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Depicting Rubin's Vase or Faces: Clarifying the Practical Value of Integrated Water Resource Management

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Abstract: This paper responds to the significant challenges to Integrated Water Resource Management (IWRM) and clarifies its practical value as a theoretical framework. Through thorough theoretical analysis, this paper examines how IWRM can be applied to distinguish water resource management (WRM) as an observable domain with an open boundary and foster sustainable ecosystem management by emphasizing the functional differentiation of WRM. Compared to the examination made solely from the WRM perspective, an IWRM perspective can better develop the structural complexity of the WRM domain and help expose misunderstandings regarding integration issues. Most importantly, IWRM is not merely an explanatory theoretical framework but also a defensive one. It can facilitate structural coupling between WRM and other domains to reduce conflicts and enable concerted action. However, this role of IWRM has been overlooked for a long time.

Keywords: Integrated Water Resource Management; ecosystem management; distinction; functional differentiation; structural coupling; knowledge and action

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1. Introduction

Water Resource Management (WRM) faces several complex challenges, as it involves multidimensional, multi-sectoral, and multi-regional levels of governance and is entangled with multiple interests, multiple agendas, and multiple causes [1]. On the one hand, it requires that all water-related sectors build capacity to manage the inter-related challenges relating to water quality and water quantity [2,3]. On the other hand, it requires the involvement of a broader range of stakeholders and sectors (e.g., agriculture, energy, industry, and transportation) to harmonize the consideration of all water-related interests throughout the overarching ecosystem management [4]. Against this background, the concept of integrated water resource management (IWRM) has gradually emerged as a popular paradigm to address water challenges in a more holistic way [5,6]. The most cited definition of IWRM was formulated by the Global Water Partnership (GWP):

"*A process promoting the coordinated development and management of water, land, and related resources, so as to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems*" [7].

This definition is comprehensive while vague and seemingly unimplementable. For instance, the literature contains attempts to enrich the practical dimension of IWRM by examining questions about *What should be integrated? By whom? How should it be integrated?* and *Is such integration possible?* in a broader sense [8–11]. These discussions have, from the outset, diverged significantly on which issues should be involved, and eventually led to different parameters and assessment frameworks on how IWRM should be processed in practice. Most representatively, Biswas [12] summarized at least 41 sets of issues that different authors consider to be the issues that should be integrated under the aegis of IWRM. Moreover, the practical value of IWRM has been challenged, as IWRM appears to merely place all the water-related elements and issues under a seemingly 'integrated' umbrella concept rather than authentically bringing a more systematic approach. If each sector in ecosystem management adopts such an integration mindset starting with its own functional differentiation to deal with conflicts or challenges that exist or may arise, then ecosystem management will become more complex because more conflicting rules will be created in the process of trying to resolve conflicts [13–17].

The existing literature lacks a solid response to the above criticisms concerning the practical value of IWRM as a theoretical framework. This paper aims to bridge the gap. Following the introduction, Section 2 provides an overview of the research method employed in this paper and outlines the research aims this paper intends to achieve. Section 3 clarifies the condition and process of applying IWRM. Section 4 then moves to unfold the performance and practical value of IWRM. Section 5 concludes the preceding analysis and provides recommendations for further research.

2. Research Method and Research Aims

The following analysis is mainly based on desk research, and Rubin's Vase-Face illusion has been applied for theoretical analysis. This illusion has been chosen because it can capture the differences, connections, and respective limitations of a functional differentiation domain perspective and a holistic ecosystem management perspective, which facilitates understanding the differences between the singular WRM perspective and the IWRM perspective. A more detailed analysis will be provided in a later section.

Meanwhile, for the sake of consistency in analysis, the examples throughout the paper are all organized around the water-level strategy for peatlands. Recently, managing peatlands has become an essential, complex, and trending issue in ecosystem management, especially in lowland areas such as the western and northern parts of The Netherlands, where the human exploitation of peatlands requires large-scale drainage to avoid waterlogged and maintain suitable conditions for agriculture [18,19]. Excessive drainage leads to soil subsidence of the peat, and continuous soil subsidence can cause long-term effects such as increasing management costs, damages to real estate foundations, emissions of greenhouse gases, and loss of biodiversity [20–23]. These effects can be mitigated by raising the surface water levels but will immediately decrease agricultural revenues. The water-level strategy for peatlands has to address a broad and diverse range of values related to WRM, spatial management, agriculture, etc., making it an ideal issue to illustrate the application of IWRM as well as examine its practical values. It is also important to note that although the issue of peatlands is very typical in the Netherlands, this paper is neither a case study on Dutch peatlands nor a discussion about applying IWRM to specific peatlands. The illustration of peatlands here is merely one of many possible illustrations in ecosystem management that have been chosen to provide a general background. It is open to being replaced by other potential illustrations, which will not affect the analysis and conclusions of this paper.

This paper seeks to contribute to the ongoing discussions on IWRM in several ways. Firstly, it demonstrates the remarkable practical value of IWRM in a general sense rather than explaining the performance of IWRM in particular cases. The content is not about how to apply IWRM to explain the performance of a particular practice or to find the causes of a particular consequence in specific case studies, but an analysis of how the framework of IWRM can be applied in a general context and provides direction for fostering sustainable ecosystem management in practice. Put differently, this paper serves to justify IWRM as a defensive theoretical framework than merely as an explanatory theoretical framework. According to Dancy's analysis [24] (p. 8), there are two types of theoretical frameworks, one is explanatory (to find causes), and the other is defensive (to find values). If the aim of a theoretical framework is to find out why and in which way a particular case has been formed, then this theoretical framework is explanatory; if the objective of a theoretical framework is to argue whether there exists a solid theoretical basis for any practical value embedded in a particular practice, then the theoretical framework is defensive. There is not much in-depth analysis that justifies IWRM as a defensive theoretical framework in the existing literature, leaving ample space for debate. Secondly, it facilitates the understanding that the knowledge shaped by different domains in ecosystem management is constructed by using different distinctions when applying their 'integrating' ideas, and is therefore pluralistic rather than universal. Understanding the constructive nature of knowledge is key to properly understanding integration-related issues in practice, as well as the cooperation and conflict involved in these issues. Thirdly, it deepens the discussions on the relationship between knowledge and action (alternatively, theory and practice) in IWRM-related issues.

3. Clarifying the Condition and Process of Applying IWRM

3.1. What Does 'Integration' Mean?

The original meaning of *integration* is the composition of a whole by combining the separate parts [25]. A critical condition hidden here is that there must exist some sort of *this* that has been distinguished to a certain level because nothing can be integrated if there is no distinction [26]. In addition, it is necessary to notice the difference between *integration* and *dedifferentiation*, which means the loss or reversal of distinguishing features of form or function [27]. If there is no *that* has already been distinguished from everything else except *this*, we can only say *this* is being dedifferentiated. Furthermore, any changes to the internal components of *this* will not be perceived as an integration issue but as an issue of internal rearrangement (See Figure 1).

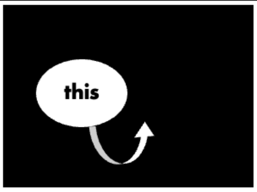
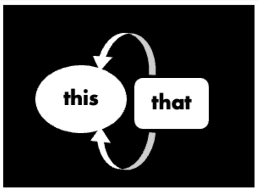
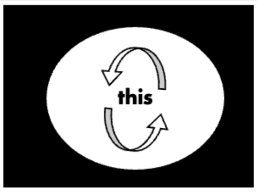
features		category
	no distinction has been made	the status of indiscernible (refers to a state in which something is unable to be distinguished by the observer, even though there might be actual distinctions present)
	some sort of ***this*** that has been distinguished; combine ***this*** with everything else	the dedifferentiation of ***this***
	some sort of ***this and that*** have been distinguished; combine ***this*** with ***that***	the integration of ***this*** with ***that***
	All operations take place within ***this***	the internal (re)arrangement of ***this***

Figure 1. Clarify the distinction between 'integration', 'dedifferentiation', and 'internal (re)arrangement'.

The same reasoning also applies to IWRM: we first need to distinguish what WRM is (*this*) and then discuss which components of the remaining ecosystem management that are not originally considered to be WRM could be further distinguished (*that*) and be considered for integration into WRM for the purpose of achieving sustainable ecosystem management. If WRM loses its functional differentiation in ecosystem management, we regard it as being dedifferentiated. For analytical purposes, we refer to the overall WRM as the WRM domain. We refer to the residual of the ecosystem management except for the WRM domain as its context. The use of the context of the WRM domain enables us to include all other domains that we are and are not yet aware of in the overall ecosystem management. In this way, the emergence of new domains will not affect the analysis and conclusions of this paper.

3.2. What Is the Condition of Applying IWRM?

To apply IWRM, we first need to distinguish the WRM domain. Based on a general definition of the WRM as *a set of coordination processes by which decisions are made to achieve the predetermined goals for water sustainability* [1,28–30], we can obtain a basic distinction that serves as a boundary between the WRM domain and its context, that is, '*has/has no predetermined goals for water sustainability*'. In this manner, WRM can be distinguished as a functional differentiation domain containing all the processes that have predetermined goals for water sustainability. A functional differentiation domain means that the domain can be distinguished, at least to a degree, as a specific sphere that operates independently due to its functional specificity. In a multifunctional domain with vertical differentiation according to rank (or status conceived as a hierarchy), the component undertaking a special function cannot be considered a functional differentiation domain or subdomain, because it is under the control of higher ranks and cannot operate independently. This kind of domain with hierarchy is referred to as a stratifactory differentiation.

However, even if we reach a consensus on the basic distinction for distinguishing WRM, where to locate this boundary for the WRM domain remains difficult. The question of whether a process has predetermined goals for water sustainability can be interpreted differently by different interpreters, and these different interpretations have a direct impact on whether and how IWRM can be applied. Differences in cognition lead to differences in action, people do not even know where a consistent starting point should be for each application of IWRM, let alone forge consensus on subsequent actions for integration. As argued in the introduction, this dilemma has been considered a major difficulty in applying IWRM.

Consider the example of three policymakers (A, B, and C) who are drafting a water-level strategy in peatlands.

A thought that the whole process of water-level management in peatlands had predetermined goals for water sustainability. For A, the whole process of water-level management in peatlands already belonged to the WRM domain, and there was no room left to apply IWRM. For A, drafting a water-level strategy in peatlands was more about the (re)arrangement within the WRM domain.

B thought that the whole process of water-level management in peatlands had no predetermined goals for water sustainability because the water level just follows its allocated spatial function. For B, the whole process of the water-level management in peatlands was a process of land use management and thus did not belong to the WRM domain. IWRM could be applied to decide whether to integrate it into the WRM domain.

C thought that parts of the process of water-level management in peatlands had predetermined goals for water sustainability. For C, those parts that were not originally considered to have predetermined goals for water sustainability did not belong to the WRM domain and thus could apply IWRM for potential integration.

Although A, B, and C were all restricted to using the basic distinction in the same case, they had different opinions on where to place the boundary of the WRM domain. Consequently, these different views influenced whether and how IWRM could be operated in this case. These differences may seem to hinder the application of IWRM, but is this a fatal flaw that makes IWRM unimplementable and reduces its value in practice? This paper argues that such an opinion is a misunderstanding of IWRM: firstly, an exclusive, commonly accepted boundary of WRM is not the condition (thus not necessarily needed) for each application of IWRM. Recall from Section 3.1 that the condition for applying IWRM is the co-existence of both the WRM domain, and its context being distinguished by the boundary. Where the boundary is placed for each application does not impede the implementation ability of IWRM. Second, although the openness in placing the boundary for each application of IWRM may result in different or even conflicting application results, this does not necessarily diminish the practical value of IWRM. Put differently, when IWRM is continuously applied to reduce conflicts that already exist or may arise in ecosystem management, it may simultaneously increase conflicts in ecosystem management system since different applications may produce different application outcomes. Both the effects of reducing and increasing conflicts must be considered in examining the practical value of IWRM. If, from an overall perspective, IWRM can provide additional strengths compared to a purely WRM perspective, we can suggest that IWRM provides practical value and vice versa.

3.3. What Is the Concrete Process of Applying IWRM?

Before analyzing the performance of IWRM, it is necessary to analyze the concrete process of its application. We use decision maker A as an example. As Table 1 shows, when we consider each application of IWRM as a stepwise process, A should follow four steps:

Table 1. The process of applying IWRM.

Background: New Issues Emerge in Ecosystem Management	
the application process of IWRM	step 1: distinguish one issue and thematize it as a component (the THAT component) that is potentially relevant to WRM.
	step 2 the observation process (the condition test): whether the THAT component has been originally considered to have/have no predetermined goals for water sustainability?
	positive: does not meet the condition for starting the operation process (move to step 4).
	negative: meet the condition for starting the operation process.
	step 3 the operation process (the decision-making moment): should the THAT component be considered to have/have no predetermined goals for water sustainability now in order to achieve sustainable ecosystem management?
	positive: integrate the THAT component into the WRM domain.
	negative: the THAT component is excluded from the WRM domain while serving as a possibility for future applications.
	step 4 the end of one IWRM application: recorded as one application rule with corresponding validity.

Step 1: distinguish a new issue and thematize a specific component (referred to as the THAT component) in ecosystem management that is potentially relevant to WRM.

Step 2: locate a boundary in ecosystem management based on the basic distinction of WRM to distinguish the WRM domain as the positive side (*the side that has predetermined goals for water sustainability*). Although A has numerous options to locate a boundary, A can choose only one at a time. This creates the condition for this IWRM application because, for this moment, the WRM domain can be indicated and observed. Immediately thereafter, A can verify whether the THAT component has initially been perceived as belonging to the WRM domain in this application. If the THAT component has already been considered to be in the WRM domain (*positive*), it will not trigger the operation process of IWRM but may trigger the internal arrangement or rearrangement of the WRM domain. If the THAT component has been excluded from the WRM domain (*negative*), it could state that the condition has been met, and the THAT component will trigger the next operation process of IWRM. Together, steps 1 and 2 can be referred to as the *observation process* of applying IWRM.

Step 3: decide to reassign one of the two values (*positive*/*negative*) to the THAT component which was initially considered to be excluded from the WRM domain in the condition. In this step, the question in step 2 could be reformulated as: *should the THAT component be considered to have/have no predetermined goals for water sustainability now in order to achieve sustainable ecosystem management*? A positive decision would lead to a process of integrating the THAT component with the WRM domain indicated in the condition and result in the relocation of the boundary of the WRM domain indicated in the condition. A negative decision would leave the THAT component in the context, where it would be available for future IWRM applications. It is important to note that both positive and negative decisions are the operational results of IWRM, and therefore the application of IWRM does not necessarily lead to the THAT component being included in the WRM domain. Step 3 can be referred to as the *operation process* of applying IWRM.

Step 4: formulate one application rule (hereafter, the rule) that can be recorded and traced. The rule mainly specifies the relevant information., on the decision-maker, the corresponding condition, the decision moment, and the decision result (whether to integrate the corresponding THAT component). This relevant information (e.g., on the authority of the decision-maker) also determines the validity of the rule. For the next IWRM application, one may follow the rule of this application and start with the boundary obtained at the end of the earlier operation, or one may ignore the rule and choose a new boundary for the WRM domain to form a new rule. Whether one is obliged to follow this rule is determined by the rule's corresponding validity.

The four steps illustrate one application process of IWRM that can be repeated.

4. Analyze the Performance and Practical Value of Applying IWRM

4.1. Applying IWRM to Support WRM as a Functional Differentiation Domain

Since the application of IWRM involves the adjustment of the WRM domain and its context, it is necessary first to discuss the relationship between the WRM domain and its context. According to the definition, since the context of WRM encompasses everything in ecosystem management except the WRM domain, the context of WRM is always more complex than the domain of WRM. This means the context of WRM can always bring new issues to the WRM domain. The latter not only has to respond appropriately to these new issues to avoid challenges or conflicts that may occur or have occurred but must also avoid point-to-point interconnection with the former when responding to these issues because full dedifferentiation means WRM ceases to be a functional differentiation domain [31] (p. 106). Therefore, the WRM domain must find ways to always distance itself from its context. As long as the WRM domain has been formed on the basis of its functional differentiation feature, the WRM domain cannot control its context because there is no hierarchy among domains that are already functionally differentiated, nor can the overarching ecosystem management have direct control at a higher level for coordination because otherwise the WRM domain and other domains (serving as the context of the WRM domain) would lose their functional differentiation characteristics as independent domains. The WRM domain can only stay differentiated through its own operation, more specifically, through the operation derived from its basic distinction to iteratively reduce the complexity of its context and to develop the internal structure of the domain. In a nutshell, maintaining difference through difference [32] (p. 99) is the doctrine followed by the WRM domain to maintain its functional differentiation in the overarching ecosystem management.

The application of IWRM is precisely one of the processes that reflects this doctrine. Referring to the application process above, each time IWRM is applied, it proposes a specific question regarding the THAT component to make a new distinction, but only in a dual-value (*positive: has; negative: has no*) and fixed-form (*predetermined goals for water sustainability*) way. This serves to keep the WRM domain closed in operation and maintain its distinction in function. When necessary, concerns embedded in other question forms could be introduced into the WRM domain through IWRM when necessary, but only after the concern has been translated by IWRM into the fixed form of question regarding the allocation of the two opposed values, and not by changing the basic distinction adopted in the fixed form. The previous example of water-level management in peatlands is used here for an explanation. A measure to mitigate a falling groundwater level in a peatland can affect both the goal for water sustainability and the goal for land use sustainability. However, when applying IWRM, one could not propose a question such as: *whether this measure has been considered to have/have no predetermined goals for water and land-use sustainability*? Neither a question such as *should this measure be considered to have/have no predetermined goals for water and land-use sustainability now so as to achieve sustainable ecosystem management*? This is because the applicator of IWRM is obliged to propose questions using the basic distinction of WRM.

Although the form of posing a question is fixed in each application of IWRM, the question can be formulated with greater exactness, mainly through typology. To continue with the example above, the possible questions that can be developed further include *whether a political/legal/scientific measure to mitigate a falling groundwater level in a peatland has been considered to have/have no predetermined goals for water sustainability, and should this measure be considered to have/have no predetermined goals for water sustainability now so as to achieve sustainable ecosystem management?* One step further and for instance, from the legal perspective, *whether a measure based on the polluter pays principle/precautionary principle/prevention principle to mitigate falling groundwater tables level in a peatland has been considered to have/have no predetermined goals for water sustainability*, and *should this measure be considered to have/have no predetermined goals for water sustainability now so as to achieve sustainable ecosystem management?* These questions can only be asked and decided on singly when IWRM is being applied. Each application of IWRM results in one decision, and each individual decision will lead to more possible questions for subsequent applications.

Throughout such iterative applications of IWRM: first, the WRM domain can recursively reduce the complexity of its context through IWRM by constantly distinguishing a new issue, thematizing it as the THAT component and making a new decision; second, in each application of IWRM, every decision is accompanied by its condition and the result of the operation is recorded as one rule. All these rules embody the very requirement of IWRM: to coordinate the WRM domain with its context in ecosystem management so as to achieve sustainable ecosystem management. Among these rules, all the rules with positive values (indicate the corresponding components that are either considered to have predetermined goals for water sustainability in the condition in step 2 or the components that should be considered to have predetermined goals for water sustainability in step 3) can form different collections based on their validities, and the arrangement of these collections can form the structure of the WRM domain (See Figure 2). This structure may be enhanced or modified by the subsequent applications of IWRM, but the structural complexity of the WRM domain itself continues to develop, which allows it to remain distinct from its context. Third, throughout the entire process, no matter how dramatic new issues may emerge, the application of IWRM can support the closed operation of the WRM domain without losing its basic distinction: a functional differentiation domain that specifically has predetermined goals for water sustainability.

To maintain the functional differentiation of the domain, the internal operation of the WRM domain ought to be a process of generating its internal structure through the repeated use of its basic distinction. However, in practice, the policy decision-makers do not always develop the WRM domain in such a way, which has resulted in a blurred boundary with a less-developed structure of the WRM domain.

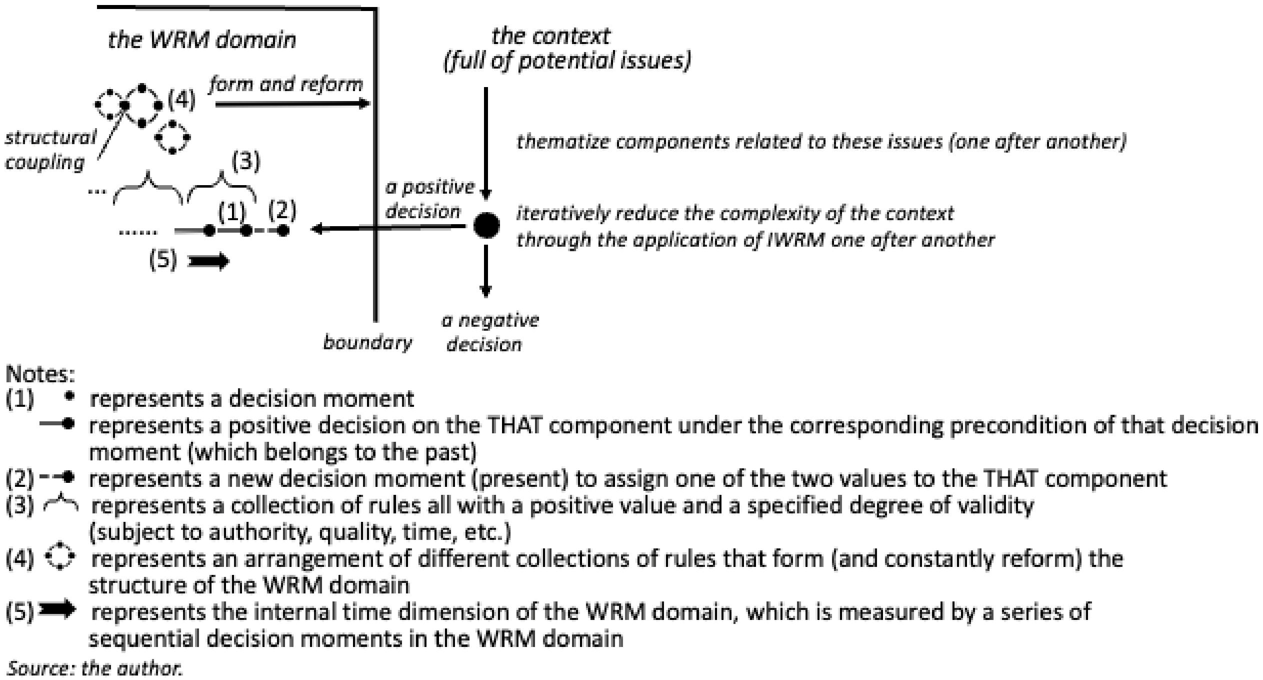
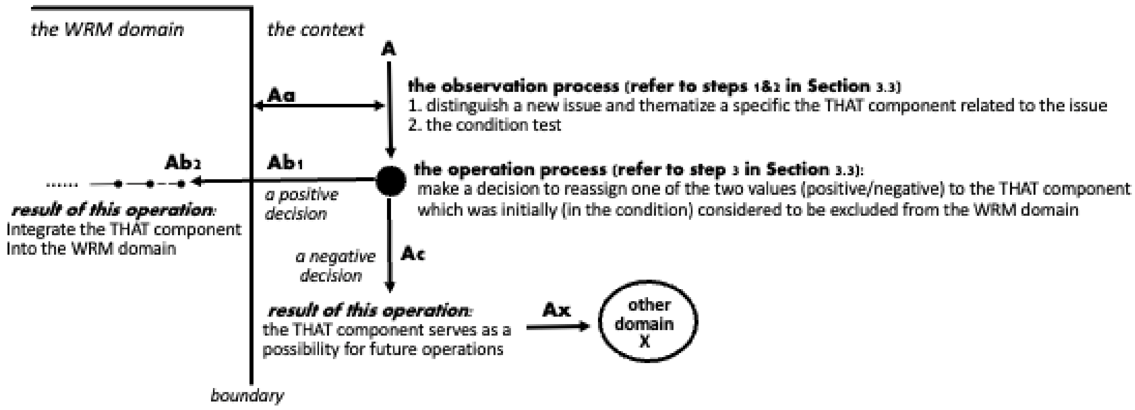


Figure 2. The application of IWRM to enrich the internal structure of the WRM domain.

4.2. Applying IWRM to Examine the Interpretation and Misinterpretation of Integration

After clarifying the concrete process of applying IWRM to develop the structure of the WRM domain, the issue of integration can be unfolded. Here again, it is important to emphasize that a functional differentiation domain cannot be directly integrated with its context, because the context is in a state with nothing being distinguished. Moreover, even if a new issue has been distinguished and thematized as one specific component in the context, it cannot be directly integrated with the domain because a functional differentiation domain is supposed to be closed in operation to avoid point-to-point interconnection. Only a component that uses the basic distinction of a domain can be recognized by the domain and trigger the operation of the domain for potential integration; whereas a component expressed with other distinctions cannot be processed by this domain and is therefore ignored. From the perspective that a domain is closed in operation to stay distinguished from its context, direct integration would not occur, but there are two other options. Both options are often misinterpreted as integration (See Figure 3).

The first option is *dedifferentiation*, which means a functional differentiation domain responds to a new issue by changing (or abandoning) its basic distinction in operation (Aa in Figure 3). The water level management in peatlands is a typical example. A measure to mitigate falling groundwater level in a peatland, which is considered to have predetermined goals for both water sustainability and land use sustainability, may not be considered to fall within the WRM domain in a policy decision-making process; neither can the WRM domain recognize whether one measure has predetermined goals for both water sustainability and land use sustainability since its basic distinction in operation concerns only whether the corresponding component *'has/has no predetermined goals for water sustainability'*. Changing the basic distinction in the form of *'has/has no predetermined goals for water sustainability and land use sustainability'* can make this multi-dimensional issue recognized by the WRM domain. Meanwhile, the change of basic distinction generates a new multifunctional domain that contains WRM at the expense of giving up the functional differentiation of WRM.



I. The figure shows an ongoing application process of IWRM conducted by decision-maker A.
II. The connections in the figure represent, respectively:
Aa: dedifferentiation; **Ab1**: resonance ; **Ab2**: integration; **Ac**: ignored by the domain ; **Ax**: the attempt of A for potential cooperation)
II. The X domain represents other possible domains that exist in the context. It can be a specific functional differentiation domain that has already been recognized in ecosystem management, or it can be a collective name for a collection of functional differentiation domains that have not yet been recognized. The X domain is designed to cover all those aspects of ecosystem management that we are aware of as well as those that we are not aware of. Otherwise, it is likely to overlook the impact, especially the indirect impact, of a measure on a domain or domains that we are not yet aware of.

Source: the author.

Figure 3. Applying IWRM to examine the integration and misinterpretation of integration.

Dedifferentiation brings the new issue directly inside the newly multifunctional domain, but this does not mean the issue has been solved. On the one hand, the new multifunctional domain can also become a functional differentiation domain (e.g., the domain of water resources and land use management) if it consistently operates with the new basic distinction. However, when faced with the mixture of internal structures and the 'blending of internal time' [33] (p. 61) brought about by the dedifferentiation, it is not easy for the new multifunctional domain to become functionally differentiated: before dedifferentiation, the WRM domain, similar to any other functional differentiation domain in ecosystem management, can be operated based on its unique basic distinctions consecutively and sequentially generate its own internal structure from a sequence of decisions. Each domain may be at a different level of internal structural complexity and development and at a different stage of internal time, but within the domain, the operation is consistently stable and sequential. Each domain considers other domains as its own context where differences can coexist. This separation of internal time and space is the great dynamic force of modernity for dealing with complexity [34] (p. 96), whereas dedifferentiation combines these different domains with different internal structures and different internal time dimensions. Although the problems regarding the mixture of internal structures are formidable, they can be alleviated by further operation (e.g., internal integration and internal differentiation); the blending of internal times of different integrated domains may pose difficulties or may even cause the operation of the new multifunctional domain to collapse [34–36]. On the other hand, given the difficulties above, the new domain is most likely to become not a functional differentiation domain but a stratifactory differentiation domain with vertical differentiation according to rank or status conceived as a hierarchy [37] (p. 130). At this point, WRM turns into a component of this new multifunctional domain and is controlled by the operation of this new domain, which means WRM has lost its distinction and independence in operation. Certainly, the advantages of being functionally differentiated are also lost.

The second option is *resonance*, which means a functional differentiation domain responds to a new issue in context by translating this issue into a form that this domain can recognize and by deciding whether it could be a meaningful interconnection (*positive*) or noise (*negative*) (Ab1 and Ac in Figure 3). For the WRM domain, the application of IWRM is one typical way to stimulate resonance. A positive decision on resonance will channel the translated THAT component into the domain WRM (Ab1 in Figure 3) and move to the next step of internal integration within the WRM domain (Ab2 in Figure 3). A negative decision would, on the other hand, leave the THAT component temporarily in the context (Ac in Figure 3). Consider the example of water-level strategies in peatlands. When WRM authority A is drafting a water-level strategy, spatial planning authority B has already drafted another strategy for the water level and is partially in conflict with A's standpoint. In this case, WRM authority A cannot directly refer to the standpoint of B, because B's standpoint adopted a different basic distinction of whether a process has a predetermined goal of land use sustainability. Instead, A can apply IWRM to trigger resonance by asking, for example, when developing a water-level strategy, does the requirement to consider the criteria in the spatial planning authority's comparable strategy set predetermined goals for water sustainability? If a positive decision is taken, the considerations in the domain of spatial planning could be channeled inside the WRM domain. Such considerations can be further concretized and integrated in terms of political, legal, and economic aspects.

This kind of integration after resonance can help to overcome fragmentation caused by the existence of various functional differentiation domains in ecosystem management. In addition, since resonance can only proceed in a singular and sequential manner, it will not lead to the blending of internal time that happens in dedifferentiation. Meanwhile, the integration process within a domain is only possible after a domain has undergone self-reflection on the new issues based on its basic distinction. Altogether, subsequent integration within the domain will be much easier than the former dedifferentiation. This option through resonance can be considered as an adaptive approach, which seems to be safer when handling new issues in ecosystem management; its most obvious drawback may be that it is more time-consuming than dedifferentiation. However, the risks of resonance are overlooked when we assume that constantly responding to new issues by including them in a functional differentiation domain is always the better option for a domain. Although resonances can be created between a domain and its context in response to new issues, resonances might also be a step toward the self-endangerment of a functional differentiation domain [31] (p.107). One might argue that when resonance is triggered, a selective threshold will be established because resonance involves a translation process based on the basic distinction of a specific functional differentiation domain. As a result, although the domain becomes open in cognition through resonance, the domain's operational closure is guaranteed. Nonetheless, this argument confuses two very different issues of how—and how frequently— resonance can be triggered. If decision-makers apply IWRM (and its analogues) to stimulate resonance whenever they face new issues in ecosystem management, then these numerous THAT components with positive decisions will be constantly channeled into the WRM domain and integrated internally. The domain will continue to grow huge and increase in complexity, which may hamper its further internal development. If this supersized domain is not already collapsing from overload at this point, it is worth reconsidering the costs and benefits of operating it through functional differentiation [38,39]. In addition to the risk of overload and cost, the domain faces difficulties related to interpreting the rationality of its inconsistencies. The greater the need to interpret these inconsistent decisions, the more instability within the domain increases, which in turn, increases the risk of the domain becoming overloaded.

Certainly, resonance does not necessarily lead to integration. A negative decision on resonance means the issue is temporarily perceived by the domain as noise and continues to remain in its context as a possibility for future operation (Ac in Figure 3). This refusal to integrate can be interpreted as an emphasis on the existing fundamental function of the domain. Alternatively, it can be interpreted as an attempt at cooperation due to the transferability of the issues in ecosystem management (i.e., the essence of cooperation is to pass on the remainder of an issue to others). The remainder of a complicated issue can be better addressed elsewhere, so a domain can refuse to provide redundant solutions through integration (Ax in Figure 3). This allows issues such as soil subsidence associated with water-level management in peatlands to be transmitted to domains such as WRM, spatial management, agriculture management, etc., and every domain can choose to simply take care of its own function while still focusing on cooperation between different domains.

4.3. Applying IWRM to Examine Potential Cooperation and Conflicts

Although the WRM domain is able to cooperate with other domains, cooperation is not necessarily achieved because the domains are in a situation of double contingency. Contingency means a situation is neither necessary nor impossible. Double contingency further makes a distinction between the observation and operation of individuals, and refers to the situation in which one domain makes its own action contingent upon the action of the other [35] (p.104). Consider the following example: in formulating a water-level strategy in a peatland, WRM authority A has observed and recognized the issue of soil subsidence triggered by a lowering water level. A may consider either that the process of water-level management associated with soil subsidence originally belonged to the WRM domain, or that it did not originally belong to the WRM domain because water level simply follows its allocated spatial function. If A decided this related process of water-level management was not originally part of the WRM domain, even if the possibility of integration exists, A could also choose not to integrate it into the WRM domain. Meanwhile, the authority of another domain (here referred to as the X domain) may also observe the soil subsidence issue and may also apply the IWRM-like approach (here referred to as the I-X-RM approach) to decide whether to integrate the corresponding component. It becomes more complicated when considering that the decisions of the WRM authority may affect the decisions of others and vice versa. For example, if A knows that other domains already have rules on soil subsidence, A may choose not to integrate soil subsidence into the WRM domain (manifesting as cooperation) or may still choose to devise different rules (manifesting as potential conflicts) (See Table 2).

Table 2. The potential cooperation and conflict between domains.

<table>
<tr><th colspan="2" rowspan="2"></th><th rowspan="2">X Domain Observation (P)</th><th colspan="2">X Domain Observation (N)</th></tr>
<tr><th>X Domain Operation (P)</th><th>X Domain Operation (N)</th></tr>
<tr><td colspan="2">WRM domain observation (P)</td><td>Potential conflicts</td><td>potential conflicts</td><td>cooperation</td></tr>
<tr><td rowspan="2">WRM domain observation (N)</td><td>WRM domain operation (P)</td><td>potential conflicts</td><td>potential conflicts</td><td>cooperation</td></tr>
<tr><td>WRM domain operation (N)</td><td>cooperation</td><td>cooperation</td><td>ignored</td></tr>
</table>

Note: 1. (P) refers to assigning the positive value, and (N) refers to assigning the negative value. 2. The X domain represents other possible domains that exist in the context. It can be a specific functional differentiation domain that has already been recognized in ecosystem management, or it can be a collective name for a collection of functional differentiation domains that have not yet been recognized. The X domain is designed to cover all those aspects of ecosystem management that we are aware of as well as those that we are not aware of. Otherwise, it is likely for us to overlook the impacts, especially the indirect impacts, of a measure on a domain or domains that we are not yet aware of. 3. For details of the observation and operation sessions, please refer to Section 3 of this paper.

In dealing with potential conflicts that accompany potential cooperation, if people do not want to abandon the functional differentiation status of a domain, most of them may argue for a consensus-based solution between domains based on values [40] (p. 16), communicative rationality [41] (p. 735), or other universal principles with or without the obligation [42] (p. 155) to mitigate conflicts. This solution assumes that when applying such an IWRM process (and its analogues), decision-makers in each functional differentiation domain can, at least initially, observe what consequences the decision-maker's possible decision (to integrate or not to integrate the related component) would have on the corresponding domain and context; then they can negotiate with each other at the level of ecosystem management and make decisions that are based on a shared consistent opinion at the level of their respective functional differentiation domains.

The question arises of whether this assumption is possible in practice, and this paper argues that: when applying IWRM, no such Archimedean point can be found in the physical dimension, which can provide domains with the opportunity to negotiate based on observing the consequences of their decisions in order to reduce the conflicting rules that may be introduced alongside when they respond to new issues through an IWRM-like process. However, IWRM can find a comparable position in the temporal dimension and mitigate the formation of conflicting rules by facilitating structural coupling among domains [43] (p. 17). This can be explained by invoking Rubin's vase-faces illusion (See Figure 4).

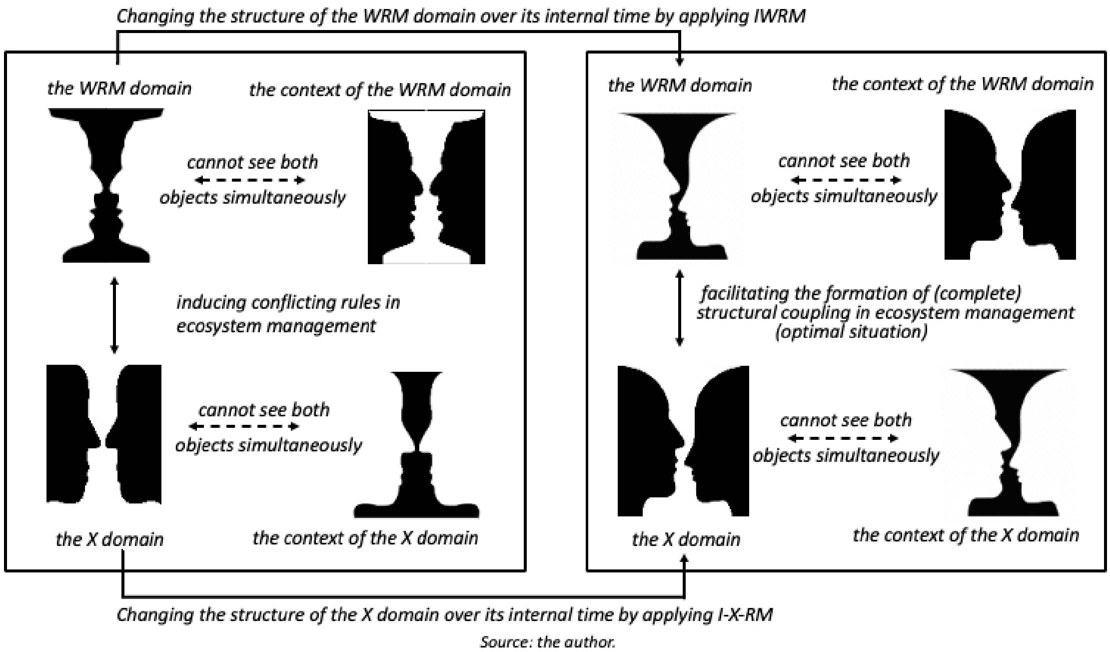
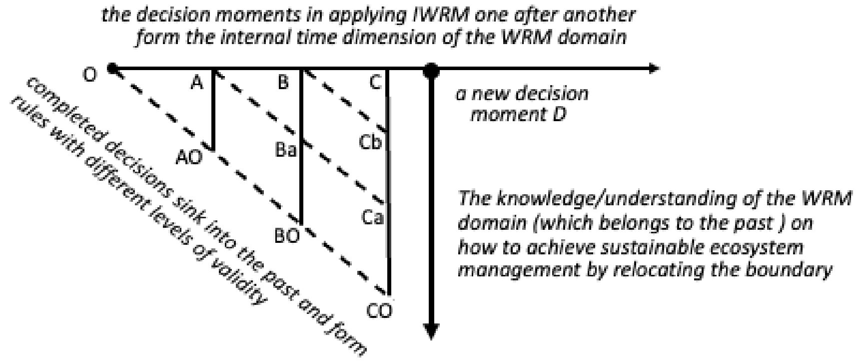


Figure 4. Using Rubin's vase-faces illusion to demonstrate how structural coupling could be formed among domains in ecosystem management.

In Rubin's illusion, objects can be distinguished from the background. One who sees the vase in the figure does not at that moment observe the rest of the picture as an object but as the background, and vice versa. One can see the vase and the two faces, but not simultaneously. Rubin's illusion demonstrates that inattentional blindness is de facto the inability to distinguish other objects when the mind is focused on one specific distinction [44,45]. This is similar to the operation and structure development of the various functional differentiation domains. For instance, the function of the WRM domain can be seen as specialized in depicting the vase in black, and the function of the X domain can be seen as specialized in depicting the faces in black. A domain-based perspective focuses on how to paint the black vase or black faces perfectly, which is, after all, the function undertaken by a functional differentiation domain (it is also possible to choose not to depict the specific object, which means the dedifferentiation in the function of the domain). An IWRM-like perspective requires these functional differentiation domains to think not only about their own functions but also about their relationships with other domains in ecosystem management because the harmonious and sustainable development of the overarching ecosystem management should be the unity of the black vase and the black faces. The problem, however, is that once a functional differentiation domain has specialized in depicting one object in black, it cannot simultaneously observe the effects of the ongoing modification of its own object on the remainder of the picture, since the remainder of the picture cannot be recognized as an object but rather as a background at this operating moment.

Despite this, for each moment at which a decision on the modification of the black object is being made by a domain, the observation of how the existing object has been drawn and how other domains existing in the context have depicted the corresponding part (both belong to the past) is possible and can serve as a reference for the ongoing operation. As each functional differentiation domain gradually changes and develops a stable structure in its internal time dimension, it also brings more stable expectations for future operations of each domain, because the decision in future operations is not completely free but is constrained by the pre-existing structure. One step further, the more stable expectations are, the more possibilities they create for partial or complete structural coupling in the overarching ecosystem management, which manifests as the emergence of consensus between domains. From here, the strengths of applying IWRM compared to a purely WRM perspective can be fully demonstrated: the black object can only be observed when it has been distinguished from the background, and without a distinction, nothing can be observed when depicting a black object on black. Similarly, a domain in the overarching ecosystem management can only be observed when it has been distinguished from its context; otherwise, the structure of the domain cannot be observed, and the domain may just develop blindly. In a nutshell, the essence of applying IWRM is based on distinction, as it is a distinction (rather than integration) that enables the unobservable to become observable [46,47] and creates perfect continence [48] (p. 27). Such continence created by IWRM is achieved by separating the observation process and the operation process of one IWRM application in the temporal dimension, as there is no transcendental Archimedean point in the physical dimension [49] (p. 419).

It is precisely because a distinction is needed to make WRM observable that, at the beginning of applying IWRM, we use the basic distinction of WRM to locate a boundary between WRM and its context. Although there are countless possibilities to locate the boundary, only one boundary can be given at a time as the condition, and this actual application distinguishes itself from other possibilities and forms one rule of IWRM. The given boundary of the WRM domain in each application of IWRM is cognitive and contingent, but the repetitive applications of IWRM produce practical consequences: firstly, the arrangement of all rules with the positive value resulting from the applications of IWRM shapes the structure of the WRM domain. In this manner, it is better to consider the structure of the WRM domain as emerging in the temporal dimension, rather than as being a physical occupation. To give an example from the Netherlands, it can be seen that from about 1100 to 1970, the WRM domain was about flood protection and managing water supply. In the 1970s, WRM was expanded to include protecting water quality from point and diffuse sources of pollution as well as the protection of drinking water resources. Later, wastewater treatment was also included in this domain. Subsequently, the protection of water resources threatened by agricultural pollution was specifically included. Then, to comply with the EU Water Framework Directive, the ecological aspects of WRM, including ecosystems that depend on good water status, have been included in the WRM domain. At the moment, adaptation to climate change and drought management are being included. These developments have resulted in a sophisticated internal arrangement for WRM. At the same time, what already belongs to WRM and what is supposed to be integrated continues to be a dynamic process. This understanding could also resolve the challenge raised in the introduction that IWRM is merely an 'integration' umbrella concept without providing meaningful connections because different applications of IWRM can, in fact, be connected in the time dimension despite their divergences and shape the knowledge of the WRM domain on how to achieve sustainable ecosystem management (See Figure 5).



1. The knowledge/understanding of the WRM domain for achieving sustainable ecosystem management includes all the existing rules regarding how to (re)locate the boundary between the WRM domain and its context for achieving sustainable ecosystem management. These rules are formed by sequential applications of IWRM under the corresponding decision maker, decision moment, decision conditions, decision value (positive or negative), and levels of validity. Simply put, the arrangement of all the rules formed by the IWRM application shapes the knowledge /understanding of the WRM domain in achieving sustainable ecosystem management. The arrangement of all rules with positive values formed by the IWRM application shapes the structure of the WRM domain.

2. For example, WRM authority O has applied IWRM and has formed the rules AAO, BBaBO, and CCbCaCO after the decision moments A, B, and C, respectively. At the new decision moment D, O cannot observe the effects of the ongoing operation on the WRM domain and its context at the decision moment D, but O can observe the (previous) distinction between the domain and its context reflected by the existing rules and use it as a reference. At the decision moment D, O may follow the existing rules for distinguishing the WRM domain from its context, as the condition for this application. Whether O is obligatory to follow specific rules as the starting point is determined by the established structure of the WRM domain.

Source: the author.

Figure 5. The development of the WRM domain from the temporal dimension.

Secondly, the arrangement of all rules resulting from the applications of IWRM continually updates the knowledge (or understanding) of the WRM domain on how to achieve sustainable ecosystem management by (re)locating the boundary between the WRM domain and its context. One concern here is that in the initial application of IWRM, the boundary for the WRM domain is given rather than observed because ecosystem management at that time presented itself as a unity with no distinction. Put differently, the knowledge obtained by applying IWRM, regarding sustainable ecosystem management, is constrained by the cognition of the WRM domain based on its unique distinction in function. The other functional differentiation domain will face the same constraint when applying a similar I-X-RM process. Each functional differentiation domain uses its own distinction to recurse and reduce the complexity of ecosystem management, which also explains why the issue in the overarching ecosystem is inevitably alienated by different functional differentiation domains. As they do not share the same knowledge about the overarching ecosystem management at a more holistic level, conflicting rules are inevitable [50] (p. 22). However, this is not a reason to abandon using an IWRM-like process: on the one hand, a domain that is not differentiated in ecosystem management cannot be observed and therefore cannot recognize related conflicts that already exist or may arise. In short, the domain has the possibility to develop blindly; On the other hand, the IWRM application can reduce the formation and effects of conflicting rules by facilitating structural coupling between domains.

5. Conclusions

At this point, it may be appropriate to summarize the performance and practical value of IWRM in practice. The essence of IWRM is to contribute to sustainable ecosystem management by emphasizing the basic distinction of WRM in function. This basic distinction enables the entire WRM to be observable and creates the condition for examining the integration issues that follow. Compared with the solely WRM perspective, an IWRM perspective can better develop and structure the entire WRM as a functional differentiation domain and can better remind a domain concerning the expense of its choice to (partially or completely) de-differentiate, resonate, integrate, or not integrate, when responding to a specific issue. To some extent, IWRM (or its analogues) can prevent a domain from developing blindly in response to arising (or potential) conflicts. However, it also reveals the inevitability of conflicting rules in the overarching ecosystem management as the unity of various functional differentiation domains. As long as these domains remain functional differentiation, they are in a state of double contingency, where cooperation does not necessarily occur in a meaningful way, and where overall ecosystem management cannot provide coordination through control. The conflicting rules introduced by the application of IWRM (or its analogues) can and preferably be resolved through the application of IWRM (or its analogues) itself because it pursues sustainable ecosystem management in the way of fostering structural coupling between different domains. It is more stable and predictable than claiming control at the expense of de-differentiation and allows the results of different applications of IWRM to be interrelated in the temporal dimension.

Recalling the most representative challenge mentioned in the introduction, namely that there were at least 41 sets of issues at that time, the number has increased now, and there will be many more issues to consider in the future to be considered under the aegis of IWRM [12]. After clarifying the application process and practical value of IWRM, it becomes clear that different understandings of these issues by different people at different times are not a problem. Instead, it reflects a dynamic process of reflection on the extent to which the unique function of WRM should be distinguished as optimal for realizing sustainable ecosystem management. From this perspective, the critical question raised by Biswas is not so much a challenge to the practical value of IWRM but rather a kind reminder on the application of IWRM (and its analogues) that we should do our utmost to move from one distinction to a better one. The purpose of seeking a better distinction is to develop better knowledge among domains on how to achieve sustainable ecosystem management and to promote the structural coupling among domains. Based on this, consensus can emerge and lead to concerted action in practice. The practical value of IWRM embodies Kurt Lewin's insight that 'there is nothing as practical as a good theory' [51]. One of the valuable suggestions for further research is to consider how society can choose between conflicting knowledge and use it to guide concerted action at a general level when no structural coupling has been formed, yet action must be taken.

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