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Integrating nature-based solutions in German flood risk management: A matter of individual beliefs?

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Abstract: The formulation of management plans is not only a key instrument for implementing EU environmental policies, such as the Floods Directive, but also important for supporting the uptake of nature-based solutions (NBS) into practice. Previous research has indicated that the uptake of NBS, such as in flood risk management plans (FRMPs), is still low and hindered by various elements of the existing water governance system. However, the self-perception of water managers in their role as "plan-makers" of solution strategies and programs of measures, as well as their beliefs in choosing certain measures in the plan-making process, has been neglected so far. The aim of this study was to shed more light on the plan-makers' reasoning for integrating or not integrating NBS into specific FRMPs in Germany. We conducted qualitative interviews and adopted a grounded theory approach to identify plan-makers' beliefs that underlie the process of formulating FRMPs as well as their role perception and responsibilities in this process. The analysis revealed several shared substantive and relational beliefs that were predominantly elicited to justify the non-integration of NBS in FRMPs. The identified beliefs about NBS do often not align with their self-perception of their roles in being the "plan-makers". We present a differentiated portrait of water managers as key actors in the decision-making on FRMPs, illustrating that while water managers are belonging to the same distinct professional group with a similar social role in the decision-making process, they do not necessarily share the same preferences.

Keywords: Flood risk management, Nature-based solutions, Policy implementation, Decision-making, Belief, Germany

1. Introduction

For several years now, European policy has been driving nature-based solutions (NBS) with the aim to tackle environmental challenges while achieving a greener economy and

sustainable development (REF). The European Commission defines NBS as *actions inspired by, supported by or copied from nature; […] [that] use the features and complex system processes of nature, such as its ability to store carbon and regulate water flows, in order to achieve desired outcomes, such as reduced disaster risk and an environment that improves human well-being and socially inclusive green growth* (EC 2015, p. 24). NBS and related concepts (e.g., ecosystem-based approaches, green infrastructure and natural water retention measures) are already frequently mentioned in various EU policy frameworks (Davis et al. 2018). A key issue, however, is the adoption of the NBS concept in the context of enforcing these policy frameworks. One potential policy instrument to support NBS implementation is the "greening of plans" (Droste et al. 2017; cf. Sarabi et al. 2019; Albert et al. 2020). The formulation of plans has become an essential instrument of EU environmental policy, in particular for implementing the Water Framework Directive (WFD) and the Flood Directive (FD) (Newig and Koontz 2014). The WFD and FD require its member states to develop management plans by assessing the current situation in a river basin, formulating measures, including NBS-type measures (EC 2012), to improve the situation and involve the public and non-governmental actors.

Research has only began to examine the uptake of NBS in water management plans. Although there are some studies that have examined the integration of the ecosystem service (ES) approach – a key component of NBS (REF) – into river basin management plans (RBMPs) or urban plans (Hansen...Geneletti). Only few studies have analyzed the uptake of concrete measures qualifying as NBS in flood risk management plans (FRMPs) (Huq...Brillinger). It is shown that the ES approach is slowly adopted by some RBMPs, while the uptake of certain NBS-types in FRMPs is still relatively low. The reasons why concrete NBS are (not) chosen for certain plans are largely unexplored. Several studies have identified biophysical and socio-economic (e.g., limited land, development trends), institutional (e.g., lack of funding, ...), and actor-specific barriers (e.g., stakeholder knowledge and perceptions) for implementing NBS in water management (REF), but deeper insights on the reasoning behind choices for NBS in RBMPs and FRMPs are widely lacking. It is particularly noticeable that research on NBS implementation has not yet adopted an actor-related perspective to explain the low uptake of NBS in the water policy arena. Such a perspective is helpful, in our opinion, because the integration of NBS into water management plans is the outcome of a policy implementation process (e.g., of the FD) whereby the actors involved have decided for or against certain measures. Research on the NBS uptake should therefore focus on the role of actors in the plan-making process and their interpretations, interests, capacities, and institutional environment.

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The aim of this study is to shed more light on the plan-makers' reasoning for integrating or not integrating NBS into specific FRMPs in Germany. We adopted a grounded theory approach to identify plan-makers' beliefs that underlie the process of formulating FRMPs as well as their role perception and responsibilities in this process. Qualitative data were collected using semi-structured interviews with plan-makers who were in charge of the formulation of one or more FRMPs in the German federal states of Hesse, Lower Saxony and Saxony. This paper begins by outlining our theoretical understanding of the role of individual beliefs in the formulation of FRMPs and the importance of plan-makers in this process. This is followed by the method section, outlining the approach used to identify beliefs in the interview material. After the presentation of the identified belief clusters in the result section, their importance for the NBS uptake in FRMPs as well as practical implications will be discussed.

2. Conceptual framework

The uptake of NBS in FRMPs is viewed here within the "Management and Transition Framework" (MTF) of Pahl-Wostl et al. (2010). It is "an interdisciplinary conceptual and methodological framework supporting the analysis of water systems, management processes and multi-level governance regimes". Following adaptive management (cf. Holling 1978), social learning (cf. Pahl-Wostl et al. 2007), and the role of institutions in collective decision-making processes (cf. Ostrom 2005), the MTF is not constrained to a specific theory, but provides a standardized language for analyzing management processes and governance systems that can be adapted to specific research questions. Special attention is given to the role of actors in social interactions (cf. Mayntz and Scharpf, 1995).

We use and refine elements of the MTF to a specific action situation: the formulation of FRMPs. The formulation of FRMPs is a collective choice process within the policy cycle for the implementation of the Floods Directive (2007/60/EC), whereby competent authorities need to choose measures for flood risk management through the "active participation of all interested parties" (para. 10, s. 2) to reduce the potential adverse consequences of flooding (Newig and Koontz, 2014). However, the FD does not define substantive goals, but merely specifies the formal requirements for the plan formulation process (REF). Not only technical flood protection measures (e.g., dikes), but also non-structural (e.g. behavior precaution) and natural water retention measures (e.g., wetland restoration) should be taken into account at the river basin level (Hartmann and Juepner, 2014; Collentine and Futter, 2016). In addition, scenarios for minor, occasional, and seldom (extreme) flood events should be considered (Hartmann and Juepner, 2014). These formal requirements for choosing measures to the FRMP challenge traditional planning of flood protection and initiate a paradigm shift towards

a risk management approach, drawing more attention to the importance of participatory planning and the legitimization of measures (Hartmann and Spit, 2015). Because of this, and because there is leeway in interpreting how to design the required planning procedure for the FRMP formulation (REF), the collective choice on suitable measures for flood risk management provides opportunities of social learning. Social learning represents a more explorative search process where the actors involved jointly develop, discuss and test (innovative) solutions for a problem (Pahl-Wostl 2009). Depending on the extent to which social learning is facilitated in the process, traditional measures or planning practices can be adapted, other problem framings and solution strategies can be explored, and underlying planning structures and processes can be reviewed (REF). In the end, the FRMP formulation process can lead to different operational outcomes. The direct outcome is the FRMP document with its contents such as concrete measures and results of the flood risk assessment. Indirect outcomes can be new institutions, e.g. in the form of new planning methods, and new knowledge such as new insights about the flood risk.

We further focus on one specific actor group - those in charge of formulating FRMPs, here called the plan-makers. This group includes individuals, usually from water management authorities, who are assigned to implement the formal planning requirements of FRMPs for a particular river basin district. Their role in the plan formulation process is subject to (normative) expectations. Plan-makers should ensure pro-forma implementation, but also satisfy the need to change existing flood management toward a more sustainable flood risk management (Heintz et al.; Jong et al.). They need to design the participatory planning process and can create opportunities for experimentation and learning to improve the quality of decision-making (Newig et al. 2016; Hartmann). They not only have to understand technical and engineering aspects of flood risk management but also moderate the participation process, weigh the interests of different actors and resolve (spatial) conflicts (Hartmann and Driessen, 2017). How actors generally act in a collective choice process is constituted by their personal characteristics and the influence of the institutional context in which the decision-making takes place (Scharpf 1997). A retrospective explanation of the decision for (or against) specific measures by actors requires an understanding of their individual reasoning for decisions in the context of the underlying management paradigm and rules (institutions) of the water (governance) system (Schlüter 2009, Pahl-Wostl et a. 2010). In the MTF, an actor's reasoning for his/ her decisions is rooted on his/ her mental model, i.e. the “internal representations that individual cognitive systems create to interpret the environment” (Pahl-Wostl et al. 2012; Denzau and North 1994, 4). It means that individual actors base their choices on their selective observation and subjective understanding of how their social-ecological environment works. We refine the mental model of an actor to his or

her beliefs about how reality works (positive beliefs) and how the actor wants it to work (normative beliefs). A belief is understood here as relatively stabilized mental model that has emerged because the subjective understanding has been confirmed several times by environmental feedbacks (Mantzavinos et al, 2004). We further differentiate between substantive and relational beliefs. Substantive beliefs refer, in the broadest sense, to the inter-dependencies and cause-effect-relationships of the social-ecological environment, and, in the narrow sense, to the decision situation under consideration. The latter is about the actor´s beliefs regarding the (decision) problem to be solved, possible solution strategies and their expected consequences as well as about the feasibility of solution options. In contrast, relational beliefs refer to planner´s knowledge about other actors (e.g. their skills and role in the decision-making process) and their self-perception of the own role (Scholz et al. 2014).

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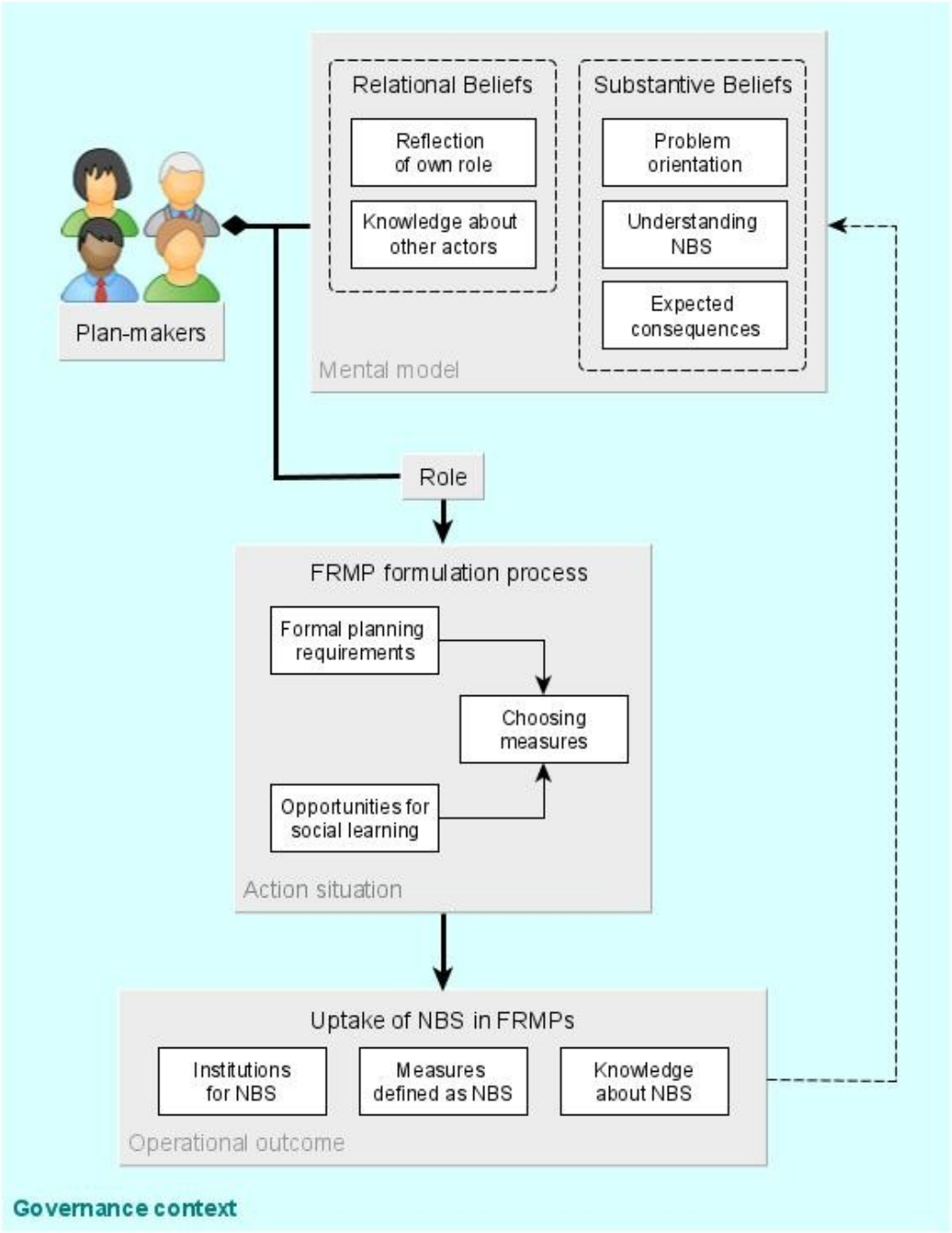

Figure 1: Stylized representation of the role of plan-makers and their beliefs about the uptake of nature-based solutions in the process of formulating flood risk management plans (FRMPs), adapted from Scholz et al. (2014).

Figure 1 illustrates the importance of substantive and relational beliefs of plan-makers for the uptake of NBS in the FRMP formulation process. The choice to integrate certain measures into FRMPs is a reasoned decision induced by plan-makers and their beliefs about NBS and flood risk management. Although, of course, other actors are involved in the process and have a say in decisions, the plan-makers are the ones who shape the involvement and participation of other actors and the practices (rules) for the choice of suitable measures through the design and execution of the FRMP formulation process. The decision as to which

and how measures are integrated is justified, on the one hand, by a plan-maker's substantive beliefs. Each plan-maker holds a particular problem orientation, in our case a particular subjective view of the purpose of formulating FRMPs, has a particular understanding of what NBS is, and thus associates certain measures with it, as well as judges the consequences of NBS in relation to flood risk management differently. Therefore, the decision to integrate NBS into FRMPs depends on what the planner thinks to know about the problem (e.g., more unidimensional or multidimensional), about nature and its benefits to people, and about nature-based measures and its effectiveness, profitability, and feasibility for solving the problem. On the other hand, a plan-maker's relational beliefs influence her or his role in the choice of certain measures. The integration of NBS into FRMPs depends on whether the plan-maker sees himself in the role of introducing NBS measures into the process and advocating for the choice. Even though not all NBS measures are completely new, they are often not common practice and have a transformative character (REF). If plan-makers actively advocate for more NBS or design the process in such a way that more NBS could be integrated, they can act in a way as change agent. Exploring NBS in the FRMP formulation process can result not only in the uptake of nature-based measures in the FRMP document, but also in knowledge about and in planning practices for NBS in flood risk management, leading in turn to changes in plan-makers' beliefs on how to mitigate floods with nature's support.

3. Method and material

The data for this study is derived from semi-structured personal interviews with plan-makers who were in charge of the process of formulating FRMPs in the three federal states of Hesse, Lower Saxony and Saxony in Germany. The sample is based on the contact details in the FRMP documents from Brillinger et al. (2020), using a snowball effect by asking the respondents at the end of the interview for recommendations of other involved plan-makers. In this way ten persons from different organizational levels in water management – namely upper water authorities, river basin communities, intermediate water authorities and planning offices - were interviewed from April to June 2018 (see Appendix A).

The interviews are semi-structured, based on questions that functioned as a lose structure but not as a fixed guideline so that the interviews have a more spontaneous character in their narration. This is due to the different roles the interviewees had in the process which are part of the study and were not obvious before the interviews were conducted. Furthermore, the processes differed between the federal states so that the interview structure was supposed to develop its own dynamic during the interviews. The guiding questions build on the results of the analysis of FRMPs in Brillinger et al. (2020) and focused on four topics: i) the

professional background and experiences with flood risk management, ii) reconstruction of the FRMP formulation process in the respective federal state, iii) reflection on selected content of a certain FRMP the interviewee was in charge of, and iv) factors influencing decisions for measures. These main questions were added by spontaneous questions, for example concerning a certain step in the process or the role of NBS. The interviews differ in length between 60 and 120 minutes and were audio recorded and transcribed afterwards as a whole for the next step.

The steps of the Grounded Theory methodology (Strauss/Corbin 1996) were used for the analysis of the interview material and adapted to the present study. In a first step, the transcripts were openly coded in order to identify main aspects in the process of formulating FRMPs - including individual views on NBS - and reflections about the interviewees on their own role and the role of other actors the process. In a second step, the generated codes were clustered along the main topics that functioned as categories and were then interpreted and linked to each other in a causal loop diagram (see Appendix B). Along Glaser's theoretical coding (Glaser 1998, 2005) in the last step, the categories were associated with substantial and relational beliefs from the conceptual framework (see Figure 1). Each step throughout the process was carried out independently by two researchers with different disciplinary backgrounds (social sciences and economics) to ensure the intersubjective comprehensibility of the interpreted results.

4. Results

4.1. Relational beliefs

4.1.1. Self-reflection of the role in the FRMP formulation process

The respondents were asked to describe what role they hold in the process of formulating the FRMPs. The overall response is shaped by the position that the respondent holds in his or her organization in the respective federal state. Nonetheless, most of the responses indicate a common understanding regarding their meaning and function for the formulation of FRMPs and the planning of flood risk management measures. The majority of interviewees report that they were responsible for coordinating the creation of at least one or more FRMPs in their federal state. Frequently mentioned tasks in this context are the cooperation with other authorities (I1, I7, I9, I10), public involvement (I3, I4, I5, I6, I7, I9, I10) and the commissioning of external service providers to carry out individual planning steps, such as the development of hydrological models, creation of flood risk and hazard maps, effectiveness analyses and environmental impact assessments (I3, I5, I7, I10).

In terms of public involvement, some respondents were primarily concerned with providing information to local authorities, for example in the form of maps (I1, I2, I3, I10). Others emphasize the importance of raising public awareness and acceptance for flood risk management (I1, I2, I6, I7, I8, I10). A few state it is important that various stakeholders get together, share their views about FRMP outcomes and check its plausibility (I1, I3, I6, I7, I10). As common strategy for how actors were involved in the process, some respondents mention that info events and workshops were organized and stakeholders could submit written comments to the responsible authorities (I1, I3, I4, I5, I6, I7, I10). The main focus of the respondents is set on the municipalities (I2, I3, I4, I7, I8, I9, I10), although the importance of other stakeholders' involvement, such upper water authorities and landowners, is also mentioned (I2, I3, I4, I8, I9, I10). Two interviewees point out that public involvement presents a new challenge for them (I6, I10) meaning that it was not part of their work before the FD.

Moreover, most of the interviewees report that they were responsible to compose a program of measures (I1, I3, I4, I5, I7, I8, I10). A common practice was that all competent implementers of measures, such as municipalities and dike associations, were asked to report on measures already planned and implemented by means of a questionnaire (I1, I3, I4, I8, I9, I10). The reporting of measures was voluntary (I1, I2, I7, I9) and the reported measures were stored in a database and systematized (I3, I4, I8, I9, I10). In addition, some respondents report that they rated the submitted measures along their effectiveness and prioritized them (I1, I6, I8, I9).

4.1.2. Perceiving the role of other stakeholders in the FRMP formulation process

During the interview, the respondents comment on various actors and their roles in the formulation of FRMPs. Most of the statements concern municipalities (I2, I3, I4, I5, I8, I9, I10) and water associations (I4, I5, I9), (local) politicians (I2, I8, I9, I10), farmers (I3, I4, I5, I6, I10) and government authorities (I1, I2, I7, I8, I9, I10). The respondents' views on these actors were similar in this regard but often rather critical. For example, many respondents emphasize that the task of municipalities and water associations is to report measures for the FRMPs and then to implement them (I1, I2, I3, I5, I7, I8, I10). However, a number of respondents complain that municipalities are often unfamiliar with flood risk management issues and rarely participate in the planning process (I1, I4, I7, I9). About the role of politicians, it is said that although they are important actors for planning measures they show little interest in flood risk management unless there is an urgent need for action (I8, I10). Some notice they would tend to favor measures that reflect the will of the public and those affected but not necessarily the advice of plan-makers (I8, I10). Statements about the role of farmers in the planning process related primarily to negotiating with them about their land. It

is reported that there are often conflicts with farmers because they either do not want to give up their land (I3, I4, I5) or have not seen their own benefit if their land is flooded more frequently through a nature-based measure (I4, I10). The role of upper government authorities in the preparation of FRM, by contrast, is perceived as beneficial, as they provide political support and determine what should happen in flood risk management (I1, I7, I9). Only the low staffing for the processing of the FRMPs is criticized by a few respondents (I1, I7, I8).

4.2. Substantive beliefs

4.2 .1. Problem orientation regarding the formulation of FRMPs

The problem orientation describes the respondents' subjective view about the purpose of FRMPs. A common view amongst the respondents is that the FRMPs present an additional, but not a new element of flood risk management. They note a rethinking but not a reinvention of how to cope with floods as a result of the Floods Directive, in which not only technical flood protection but also non-structural measures (e.g. behavioral precaution, warning systems) are considered (I1, I3, I4, I7, I8, I10). In this context, most respondents emphasize the main goal of effectively lowering flood risk by reducing potential damage to people and their activities, buildings and facilities (I4, I5, I6, I8, I9). Often the reference quantity are rare flood events like 100-year floods or extreme events (I1/2, I4, I5, I8, I10). Some respondents add that flood risk management aims also to create synergies with the Water Framework Directive (WFD) and nature conservation (I1, I2, I4, I8), while a few mention the creation of retention areas as further objective (I4, I6).

Furthermore, the majority of respondents states that the main goal of the FRMPs is the systematic collection of existing considerations of measures and their comparability in order to fulfill requirements of the Flood Directive and to support the coordination of measures among federal states (I1, I2, I3, I6, I7, I9, I10). Three selection criteria are mentioned as important for the systematic collection of measures: Several interviewees emphasize that only measures that i) are necessary for flood management, ii) create synergies with the WFD (and nature conservation), and iii) are feasible are considered for FRMPs (I1, I2, I4, I5, I6, I8). For a few, the effectiveness and economic efficiency of measures is of secondary importance for the selection (I3, I6). One respondent reports that the goal is to create the FRMPs as efficiently as possible (I9).

4.2.2. *Perceptions of the term NBS and different types of measures*

Among all respondents, there is no shared understanding about what nature-based measures for flood risk management are. Some understand nature-based measures as an attempt to return to a natural state (I2, I5, I7, I9) while others consider the term "nature-based" as a compatible use of nature (I1, I2, I3, I5). A few respondents question whether a distinction between nature-based and technical measures is useful since both imply construction works that can be inspired by nature (I1, I3). Therefore, nature-based measures intervene structurally in the river system, but it is not enough, as one respondent says, to "simply throw stones into the river" (I5). Other responses are further related to the purpose of nature-based measures. Some respondents note that these measures pursue ecological goals, such as the objectives of the WFD or improving the function of floodplains (I2, I4, I9, I10), but also the need to fulfill a technical function (I4) and to create synergies (I4, I7, I10). In this context, concern is expressed about the contribution of nature-based measures for flood protection (I1, I9, I10). As one respondent puts it: "they [NBS] are accompanying synergy measures" (I7) - thus, more likely to serve as a supplement to conventional flood protection measures. Moreover, nature-based measures are classified as land-intensive (I3, I4).

In addition, the respondents mention one or more examples of measures in the discussion on nature-based measures for the FRMPs. On the one hand, a variety of measure types are associated with nature-based such as measures of the WFD (I1, I3, I4, I9, I10), renaturations (I3, I4, I5, I10), the creation of riparian forests (I4, I7), river widening (I3, I8), dike relocation (I6), polder (I1, I2, I6) and even flood control reservoirs (I1, I3). On the other hand, a number of other types of measures are mentioned as options for the FRMPs, but not in context with nature-based measures. These are namely dikes (I1, I2, I5, I6, I7, I9), the dismantling of weirs (I5, I9), property protection (I3, I4, I7, I9) and behavioral precautions such as communication measures (I3, I4, I7, I8, I10).

4.2.3. *Judging the effectiveness of NBS*

In the interviews, the respondents make a number of subjective judgments about the effectiveness of nature-based measures. The majority of respondents assume that the benefits of nature-based measures for flood regulation are generally low or limited (I1, I3, I4, I7, I8, I9, I10). With the exception of polders, it is assumed that the mentioned NBS types (see 4.2.2) have a small or even negative influence on human concerns and the flood discharge (I3, I4, I5 I8, I9). A few respondents confirmed that nature-based measures can have a potentially positive effect on frequently recurring flood events such as HQ10[1] and slow down the flood runoff (I4, I7, I9, I10). In contrast, it is doubted that these measures can

[1] A HQ10 indicates a flood event that is reached or exceeded with a probability of 1/10 every year

protect against extreme events and provide an effective relief (I1, I4, I7, I10). The effectiveness of NBS-related measures is judged depending on the intensity of the flood event (I1, I4, I7, I9, I10), the time of onset of the measure's effect (I6, I8) and the dimensioning of the measure (I3, I4, I8, I9).

One striking observation that emerges from the data is that the respondents frequently put the effects of nature-based measures into context and remark the proportionality of different types of measures. Although the NBS performance for flood regulation is generally assumed to be low, some respondents still stress the usefulness of nature-based measures (I1, I2, I4, I9, I10). Nature-based measures would generate more benefits for nature and biodiversity and for other administrative interests than flood risk management such as synergies with the WFD (I1, I2, I4, I7, I8). The proportionality of measures such as dikes, polder and flood control reservoirs is rather doubted (I4, I5, I6, I9), although their impact on flood regulation is judged more positive. One respondent states that investments in technical flood protection often do not pay off, because the costs that occur over a period of 100 years will not cover the possible benefits in terms of avoided flood damages (I9). Another respondent reports that flood control reservoirs often require a lot of maintenance and are problematic in terms of nature conservation (I4). Interestingly, non-structural measures in terms of property protection and behavioral precaution are judged exclusively positive. According to some respondents, they represent a cost-effective strategy for flood risk management and have hardly negative effects on flood events (I3, I5, I9).

4.2.4. Judging the practical viability of NBS

The respondents frequently comment on the practical viability of nature-based measures for flood risk management. These views surface mainly in relation to land availability, finances and evaluation approaches. On the theme of land availability, most respondents express concern about the procurement of land needed for nature-based measures (I2, I3, I4, I5, I6, I7, I8). Therefore, land is generally limited and different policy areas such as WFD, nature conservation, agriculture and urban planning compete for the land (I4, I5, I8, I9). Some particularly mention conflicts with farmers about land ownership (I3, I4, I5). A number of respondents also draw some conclusions from the limited availability of land for nature-based measures. For some, financial resources will be required for the land acquisition in general and for compensation payments to farmers in particular (I4, I7, I9). For this, however, a few state a lack of suitable instruments like innovative compensation schemes (I8, I9). In addition, the approvability of measures is an important criterion for evaluating the feasibility and is linked to land consumption (I3, I4, I8, I9).

With regard to the financing of nature-based measures, it is noted that the current funding conditions for nature-based measures are in principle not worse than for technical flood protection (I4, I7). For example, one respondent notices that "[...] funding rates for NBS are not significantly higher than for technical measures" (I4). Another respondent reports that the national flood protection program provides funds for natural water retention measures and dike relocation and not for dike rehabilitation (I9).

Another major theme related to the practical viability of nature-based measures is the evaluation of their effectiveness and economic efficiency. Here the respondents show a divergent view between nature-based and technical measures for FRMPs. With respect to nature-based measures, the majority of respondents reported uncertainties in justifying its necessity to stakeholders. Some of them argue that there is a lack of experiences and knowledge about how to evaluate the effects on flood regulation as well as the ecological and economic benefits of NBS-like measures (I3, I4, I8, I10). Additionally, some respondents are not aware of suitable valuation methods (I4, I6, I10), whereas others stress that number-based assessments are needed (I3, I7, I8) and especially the benefits, for example in terms of the WFD and ecosystem services, need to be demonstrated (I6, I8, I9). This is regarded as complicated for nature-based measures (I10) or can only be achieved with a large input of resources like data and staff (I8, I9). Some respondents explain that, for nature-based measures, a comprehensive evaluation is often only possible qualitatively and is usually not obligatory (I7, I8, I10). With regard to technical measures, however, the respondents commonly state little problems with effectiveness assessments and cost-benefit analyses. It is emphasized that a lot of experience has been gained, technical measures have been examined in all details and clear cost-benefit analyses are possible (I4, I8, I9, I10). With regard to technical and large-scale measures, some note that an objective and substantiated evaluation is necessary to justify their eligibility (I1, I2, I8, I9) and to explain their priority setting to stakeholders (I8).

5. Discussion and conclusion

The present study was designed to understand why plan-makers chose to integrate NBS into FRMPs or not. The choice of measures for FRMPs is viewed here as reasoned decision largely shaped by plan-makers, their mental model and their role in the FRMP formulation process. We conducted qualitative interviews with plan-makers to elicit their reasons for integrating specific measures, including NBS, into FRMPs for which they were in charge, and revealed several shared substantive and relational beliefs about NBS in flood risk management. These identified beliefs may help to explain the limited uptake of nature-based

410 measures found in Brillinger et al. (2020) in German FRMPs as well as choices of NBS in
411 other FRMPs of European countries.
412
413 With regard to substantive beliefs, the results show that interviewees perceived the purpose
414 of FRMPs as to effectively reduce flood risks, with nature-based measures being inferior and
415 technical flood protection and non-structural measures being prioritized. In doing so, FRMPs
416 are understood as an additional tool to identify shortcomings in existing flood risk reduction
417 strategies, rather than opportunities to create new strategies for river management or to
418 experiment with new practices. Historical rules of flood management still seemed to strongly
419 influence problem framing in terms of path dependency (cf. Krieger et al. 2013, Otto et al.
420 2018). This was also reflected in the strong orientation of interviewees towards risk aversion
421 (focusing on a hundred-year flood event) and the obligation of the state to provide security
422 against flood risks within clearly defined probabilistic boundaries. Further, no common
423 understanding of NBS among the plan-makers was evident in the interviews. Their
424 understandings varied in terms of normative expectations for NBS (e.g., be ecologically
425 sound, return to natural conditions, achieve WFD goals) and in terms of examples given
426 (from ecological practices to hydraulic engineering practices such as polders). An alternative
427 view of NBS as options for working with nature (Ounanian et al. 2018) and to create new,
428 functional ecosystems (REF) did not emerge. This accords with other studies reporting that
429 there is still a wide ambiguity among practitioners as well as scientists about how to define
430 and operationalize the term NBS (Moosavi et al., Bark et al, Hanson et al). Moreover, the
431 interviews illustrated that plan-makers principally question the effectiveness of NBS against
432 flood risks and its practical viability. They found NBS as more difficult to implement given the
433 need for land, and more uncertain regarding their likely impacts in actual flood risk mitigation.
434 Nonetheless, plan-makers were generally aware of the multifunctional character of NBS to
435 provide several additional ecosystem services besides their contribution to flood risk
436 management.
437
438 With regard to relational beliefs, it appeared that the interviewees had a shared
439 understanding of what role they hold in the FRMP formulation process. They interpreted their
440 role as executors of FRMP regulations as well as coordinators and facilitators of the
441 respective plan-making process, particularly with regard to public participation and
442 compilation of the program of measures. While partially recognizing the multiple challenges
443 that come with this task (cf. Hartmann and Jeupner 2014), the interviewees did not perceive
444 themselves as responsible actors for NBS implementation. In contrast, they viewed other
445 stakeholders, such as municipalities and water boards, but also farmers and politicians, as
446 responsible for promoting NBS. None of the interviewees saw her- or himself as impetus for

NBS that would have been instrumental to facilitate greater NBS uptake (cf. suitable reference here). In addition, plan-makers often anticipated resistance from other stakeholders against the implementation of NBS, especially when a potential added value could not be convincingly communicated to key players. They feared that the effectiveness and feasibility of NBS to address flood risks could not be demonstrated sufficiently to convince other stakeholders of the preferability of those measures.

Looking across the substantive and relational beliefs, our results primarily point to reasoning by plan-makers *against* the choice of NBS. First, NBS seemed to be less supportive of the purpose the plan-makers serve with FRMPs, as the focus was on the outcome of FRMP formulation in terms of effective risk avoidance, rather than the process of plan-making, such as communicating and deliberating possible measures and its risks with stakeholders (REF). Second, plan-makers' vague understanding of FRMPs implied that NBS was not part of their repertoire for managing flooding. So the question of whether NBS should be integrated into FRMPs probably might not even arise in the FRMP formulation process. Third, what plan-makers thought to know about NBS may not have matched their expectations for effectiveness, efficiency, and feasibility. Measures of flood risk management have traditionally been justified using expert knowledge, engineering evidence, and measurable data (Hartmann and spit). For NBS, however, experiences, data, and appropriate evaluation methods are often limited (REF). The assessment of the suitability of NBS for FRMPs is therefore likely to be guided by information and routines that have been proven reliable for traditional flood management. Fourth, more conflicts and resistance in the FRMP formulation process appeared to have been expected with NBS than with other measures. Particularly because plan-makers saw their role as mediating between divergent stakeholder interests with the intent of minimizing conflicts and adequately addressing stakeholder concerns, it may be counterproductive for plan-makers to propose NBS for FRMPs so as not to provoke further disputes. Interestingly, Descher and Sinasac (2020) also observed - albeit not for plan-makers and FRMPs - that residents' decisions to install green stormwater infrastructure were influenced more by their normative, relational beliefs than by their beliefs towards the effectiveness. We therefore assume that the plan-makers' current understanding of their role and their concerns regarding the acceptance for NBS by stakeholders might be another reason for not integrating NBS in FRMPs.

We further reflected on what possible lines of reasoning there would be *for* choosing NBS (see Appendix C). Given our findings, the choice for NBS may be grounded in purely factual reasons, i.e., positive-substantive beliefs. This means that plan-makers have or use solid data and knowledge about NBS and its performances, e.g. through experiences or study

results, weigh up the available information, and concluded that one NBS is more suitable than other possible solutions. Another reasoning for NBS relates more to normative-substantive beliefs. It means the implementation of NBS is basically considered right and endorsed due to societal norms, even though there are knowledge gaps and uncertainties about NBS. For example, it is assumed that NBS are fundamentally "useful", create synergies with the WFD, are good for nature and people, or contribute to sustainable development. This line of argumentation is also visible in the interviews and (often) in the scientific and policy discourse on NBS. Moreover, NBS can also be reasoned from relational beliefs. For example, if a plan-maker has the self-perception that he or she has the necessary experience and skills to drive NBS implementation, or if he or she feels obligated and encouraged to do so because other stakeholders or societal norms demand it.

The generalizability of these results is subject to certain limitations. As the findings summarized above stem only from a relatively low number of respondents, we cannot comprehensively extrapolate those results to the entire cohort of plan-makers of water management plans in Germany. Given that we already interviewed key informants from three purposefully selected federal states and given the extensive, qualitative nature of our interviews, we are confident about the broader generalizability of the results. We cannot provide a full account of the individual beliefs of all plan-makers, nor can we provide insights concerning how those beliefs might change over time. Further research is needed for better capture the temporal evolution of beliefs from an even wider set of federal states and plan-makers. We are aware that our own beliefs and mental models may have influenced our interpretation of the result, but applied intersubjective comprehensibility of individual interpretations by two scientists to avoid unidimensional interpretations.

In conclusion, we assert that the plan-makers interviewed were not sufficiently convinced by NBS in the FRMP formulation process. The identified beliefs suggest that they were less able or willing to substantively justify natural-based measures for flood risk management, and, because of their own role expectations, tended to avoid to propose potentially contentious measures in the plan-making process. Our interviews, therefore, do not indicate that the FRMPs were formulated to stimulate a discourse about different types of measures and their risks beyond engineered flood protection. We recommend that the FRMP formulation process be designed more outcome-open and that the purpose of the FRMP document be revisited. FRMPs should not just be a formality, but should be seen as an opportunity to discuss and learn with stakeholders about different ways to manage flood risks in a river basin, including NBS. The question this study raises is what role plan-makers should play in the FRMP formulation process to encourage NBS uptake. For example, should plan-makers

521 (be allowed to) actively engage in NBS uptake because they believe related measures are
522 sensible? Further research is needed to examine the role and beliefs of plan-makers and
523 other stakeholders for NBS implementation in participatory decision-making processes such
524 as the formulation of FRMPs.

525 References

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