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Research article

The spatial turn and the scenario approach in flood risk management—Implementing the European Floods Directive in the Netherlands

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Abstract: The European Floods Directive requires member states to prepare flood risk management plans for their river catchments. The first generation of those plans was just developed at the end of 2015; the next revision is due in 2021. The new instrument institutionalizes an ongoing paradigm shift from flood protection to flood risk management in Europe. It implies two major governance challenges: the spatial turn and the scenario approach. This contribution studies the implementation of these two governance challenges in the Netherlands, where the paradigm shift is considered to be advanced. Therefore, the spatial turn and the scenario approach are operationalized. The spatial turn consists of three aspects: space for the river, an integrated approach, and beyond structural measures. The scenario approach introduces the vulnerability of society in flood risk management. It is discussed how the challenges of spatial turn and the scenario approach—and thus the shift towards flood risk management—have an effect on the prevailing modes of governance in water management in the Netherlands. This helps understand the tensions and frictions with implementing the plans, but also illustrates how the European Floods Directive institutionalizes the shift towards flood risk management. The analytical scheme, consists mainly of operationalization, can foster future comparative studies with other countries and over time, to trace the changes in approaches to flood risks in Europe.

Keywords: EU Floods Directive; flood risk (management plan); (modes of) governance; spatial planning; space for the rivers

1. Introduction

Since the end of 2015, the European Floods Directive [1] has required member states to prepare flood risk management plans for their catchments. These flood risk management plans shall reduce "potential adverse consequences of flooding for human health, the environment, cultural heritage and economic activity" ([1], Article 7,2). Currently, the first generation of these plans has just been released, providing an opportunity to evaluate these new instruments of flood policy. What is so special about these plans that they need to be evaluated?

Historically, flood protection was the dominant approach to deal with floods in Europe. It is based predominantly on dikes and other engineering solutions to defend against water and enforce a strong boundary between land and water [2-5]. In the last decade of the 20th century, major floods in Europe encouraged a gradual paradigm shift. Water managers were no longer providing a "line of defence", and spatial solutions were necessary. Consequently, flood policy is now shifting from the rather robust defence against floods towards flood risk management [6-9]. By questioning and challenging existing flood defence lines, flood risk management to some extent conflicts with the robustness of existing spatial structures and land use rights [10]. Therefore, the flood risk management plan requires coordination at the level of the river basin districts as well as a collaborative approach between water management and other stakeholders ([1], Article 7,3). This ultimately requires an integration of spatial planning and water management [11,12]. This integrated approach is not necessarily innovative. However, flood risk management plans are the first attempt of an institutionalization of the paradigm shift from flood protection to flood risk management in Europe [11].

This institutionalization implies two major governance challenges: the spatial turn and the scenario approach [11].

The spatial turn refers to the need for land in flood risk management. Since the flood events in 1993 and 1995, in response to which the Dutch government released the "Space for the River" programme, the scholarly debate has acknowledged and supports the claim for more spatial flood risk management [13]. As a result of the introduction of flood risk management, water management and spatial planning have to cooperate. In the European flood risk management plan, coordination should take place at the river basin level, and the plans should take into account the relevant aspects of soil and water management, spatial planning, land use, nature conservation, and port infrastructure ([1], Article 7,1 & 7,3). Approaching the river basin as a whole means that water managers need to enter a new governance arena [14] of spatial planning. The collaborative involvement of more actors in water management is not currently consistent with the established working paradigm of water management [15], as it includes elements of "throughput legitimacy" [16], i.e., stakeholder involvement and citizen participation in flood risk management. To tackle this, new governance concepts need to be explored, such as "governance learning" [17], "co-evolutionary approaches" [18] or "interregional co-operation" [19]. Whereas it needs to be acknowledged, that although this participatory approach is new for flood risk management, at least since the European Water Framework Directive [20] water management transforms towards more collaborative planning approaches [21].

The second governance challenge is the scenario approach. In managing flood risks, water managers use design levels to determine the height of flood defence systems (e.g., dikes). These design levels are based on hydraulic modelling or expected water levels [5]. Along Dutch rivers, a norm of 1:1250 is often applied, which means these dikes should withstand a flood that statistically

occurs every 1250 years. If a dike or other flood defence measure meets this norm, the dike is regarded as "safe" and the areas behind are considered "risk free" [22]. However, recent flood events have not only illustrated the limits of flood defence but also of forecasting. Flood risk is not static but increasing in most places. Therefore, the European Floods Directive requires member states to also take different scenarios in their flood risk management plans into account, including overflowing or failing dikes ([1], Article 6,3 & 6,4). These different levels have crucial impacts on water management and also on land uses behind the dikes. Even if structural measures remain unchanged, the information on these scenarios alone makes it necessary to adapt land use behind the dikes. Several questions can arise in response to this: Should a commercial area be inundated more often than a residential area, or vice versa? What is the right level of protection for cultural heritage buildings or other public buildings? Is more differentiated land use planning required?

The spatial turn and the scenario approach are both essential aspects of the shift from flood protection to flood risk management, and European flood risk management plans need to take them into account. But how do these two aspects translate into practice? This contribution analysis shows how the spatial turn and the scenario approach have been treated in the first generation of flood risk management plans. The result of this analysis teaches about how policy and practice deal with flood risk, but more importantly, it can help provide lessons learned for future generations of flood risk management plans. In addition, this contribution suggests an operationalization to analyse the paradigm shift in flood risk management.

Analysing the implementation of European directives requires national case studies. Various studies have been conducted. A special issue in the Journal of Flood Risk Management explored the spatial turn and the scenario approach in the UK [23], France [24], Germany [25,26], and the Netherlands [12]. However, this research was conducted before the finalization of the first generation of the plans. It indeed laid out the basis for this research. Also an analysis of the Swedish implementation of the Floods Directive has been published before the first plans have been released [27]. Other analysis of the implementation of the Floods Directive focused on the process of setting up the plans (for example in Germany) [17] or the changing stakeholder involvement [18]. Most of the existing studies focus on the process towards the flood risk management plans. Academic analysis of and reflection on the final flood risk management plans are rare yet, which mainly has to do with the fact that the first generation of plans has just been published in the end of 2015. So, this contribution can be considered as one of the first academic analysis of published flood risk management plans to be reflected on in an international journal.

The Floods Directive itself gives limited guidance for member states in setting up these plans [28], but leaves the concretization of the instrument to individual member states [29-31]. Thus, each member state has to transpose the Floods Directive into their respective domestic water laws, eventually leading to different implementation instruments and institutions. The Netherlands are often considered as forerunners in water management in Europe and they have a fairly advanced approach to integrated water management [32]. The Floods Directive has also been developed based on a Dutch proposal for a flood prevention programme [12,33]. Therefore, this contribution analyses the implementation of the Floods Directive, in particular flood risk management plans, in the Netherlands.

A methodology was developed to trace the spatial turn and scenario approach in flood risk management plans. Before elaborating on the method and the analysis, the governance challenges are discussed in more detail in the following sections. Afterward, the spatial turn and the scenario

approach are operationalized so that they can be analysed. Finally, the experiences with the flood risk management plans in the Netherlands are discussed and a conclusion is drawn with suggestions for further research questions.

2. The spatial turn

Based on the European Floods Directive, two characteristics of the spatial turn in water management can be distinguished. Coordination at the entire river basin districts, and including all relevant aspects of soil and water management, spatial planning, land use, nature conservation, navigation and port infrastructure [11]. This means water managers have to take into account the areas behind dikes, manage the entire basin of rivers, and work together with other sectors as water management. Spatial planning and water management have to cope with different modes of governance [7,15,34]. It is interesting to note that a catchment approach is not entirely new in European water policy. The European Water Framework Directive (WFD) already demands a more spatial approach to water management. It was actually the first European attempt to a catchment approach in water management [35,85]. However, in the field of flood risk management, the institutionalization of the catchment approach can be considered as new.

The literature research on the operationalization of the spatial turn brings three aspects to light that indicate a spatial turn: the policy of more space for the river, an integrated approach to the issue, and an approach beyond structural measures.

2.1. Space for the river

Starting in the last decade of the 20th-century, awareness that water needs more space has risen in the highly urbanized Western-Europe areas [36]. The European Commission affirmed that a shift in managing floods is necessary: "straightening of rivers, settlement of natural floodplains and land uses which accelerate water runoff in the rivers' catchment areas" [37]. The floods in 1993 and 1995 on the River Rhine gave place for a conversation about the river doctrine. First, the Dutch government formulated the policy "Ruimte voor de rivier" (space for the river) [38]. The idea quickly spread to Germany and the UK [39]. By literally retreating the traditional "line of defence" between water management and spatial planning, the retention capacity of river systems is increased and vulnerabilities are reduced, but at the same time it brings along more complexity for water management, including conflicts on property rights and land use [40].

In a traditional approach to flood protection, the dike is the division between the responsibilities of the water manager and the spatial planner. But dike reallocations, floodplain excavations, flood channels, barrier removals, and retaining water have considerable impact on land use and infrastructure [5,41,42]. The idea of space for the rivers is to retain water. Water retention is about temporarily storing water in the water cycle [43]. There are technical measures, such as dikes and controlled polders, but also natural flood management, which includes measures that "alter, restore or use landscape features to manage flood risk" [44]. These measures have the potential to reduce extremes in the flow discharge, and thus help level out flood conditions. Besides preventing flood damage, such measures can also have beneficial effects for the environment [8]. However, "policy initiatives in floodplain restoration were, in the late 1990s, limited to a few forerunners" [8]. Even still, implementation of space for the rivers is hampered by the lack of available rights on land (i.e., land use and land ownership) [40].

Other measures that fit in the "space for rivers" doctrine are natural water retention measures (NWRM). These include (1) interception (retaining water in and on plants), (2) increased plant transpiration, (3) improved soil infiltration, (4) ponds and wetlands, and (5) reconnecting the floodplain. These measures have the potential to reduce extremes in the flow discharge, and thus help level out extremes [43].

Finally, space for the rivers means to increase retention capacity in the hinterland by natural water retention measures or along the stream with natural flood management. The more a flood risk management plan takes the "space for the rivers" doctrine into account, the more it turns towards a spatial approach, or spatial turn [11]. One consequence of the space for the rivers policy is that it increases land use and property rights can often conflict, as more land is needed.

2.2. Integrated approach

A further characteristic of the spatial turn is an integrated approach to flood risk management. This integrated approach refers to cooperation between stakeholders in three ways: across the dike, along the river, and between sectors.

First, cooperation across the dike means the dike does not function any longer as a physical boundary between responsibilities of water managers, or flood risk management, and spatial planners [3]. Although this separation of responsibilities is not a formal divide, in practice the dike was a separating line between the two institutions for a long time.

Institutions with responsibilities on both sides of the dike have to cooperate. This has a huge impact on spatial developments, as there are great cultural differences between water managers and spatial planners [14]. In an integrated approach, a characteristic of the spatial turn in flood risk management, water management, and spatial planning need to be integrated within each other [44-46]. This is not without disturbance, as both institutions pursue fundamentally different governance approaches [15].

Second, the catchment perspective of integration: flood risks should be coordinated for the river-basis, has long been agreed upon in the scholarly debates [47,48]. Consequently, the Floods Directive demands a catchment perspective for the flood risk management plans [49]. Up and downstream measures influence each other, which makes teaming up more important [50,51]. Furthermore, cooperation along rivers can prevent free-riders but imposes a great challenge for historically grown (governmental) institutions. In search for a better fit, existing institutions are oriented around biophysical systems like the river basin [52]. Misfits always occur and "fit-for-purpose governance" can be a solution [53]. This requires national and internationals cooperation of institutions.

Thirdly, an integrated approach means different sectors have to cooperate. Urban development and water management along rivers requires a more integrated and coordinated approach to water management and spatial planning. A long rivers space is limited and urbanization often high. Waterfront development is attractive to a city [54], as it can be developed as a multifunctional space for economy, ecology and social activities on the interface between land and water [55]. Multiple sectoral orientated work fields have to come together. Water management becomes facet policy instead of a sectoral policy [56]. Covering the whole river basin from a national level fits in the traditional approach of top-down [15]. This involves a lot of actors and makes water management problems wicked [53,57]. This imposes new challenges on how to deal with this complexity in water management.

The integrated approach, consisting of integration across physical boundaries (such as dikes), across catchments, and across sectors, is inherent to the spatial orientation of flood risk management. These three dimensions of integration can therefore be used as indications of the spatial turn.

2.3. Beyond structural measures

The third characteristic of the spatial turn in flood risk management is the extension of the scope of measures used in flood risk management beyond structural measures. The ongoing paradigm shift in water management over the last 20 years from a "defense against floods" to a more integrated and management approach of "flood risk management" [6,7,58,59] has also led to changing methods and measures. The focus is not solely on protecting against floods by taking technical and engineering measures to reduce flood risks [60], but extends to reducing the vulnerability in floodplains [5,7].

There are different ways to categorize the measures in flood risk management, often along the risk-cycle [61]. A categorization that makes the difference between structural and non-structural measures explicit, and at the same time illustrates the spatial turn, is suggested by Patt & Juepner [5], which they linked to the German Working Group on water issues of the Federal States and the Federal Government [62,63]. Accordingly, measures can be distinguished in four groups: spatial flood protection measures, structural measures, precautionary measures, and disaster management.

- Spatial flood management includes the provision of inundation zones, and retention in the river, polders, and hinterland [64]. Measures such as natural water retention management (see above) are included. Many measures for spatial flood management relate to space for the rivers, but decentral rainwater management [41] or retention by certain land use in the hinterland (i.e., reforestation, agricultural water management, etc.) [64] are also measures of spatial flood protection measures.
- Structural measures mainly cover dikes and dams, but certain mobile flood barriers or measures in the sewage system are of a technical or engineering nature. Such measures are sometimes referred to as 'grey' infrastructure [65].
- Precautionary measures include adaptive building, individual risk prevention, or information. Those measures form the most diverse group, including approaches such as laws and regulations [6], economic instruments [50], voluntary agreements [19,25], awareness-raising and improving information [66], flood-related databases and so on [67]. Most of those measures can be summarized under the keyword 'resilient city'.
- Disaster management refers to all measures that enable more effective and efficient actions during a flood event. Among those measures are flood forecast warning systems and briefings and trainings of disaster forces [5].

Non-structural measures are becoming increasingly popular in flood risk management. In particular, spatial flood management and precautionary measures are an indicator of a spatial turn: whereas structural measures show themselves mostly along riverbeds and in coastal areas, (most) non-structural measures spread out over the whole flood-prone region and sometimes even further in the hinterland. This involves water management behind dikes, and cooperation between water managers and other sectors. This is how those measures can be considered a characteristic of the spatial turn in flood risk management.

Table 1. Characteristics of the spatial turn in flood risk management.

1: Space for rivers
Retreat flood defense lines
Increase natural flood risk management
2: Integrated approach
Across physical boundaries (beyond dikes)
Across catchments (upstream and downstream)
Across sectors
3: Beyond structural measures
Spatial flood management
Precautionary measures

3. Scenario approach

Beyond the spatial turn, another feature of the flood risk management approach of the Floods Directive is the scenario approach. In accordance with the Floods Directive, flood risk maps must depict different flood scenarios: "floods with a low probability, or extreme event scenarios; floods with a medium probability (likely return period ≥100 years); and floods with a high probability" ([1], Article 6,3). These scenarios form the basis for the flood risk management plans. This requirement forms the scenario approach and it has crucial implications.

The scenario approach accepts that structural measures that are based on one design level are not sufficient to prevent damage, even "[…] the use of engineered flood defences (e.g., embankments and dikes) has increasingly been viewed as counterproductive. Flood defences fail to provide safety, have adverse effects on natural retention space for water, create a false public sense of security behind defences, and are costly to build" [58]. This effect has been described as the dike paradox or escalator effect [68]: investments in structural protection measures may increase risk, as people feel safe behind the dikes and accumulate value [69].

Using design levels and a technically-oriented approach to flood risks creates a lock-in [70]. Flood risks are continuing to increase in most parts of Europe. This is not only due to changing environmental conditions, triggered by climate change, but also due to demographic and economic developments. This requires a different approach to flood protection [71]. Climate change raises the urgency and pressure on water management [14,72]. Technical flood defenses can respond poorly to changes in context. Managing this increasing flood risk requires a different approach. In recent years, awareness has grown about considering flood plains behind dikes as "risk free" [22]. Floods in recent decades, however, have made clear that dikes alone cannot provide complete safety [58,73,74]. As outlined above, the rising awareness of the "risk-free myth" gives way to flood risk management. This assumes that flood risks can differ and that calamities will occur [10]. The use of scenarios embraces this option and acknowledges that 100% flood protection is impossible and flood risk instead can at best be managed [7,75]. A risk-based approach does not only focus on the probability of the hazard but also on the consequence and the vulnerability of society.

The formal requirement of the Floods Directive to incorporate scenarios has the following implication: it raises the discussion on the risk absorption capacity of different land uses. In Eastern Germany there are parts of the country where the dike is the most expensive construction, which takes the approach of one design level ad absurdum [76]. The scenario approach of the Floods

Directive opens the debate whether it is technically possible or economically desirable to protect all properties with the same protection level [6]. Essentially, it puts questions like these into the discussion on flood risk management: where should the kindergarten or the gas station be? What may be in the zone that is inundated in extreme floods: residential or industrial sites? Such questions essentially affect issues of justice, effectiveness, legitimacy and efficiency of flood risk management [16,77]. In Europe, flood protection by technical measures is the most prevalent approach to deal with floods. It basically transfers responsibilities from the individual to the state [68]. As a result, the government is responsible for the impact of the flood, and ultimately makes flood protection part of the welfare state [24]. The scenario approach questions this relationship.

Also, "the mere existence of information about flood scenarios creates a responsibility to address such questions" in land use planning [16]. Investments in flood protection have a direct impact on the value of the property behind the dike. The technical measure has made people more wealthy. Improving the measure makes more people richer, but is unsustainable on the long term. Because spatial planners are used to balancing different interests, and they always discriminate between different land uses [78], "spatial planning can make people poorer or richer" [79]. Because of new approaches to flood risk management, water management can make people poorer or richer.

The aforementioned issues show that the scenario approach opens new discussions about flood risk management. Whereas the spatial turn has already been much discussed in literature since the 1990s, the scenario approach is less prevalent in literature. The question now is, how the spatial turn and the scenario approach interact in the realization of flood risk management plans, as prescribed by the European Floods Directive. This will be shown in the subsequent section, using the example of the Netherlands.

4. Flood risk management plans in the Netherlands

The Dutch government tried to implement the plan with minimal institutional changes [28]. Accordingly, flood risk management plans are set up on the national level in cooperation with lower tiers of government [33]. Plans were prepared through 2015 for the four river catchments on which the Netherlands participate: the Rhine, the Meuse, the Schelde and the Eems. In general, the four plans are alike, with only minor differences (e.g., geographical specifications). So, although explicit reference is made in the following text to the flood risk management plan of the Rhine as the most important catchment for the Netherlands, the findings apply to the other plans as well. The plan documents have the character of general master plans, providing guidelines on how to achieve defined goals. To what extent are the spatial turns and the scenarios mirrored in the plan documents?

4.1. Spatial turn

The spatial turn can be characterized with the three elements: space for the rivers, an integrated approach, and measures that include precautionary and spatial measures.

Space for the rivers means moving dikes and flood defense lines as well as natural flood risk management. Regarding the first aspect, the Dutch flood risk management plans give way to reaching the mandatory protection levels in more ways than a traditional approach of enforcing technical measures, such as "creating more space for rivers in their riverbed can be an attractive alternative for dike reinforcement, because this can contribute to prevent critical water levels" ([80] p.48). For moving the "line of defense", the plans offer multiple options, in particular "floodplain or shore lowering,

removal of summer quays and creating bypasses" ([80] p.53). Creating calamity polders is not seen as a realistic option because of the institutional difficulties, as already explored earlier [81]. Ultimately the foreseen measures all have a substantial impact on the land uses along rivers.

In terms of natural flood risk management, the plans stress that Dutch water systems are of great importance for many other sectors: "branches of the Rhine are also busy shipping lanes; the IJsselmeer and the Markermeer are large freshwater basins and play an important role in agriculture and the drinking water supply. Almost all waters in the river basin also have a function for recreation and wet nature (fresh, brackish, and salt)" ([80] p.29). The multi-functional aspects are consistently highlighted. The Dutch flood risk management plans strategically search for combinations of measures for flood protection and other goals: "where possible, the Netherlands takes opportunities to combine measures for flood protection with goals in other sectors" ([80] p.48). Regarding urban developments, the use of a floodplain is restricted ([80] p.52), but the flood risk management plans do not explicitly incorporate ambitions on further restricting land use, as Dutch water policy in the 1990s did [13]. In this respect, the plans can be seen as a step backwards. In the plans, the focus is put on enforcing flood defenses and broadening rivers [80].

The integrated approach of the spatial turn incorporates three aspects: integration across physical boundaries (beyond dikes), across catchments (upstream and downstream), and across sectors. Regarding the first aspect, the Floods Directive demands that flood risk management plans are coordinated at the level of river catchments, also incorporating areas behind dikes. Because in the Netherlands the risk of flooding covers most of the country, the flood risk management plans and their related maps illustrate "significant risks of floods, which will result in fatalities or have a substantial impact on society at a national level" ([80] p.19). Areas behind dikes are explicitly incorporated. This embraces the integrated approach demanded by the Floods Directive. This is particularly important because in the wider public, flood risk is usually associated with coastal floods (e.g., flooding in 1953) [64].

By approaching the river basin as a whole catchment upstream, downstream effects have to be approached integrated. The flood risk management plans are complemented and embedded in international plans for each river. All rivers in the Netherlands have not only an international catchment, but they are also all located downstream. Therefore, incorporating upstream parts of the catchment are of great importance and one of the main reasons the Netherlands initiated the European plans. In particular for the river Rhine, experiences with a catchment approach exist via the International Commission for the Protection of the River Rhine. The flood risk management plans in the Netherlands connect to these experiences [81]. The flood risk management plans state that land use and measures in one country can create risks in bordering countries. Solidarity between member states is important in the flood risk management plans. Undesired transboundary effects are prevented or aligned [80].

A third aspect of the integrated approach—integration across sectors—is well established in the Netherlands. Coordination with other water policies like the Water Directive or the Dutch water stress test ("*watertoets*") is already done at the national level. In particular, the recent reform of Dutch water laws made a step forward in this direction, when 8 separate water laws were integrated into one comprehensive water law in 2010 [32,82]. However, in the flood risk management plans, integration with other policy fields is limited. Even though the plans cover the whole catchment area, they make little reference to other policies (i.e., land use planning). This also has to do with the relatively weak statutory character of the plans in the areas behind the dikes. This is still the main

domain of spatial planning [7,12]. Measures that focus on reducing vulnerabilities of land uses do not have obligatory power and are delegated to local authorities. It remains to be seen what the effects of the forthcoming law are on environmental changes in this respect [32].

The final aspect of the spatial turn is the incorporation of measures for spatial flood management and precautionary measures. Even though the Floods Directive gives way to a more spatial flood management approach and provides precautionary measures in the Dutch flood risk management plans, structural measures are still the measure of choice. For regional flood defenses, spatial flood management is seen as an option, but for the primary defenses, only moving the "line of defense" is prevalent. The flood risk management plans do not make the effort to embrace measures beyond structural measures.

However, the flood risk management plans state an ambition "for climate proof and water robust land use" ([80] p.59,60), such as reducing the flood risk with non-structural measures. But this should be considered with further local policy. This fits earlier attempts of other countries regarding integration of precautionary measures. A study on such measures revealed that the more that collaboration with other stakeholders is necessary to realize certain measures, the less important and strong the policy objectives are stated in plans [83]. This also applies to the Dutch flood risk management plans.

Table 2. The implementation of the spatial turn in Dutch flood risk management plans.

Characteristics of the spatial turn	Realization in Dutch flood risk management plans
1: Space for rivers	
Retreat flood defense lines	Serious efforts to make space for the rivers
Increase natural flood risk management	Embracing multi-functional use of water bodies
2: Integrated approach	
Across physical boundaries (beyond dikes)	Incorporation of areas behind dikes
Across catchments (upstream and downstream)	Embedding of Dutch policy in international cooperation across the river basins
Across sectors	Focus on other water issues, moderate integration with other policy fields
3: Beyond structural measures	
Spatial flood management	Moderate effort to push spatial flood management
Precautionary measures	Precautionary measures are still not pursued

4.2. Scenario approach

The scenario approach is much more recent in flood risk management. Its analysis is therefore not based on an elaborated operationalization as it is for the spatial turn. How do the Dutch flood risk management plans embrace and deal with the scenario approach, as introduced by the Floods Directive?

First of all, the plans acknowledge that protected wetlands are not risk-free. The plans admit that even with a high level of protection, floods are a natural phenomenon that will occur: "Floods are a natural phenomenon and cannot be eliminated" ([80] p.14). Instead of an engineering approach based on design level, differentiated flood risks are used in the plans. This means integrating the

possibilities of floods and their consequences in the goals of the flood risk management plans. Priority is given to health and safety and economy: "an indication is given of the possible number of people affected, economic activity, protected areas and installations that are hazardous to a greater or lesser extent. These installations could harm environment or human health in the event of a flood. Additionally, the Netherlands also maps the cultural and historical objects" ([80] p.34).

Therefore, the Netherlands applies a concept of "multiple-layer safety". Even so, protection is still the main tool in flood risk management [80], and managing the flood-risk is mostly done with technical and structural measures. The choice to manage the flood risk by strengthening the "line of defense" is a situation which leads to an entrenched solution in the Netherlands. The very high design levels of existing defenses and the high economic value of the land protected by the dikes are the perfect circumstances for a dike-paradox [11]. Starting in the twelfth century, economic value has accumulated in the Dutch flood plains [84]. This resulted in a lock-in situation where using the scenario approach and embracing flood risks were highly contested in the society. Accordingly, the plans state that "flood prevention is therefore the most important way to reduce the risk of flooding. The greatest efforts in the Netherlands to reduce the risk of flooding are therefore the result of the targets for flood protection" ([80] p.43).

It is not likely that the scenario approach of the Floods Directive changes the relationship between water management and spatial planning in the short term. Creating multiple "lines of defence" would have a great impact, but in Dutch water management, the lock-in in the "dike-paradox" hinders such approaches [70]. This leaves water managers and spatial planners with the great challenge of finding a new way of legitimizing non-structural measures.

5. Discussion

This study is based on the first generation of flood risk management plans, which have to be revised every six years. The proposed scheme of operationalization allows comparison of first generation plans with future attempts.

In addition, this contribution also illustrates that the spatial turn and the scenario approach are not parallel developments within the shift from flood protection to flood risk management, but rather gradual and phased developments. The spatial turn started in the Netherlands in the 1970s with the rising awareness of ecological value in water management and has continued ever since, whereas the real trigger certainly was the 1993/1995 floods at the river Rhine. The introduction of a risk-based approach to flood protection is the basis of the scenario approach, and is a thought that came up in the 1990s, but after the floods in 2002 in Eastern Europe, began slowly to institutionalize. Creating adaptive and sustainable spatial planning remains a challenge for future years and decades. Additionally, the analysis of the Dutch flood risk management plans showed that traditional flood protection will not be completely abandoned; it is still the dominating way in which flood risks are managed all over Europe. It would be more accurate to not only speak of one paradigm shift, but parallel changes of patterns in flood risk management, which in sum can be designated as a paradigm shift (see Figure 1).

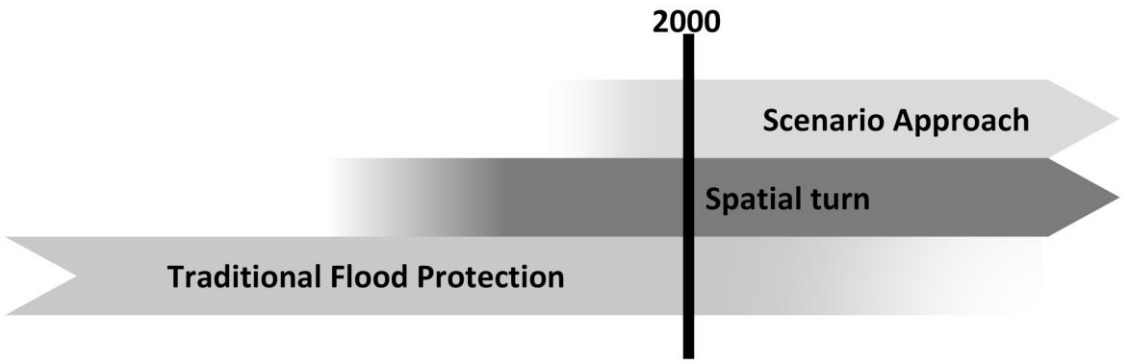

Figure 1. Paradigms in flood risk management.

Finally, the concepts of the spatial turn and scenario approach are still relatively recent in the literature on water management and spatial planning. The spatial turn and the scenario approach are not necessary sharp distinctions, but an analytical framework to grasp the ongoing changes in European flood risk approaches. The concepts are still in development. The major changes in flood risk management at the moment require much more empirical research and academic attention. This study of the implementation of the flood risk management plans in the Netherlands needs to be further deepened and extended. Not only the institutional changes fostered by the Floods Directive, but also changing environmental conditions (i.e., by Climate Change) and socio-economic dynamics urge for such an extension of research. This opts not only for research on other areas, but in particular long-term observations. How do the flood risk management plans change flood risk in practice? What are effects of the spatial turn and the scenario approach? How will they develop in the next generations of flood risk management plans?

6. Conclusion

The analysis of the Dutch flood risk management plans has given insights into how policy and practice deal with flood risk in the Netherlands. The spatial turn and scenario approach in the Dutch flood risk management plans are characteristic of an ongoing paradigm shift. Operationalizing them to a level where an analysis of plans is possible makes the abstract paradigm shift relevant for practice.

The analysis revealed that although the Netherlands are often considered the forerunner in water management in Europe, they are still mainly focused on strengthening the "line of defense". Even though there are admirable efforts to create multiple "lines of defense" as well as climate proof and water robust land use, in the short term, it is not likely to have a great impact on the relation between water management and spatial planning in the Netherlands.

The framework developed in this research and applied to the Dutch flood risk management plans can be used in similar studies on flood risk management plans in other European countries. Using similar analytical frameworks, building on the operationalization of the spatial turn and the scenario approach will give options of comparing flood risk management policy throughout Europe. This will teach lessons on what works and what does not, in terms of institutional framework and governance responses.

Lessons learned from European flood risk management and the analysis of the national implementation of European Directives are relevant beyond the European Union. Whether the

European Floods Directive can be considered a unique forerunner or a huge experiment can help improving flood risk management also in other places of the world.

This sets a future research agenda. Beyond the description of how the spatial turn and the scenario approach are implemented in the Netherlands, this paper makes a plea for more research on the paradigm shift in flood risk management. This shift has been triggered—or at least institutionalized—by the European Floods Directive, but imposes new challenges for spatial planners and water managers.

Conflict of interest

The authors declare there is no conflict of interest.

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