measures are available for the implementation of sustainable long-term flood protection? E.g. swamp and floodplain renaturation
5.17*	To what extent should renaturalisation in rural areas (e.g. of watercourses) consider extreme precipitation (drought/floods)?

1.6 Limburg

The province of Limburg, provided three key messages on the 2021 floods for Limburg: 1) we need an improved transboundary system on early warning on the regional river basins, 2) we need a transboundary approach to minimize the consequences of extreme floods and 3) we need more attention to flood risk management in smaller regional river basins.

Participants from Limburg discussed the research topics as presented in Table 6. Topics labeled with an asterisk (*) have been mentioned also in other workshop groups. Focal points for the region are Jeroen Aerts (VU) and Kymo Slager (Deltares). They will follow up with other JCAR ATRACE partners on the ideas with the knowledge clients in 2024.

Several of the topics identified are directly related to transboundary cooperation with Wallonia and North-Rhine Westphalia.

Table 6 Overview inventory research topics on floods and droughts in Limburg regional water systems

ID	Description
6.1*	How can we make cross-border cooperation a regular feature (structure it)?
6.2*	What is maximally feasible in terms of increasing sponge effect (e.g. Deltares study: 70% of water is already in the sponge)?
6.3	What is the probability of coincidence high water Meuse and tributaries?

6.4*	What results can we achieve by retaining more water on Walloon territory? What is the maximum range and what is needed to achieve it?
6.5*	In a system approach to river basin Geul/Gulp (from source to mouth), can a no regret measure also be found quickly?
6.6	We can measure, but with 130 m3/s discharge no time to warn? Can we improve this with big data (measuring versus forecasting)
6.7	How to achieve international agreements on crisis situations/scaling-up in crisis situations, congruent methods and models?
6.8	How can the importance of aspects other than flooding be demonstrated when deploying Nature Based Solutions (think drought, nitrogen, etc.)?
6.9	Which ambitions in the spatial domain can be concretely taken together? (e.g. housing and energy transition)
6.10*	How to achieve data exchange. Whether or not for integration into national systems --> unification
6.11	Research on international knowledge system
6.12	How do we ensure (1) actuality and (2) transparency of what is going on in the regions?
6.13	How to improve multi-day weather forecasts for the purpose of warning systems in small-regional basins?
6.14	Assessment of existing research in view of decision making on possible measures and strategies
6.15	Warning systems for regional / pluvial flooding multiple days ahead on a postcode scale

1.7 General

Other participants discussed more general research topics as presented in Table 7. Several of the identified topics may in general be relevant for transboundary cooperation on flood and drought risk. As JCAR ATRACE focuses on regional river basins, only the research topics that can be directly related to the regional basins will be further discussed later in the programme. The topics will be considered by all JCAR ATRACE partners where applicable in the geographical areas or in general.

Table 7 Overview inventory research topics on floods and droughts in general or the Meuse main river basin

ID	Description
7.1	Can we make/follow course on international cooperation?
7.2	How do we achieve river basin-level planning (and decision-making)? How do you do that? And how do you facilitate decision-making?
7.3	What is needed to jointly develop a successful river basin management plan for the Meuse river basin?
7.4	How do we strengthen the IMC's mandate for better cross-border cooperation?
7.5	How to properly distribute water in case of extreme drought? Cross-border and area-specific (arrive at a cross-border displacement series per river basin)
7.6	The 2021 floods caused a lot of ecological and morphological damage at the Meuse. Could you prevent this?
7.7	How do you reserve enough and the right space in the landscape to achieve a resilient system?
7.8	How can we develop information exchange system to gain real-time insight into dam and hydropower plant management during (the run-up to) high waters on the Meuse? And how can this be incorporated into overarching models?
7.9	How to deal with uncertainties in discharge and water level forecasts for operational water management?
7.10	How do we get more insight into Walloon weir management on the Meuse (with hydropower plants)? This leads to large unpredictable effects downstream with major problems
7.11*	How can we increase forecasting capability? Incl improve chain management and clear (international) agreements on codes green, yellow, orange and red (or also blue?) aimed at informing the public (what does a code mean and what should/shouldn't you do?
7.12	Is a single crisis coordinator needed for the entire Meuse basin? ('international Meuse boss')
7.13	What activities raise people's awareness of water (both high and low water)?

7.14	What level of protection can you achieve/guarantee in a resilient stream/river system? (Taking climate and culture into account)
7.15	How do we arrive at "one language"? One hydro base from source to mouth?
7.16*	How do we make different GIS systems work well together? (So that we can make uniform maps at catchment level). Is about unifying GIS and data storage systems. How are we going to create a metadata portal in this programme?
7.17	Is AI suitable for quickly calculating deviating scenarios during high waters on the Meuse (e.g. calamities caused by shipping, blockage of weirs/failure of the Liege barrage July 2021, failure of measuring points, etc.)?
7.18	How to deal with the unknown 'unknowns'?
7.19	What is considered potential significant flood risk (floods directive) in the countries?
7.20	Share of stakeholders in a solution
7.21	How to ensure that research results will be picked up practice -> strategies per country, organisation
7.22*	What are to be expected cascade effects related to floods? Vital infrastructure? Water quality?
7.23	What are opportunities for room for the river in urban areas?
7.24	Is it possible to increase awareness using serious gaming
7.25	How is decision making organized on both sides of the borders
7.26*	Impact of reservoir management downstream
7.27*	Interaction of Water quality and quantity in view of flood and drought mitigating measures
7.28	How to store water (in groundwater or at the surface) during wet periods for later use
7.29	What is the effect of land use on water management during extreme wet and dry conditions
7.30*	What are sponge landscapes
7.31	Development of an app for evacuation
7.32	Effect of the closing of lignite mines on the groundwater
7.33*	What are topics for transboundary cooperation

2 Preliminary synthesis

Th meetings during which JCAR ATRACE collected these topics were short and the individual topics mentioned were not all discussed in detail. As was stated before, we can consider this a preliminary albeit quite extensive list of topics that have the attention of the various stakeholders. However, scattered the topics, we can identify some first commonalities:

- There is a clear interest in the geographical dependencies, e.g. upstream and downstream impacts of measures (a.o. the ecosystem-based) and what is required in terms of governance to strengthen practical transboundary water management.
- Several authorities feel they lack a complete overview of (joint) data, information and knowledge available, particulary at river basin scale. This counts for all of the transboundary regional river basins. Next, there seems no common understanding about who are the various stakeholders and what is exactly their stake in that river basin.
- The need for common forecasting and warning systems, including effective common crisis communication (government to government, government to public).
- Remarkably absent were research questions (despite one or two) focused more on the recovery phase in disaster risk management.
- Frequently mentioned themes are, beyond many of the topics put forward in the workshop instructions:
    - statistics on flood protection design;
    - water-soil system understanding under extreme conditions (stresstests);
    - functioning of water infrastructure under extreme conditions;
    - impact of housing policies / flood zoning on flood awareness;
    - effectiveness of adaptation at household level;
    - effectiveness and limits of ecosystem-based solutions.

The themes become also relevant in a transboundary setting since perspectives how we use standards, what we consider acceptable and even what we mean with these themes varies from country to country. For a joint development of river basin management, a common understanding, a common language, is considered pivotal.