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PUBLIC DESIGN FOR THE WATER TRANSITION

Towards responsible water banking: An exploratory synthesis of Responsible Innovation and Value Sensitive Design for inclusive water management

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Abstract Water banking offers a transformative solution to freshwater scarcity, but stakeholder involvement is essential for success. Responsible Innovation (RI) and Value Sensitive Design (VSD) include stakeholders in design but both exhibit methodological flaws. This study addressed these limitations by performing an exploratory synthesis of the two approaches within an empirical case in the Dutch Southwestern Delta. First, a systematic literature review produced values inventories for water and water banking; then, a stakeholder workshop used an RI–VSD approach to validate the inventories. The validation highlighted several missing values, such as *fit for use* and *broad prosperity*. Stakeholders also emphasised that values are dynamic, influenced by water availability, technology development, and regional specifics such as flood history. Using an RI–VSD approach resulted in a thorough and validated values inventory, contributing to the limited empirical evidence available and forming the basis for inclusive design of a water bank to manage freshwater scarcity.

Keywords Freshwater management · Responsible Innovation · Value Sensitive Design · Water banking · Water governance · Water transition

INTRODUCTION

Population growth and unsustainable water consumption patterns are exerting increasing pressure on global freshwater resources. This is further exacerbated by climate change impacts on water quality and quantity, leading to prolonged periods of drought and water scarcity (UN-Water 2020). The critical interdependencies between water, energy, and food mean that without water security, sufficient food and energy supply are also at risk (Lalawmpuii and Rai 2023).

These challenges drive the need for a water transition, prompting many countries to focus more on existing water sources and demand management (Montilla-López et al. 2016). Resource allocation requires a detailed strategy to overcome the uncertainties of freshwater supply management, such as different scales of governments, supply and demand regulation, infrastructure and potential conflicting interests (Thissen et al. 2017). One such resource allocation strategy is a water bank.

O'Donnell and Colby (2010, p. 2) define a water bank as "an institutional mechanism designed to facilitate transfer of water on a temporary, intermittent or permanent basis". Through depositing and withdrawing different types of water, a water bank can organise demand, supply, and storage, creating a reliable water supply in the future and thereby contributing to regional flexibility in tackling freshwater scarcity (Fazeli et al. 2021). Despite successful cases in Australia, Spain, and California (Montilla-López et al. 2016), both a failed attempt at a new water bank in California in 2009 and the implementation framework by Fazeli et al. (2021) highlight the need for stakeholder participation when developing water banks, to maximise societal benefits from water exchanges (Montilla-López et al. 2016).

In order to achieve this stakeholder involvement and also avoid a technological fix for a societal problem, Responsible Innovation (RI) could be used (De Jong et al.

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2015). RI is a procedural method, often seen as an inclusive and risk-mitigating approach to societal challenges (Wiarda 2023), guiding innovators to produce socially desirable products by aligning science and technology with societal values (e.g. justice, fairness, honesty) (Boenink and Kudina 2020). Embedded within European research agendas, RI has been empirically used to analyse debated innovations such as genome editing, biotechnology, and IT (Sjøtun and Solheim 2023). Despite occasional academic analyses, experience shows that the lack of clarity and understanding on what RI actually is forms a barrier to implementation in practice (Fraaije and Flipse 2020). Moreover, in spite of RI aiming to align technology with *societal values*, values themselves do not explicitly take centre stage in the procedural approach. Both Boenink and Kudina (2020) and van de Poel et al. (2020) note the curious absence of reflection in RI literature on what values actually are and how they can be identified.

On the other hand, Value Sensitive Design (VSD) is a substantive approach, which works explicitly with values. Originally adopted for computer science and information systems design, VSD aims to systematically incorporate values into technology development (Friedman et al. 2006). The design of a technology can be significantly improved through endeavouring to identify and address the human values impacted by its use (van den Hoven et al. 2015).

Previous research highlights that both approaches have shortcomings: there is ambiguity regarding what is considered good quality RI (Fraaije and Flipse 2020) and VSD is said to have a lack of methodological guidance and reflexivity (Timmermans and Mittelstadt 2014). Jenkins et al. (2020) also argue that despite the appearance that both RI and VSD strive for a common normative goal, the approaches seem to exist in academic silos, thereby obscuring overlap and reducing their practical significance. A solution to combat the identified weaknesses and improve real-world application could be a complementary combination of RI and VSD.

This study therefore attempts to synthesise the two approaches by connecting the procedural aspects of RI to the substantive values in VSD. By means of an empirical case of a regional water bank in the Southwestern Delta of the Netherlands, VSD is used to identify stakeholders' values while following RI procedures. Using the VSD approach to operationalise the concept of RI offers unique insights into the practical challenges of moving from theory to implementation. The lessons learned from the case contribute to the limited existing empirical evidence in several ways. First, this study highlights how the use of an exploratory RI–VSD synthesis can overcome identified weaknesses in the independent approaches. Second, the case enriches available literature on reconciling procedural and substantive values. Finally, by creating a thorough and validated values inventory, this study lays the foundation for the next steps in the inclusive design of a water bank to manage freshwater scarcity.

THEORETICAL FRAMEWORK

Responsible Innovation

The majority of scholars view responsible innovation as "taking care of the future through collective stewardship of science and innovation in the present" (Stilgoe et al. 2013, p. 1570). Another definition is seen in Von Schomberg (2011, p. 9):

> a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society).

In response to concerns on transparency and risks when it comes to innovation, Stilgoe et al. (2013) proposed a guiding framework of four dimensions, commonly referred to as the AIRR dimensions. The framework highlights how to develop innovations in a responsible way by considering four elements: Anticipation, Inclusion, Reflexivity and Responsiveness. **Anticipation** encourages researchers and organisations to ask "what if?" regarding possible, desirable and also potentially detrimental implications of new innovations. This anticipation could highlight innovation opportunities and thereby increase the long-term resilience of a design. Dreyer et al. (2017) compare Anticipation in industry to a risk analysis in the sphere of project management. Practically, Anticipation has been applied in Agri-technology innovation by Jakku et al. (2022) through stakeholder interviews and Prutzer et al. (2023) in mapping potential drivers and barriers of climate-smart irrigation in South Asia.

Bottom-up involvement of stakeholders and members of the public is called **Inclusion,** leading to unknown insights and helping ground innovators in the real world. Opola et al. (2025) applied Inclusion to an assessment framework for just and socially inclusive digital innovations in less industrialised nations, and Lowe et al. (2025) used Inclusion to achieve shared consensus in the co-design of sustainable urban pest management strategies in Australia.

Reflexivity urges reflection and scrutiny on how actions align with social values and responsibilities and **Responsiveness** requires adequate reaction to insights gained from anticipating, including and reflecting. If the design of an

innovation is redirected in response to new knowledge and stakeholder perspectives, the innovation can then be considered responsible (Stilgoe et al. 2013). Both dimensions are encouraged by Moesker et al. (2024) in their study on direct potable water reuse, maintaining that better reflexivity and responsiveness could help to ensure meaningful public engagement and improve public acceptance.

Limitations

Conceptually, RI remains vague and ambiguous with wide-ranging definitions and interpretations (Thapa et al. 2019) and in practice, despite its popularity, its lack of clarity makes it difficult to grasp (De Jong et al. 2015; Fraaije and Flipse 2020). In short: "if RI is to be effective as a guiding principle in science, there needs to be a greater, common understanding of what it means in terms of concepts and methodologies" (De Jong et al. 2015, p. 58).

From a practical perspective, RI should provide guidance on both innovative processes and the products they create. Van De Poel and Sand (2021) describe the AIRR dimensions as procedural and critically reflect that implementing the criteria for the RI process alone does not guarantee a responsible product. De Hoop et al. (2016) also view RI as a process based on the predominance of *procedural norms* in RI literature, which Boenink and Kudina (2020) interpret as intending to unlock *substantive values* which are often provided by stakeholders. As Boenink and Kudina (2020, p. 451) state: "RI comes with a great deal of 'value work': values have to be identified, deliberated upon, weighed, balanced or prioritized". They maintain that thinking of values as entities waiting to be identified underestimates the labour and methods required to help stakeholders uncover their values. It is misleading to suggest that by simply asking relevant stakeholders what their values are, a meaningful and transparent list of values can be drawn up (Boenink and Kudina 2020). This simplification of values work is also seen by De Hoop et al. (2016) who compare the lack of acknowledgement of competing values, for example, in RI literature to the extensive coverage of the same problem in participatory design and constructive technology assessment literature.

Silva et al. (2019) studied the role of stakeholders in RI and found a contradiction between literature and empirical evidence. RI literature indicates that stakeholder involvement is imperative; however, there is no clear guideline on how to identify who the correct stakeholders are, when to include them in the process, and how their involvement eventually leads to a responsible innovation. Previous research has highlighted "a lack of stakeholders' involvement in the early innovation stages, which ultimately leads to a lack of anticipation" (Silva et al. 2019, p. 13) and "a missing connection and involvement of key stakeholders" (Sjøtun and Solheim 2023, p. 3).

Additionally, the actual added value of involving stakeholders can sometimes be contested due to the struggles of managing differences in power, vision, and motive (Blok and Lemmens 2015; De Jong et al. 2015). With this in mind, VSD might be better equipped to overcome this criticism, working towards inclusivity and stakeholder involvement.

Value Sensitive Design

Despite design being traditionally seen as a technical task producing functional outputs, the moral values of technology users and society in general can also be included in design (van den Hoven et al. 2015). Bos-de Vos (2020) explains that a technology can generate different worth to different stakeholders, and by involving these stakeholders throughout the design process, a variety of ideals and motivations such as *harmony*, *security*, and *well-being*, can be integrated. "Value Sensitive Design is a theoretically grounded approach to the design of technology that accounts for human values in a principled and comprehensive manner throughout the design process" (Friedman et al. 2006, p. 2). In other words, VSD aims to systematically incorporate social and moral values in technology development. A value can be defined as "what a person or group of people consider important in life" (Friedman et al. 2006, p. 2), values guide and motivate actions and give meaning to human life (Care et al. 2025). Examples of human values include *privacy, trust, autonomy* and *informed consent*.

VSD is based on the premise that human values and norms can be transferred to the things that we create, making technology value-laden as opposed to value-neutral (Winner 1980; Timmermans et al. 2011; Correljé et al. 2015). Thus, technology can have a moral and political impact on the user and technologies can evolve depending on how they are used (Manders-Huits 2011). VSD's proactive design approach can help to confront this issue by identifying potential ethical concerns with technology interaction before they arise (van den Hoven et al. 2015; Jacobs and Huldtgren 2021).

VSD consists of a tripartite methodology which integrates conceptual, empirical, and technical investigations into step-by-step advice for designers. The conceptual investigations start with identifying direct and indirect stakeholders and how they are affected by the design. It continues with the work necessary to highlight the implicated values and a conceptual analysis on how said values might compete with one another and how trade-offs could be managed (Friedman et al. 2006). In the example of potable water reuse, Moesker and Wiarda (2025) show how

optimising for one value such as *reliability* in water treatment systems, by using more chemicals, can conflict with the value of *sustainability*. Empirical investigations then question technology users about how competing values are prioritised and investigate if there is a difference in what people say compared with what people do (Friedman et al. 2006). Finally, technical investigations focus on the technology being developed to see how its properties can help or hinder human values identified by end users (Friedman et al. 2006). Relatively abstract values such as *human dignity, respect* and *justice,* should be translated to more concrete design requirements (Jenkins et al. 2020).

One core strength of VSD is its flexibility, enabled by the range of methods available, such as the Envisioning cards toolkit for empirical investigations and value dams and flows for prioritising values (Jenkins et al. 2020). The defined roles in VSD and large responsibility placed on designers to translate knowledge into values can also lead to more proactive rather than reactive ethical analysis (Jenkins et al. 2020).

Limitations

The main critique of VSD is its lack of commitment to an ethical theory. Friedman et al. (2006, p. 86) take the stance that "certain values are universally held", which is enough to provide normative direction during the design process. However, some researchers imply that without an ethical grounding, a methodological distinction from moral values and the basic preferences and wishes of involved stakeholders cannot be made (Manders-Huits 2011; Jacobs and Huldtgren 2021).

Timmermans and Mittelstadt (2014) also note a lack of reflexivity when it comes to the person conducting the method. They argue that even if VSD is carried out in a purely procedural manner and methodological steps are strictly followed, introducing a substantive element in the form of the personal views of the researcher is unavoidable, leading to the researcher and their own opinion having significant influence. This is supported by Jacobs and Huldtgren (2021) and van den Hoven et al. (2015) who both refer to the use of "a disembodied voice" in VSD as a failure to clarify who is making the claims. A lack of reflexivity in VSD could unintentionally create a power imbalance, meaning that stakeholder values have less influence on a final technology design than intended (Timmermans and Mittelstadt 2014).

Another methodological critique is the lack of a systematic method for identifying stakeholders and the failure to jointly reflect on elicited values (van den Hoven et al. 2015). Manders-Huits (2011) also criticises the lack of guidance on what to do with the identified values and how to determine which values matter. However, they also note that despite the conceptual vagueness, it could be the purpose of VSD to leave this analysis open to the researcher and the context specificity of each case.

VSD has also been criticised for its temporal limitations. By focusing mainly on the values that arise during technology development, the values that can arise during the subsequent phases of technology implementation and use remain underexplored. This can lead to limited reflection on potential unintended side effects and their associated ethical problems (Jenkins et al. 2020). This is supported by De Reuver et al. (2020), who recommend extending VSD for the entire life cycle of a design and introducing a fourth *reflexivity* investigation for assessing a technology's value realisation.

Lastly, the focus of VSD on technology as opposed to other potential systems has been seen as a weakness (Jenkins et al. 2020), as the institutional context and stakeholder relationships can also influence value conflicts (Correljé et al. 2015). Dignum et al. (2016) applied VSD in the case of the Dutch shale gas debate and as a result argue that VSD could also be used for the design of socio-technical systems and institutions. This study will expand on their work by applying it to the design of a water bank.

METHODS

Case: STURDI-Water

The extreme dry weather in the Netherlands in 2018–2020 had a particularly profound impact on its Southwestern Delta, owing to its disconnection from freshwater river systems and its surrounding saline surface and ground water (Provincie Zeeland 2021). A lack of direct freshwater supply leaves larger water users vulnerable, especially during periods of precipitation deficit (Veraart et al. 2017).

To combat these challenges, the Province of Zeeland published a *Zeeuws Deltaplan Zoet Water* (2021), a coherent plan with the ambition of securing resilience for the province in the face of freshwater shortages. The plan aims to increase freshwater availability through a robust water system, achieved by delayed drainage of freshwater to sea and efficient use, storage, and reuse of water. Within this context, the NWO-KIC project "Storage, Upgrade, Reuse and Distribution of Water in regional collaborative networks" (STURDI-Water) was developed. The STURDI-Water project aims to design a governance innovation in the form of a regional water bank for multi-sectoral water supply. To achieve this, many parties must work together to overcome both technical (e.g. treatment efficiency, removal of persistent pollutants) and non-technical (e.g. limiting legislation, economic incentives) barriers. The consortium therefore consists of relevant

stakeholders in the water system: government, industry, agriculture, nature conservation, citizens, drinking water providers, water technology developers and researchers. The water bank is envisioned as a collaborative legal entity arranging a sufficient amount of water of the required quality for a user when needed, in a fair way and for an affordable price.

When matching supply and demand of fresh water, a water bank may be faced with decisions which could include conflicting values, for example, *food production* versus *human health* when using recycled municipal effluent water for agricultural irrigation. Both the procedural aspects of RI and the substantive features of VSD are therefore applied in an attempt to make the design of a water bank value-sensitive. This application is unique as it not only translates both RI and VSD simultaneously to a real-life case, but it also involves the design of a socio-techno-ecological system as opposed to a technological innovation most commonly seen in RI and VSD.

Exploratory synthesis of Responsible Innovation and Value Sensitive Design

Figure 1 shows how the four AIRR dimensions of RI and the three investigations within VSD would ideally interact within an RI–VSD synthesis, with the orange area showing the position of this study. Conceptual and empirical investigations were both partially performed through the identification and preliminary definition of stakeholder values. However, a full conceptual analysis on value conflicts and trade-offs falls out of the scope of this investigation.

The first step of conceptual investigations within VSD is the identification of the stakeholders affected by the design. As these investigations were conducted within the STURDI-Water project, the stakeholders were already identified. The STURDI-Water consortium was established with the aim of including the most relevant stakeholders from the outset, with consortium invitations sent to: (a) at least one stakeholder per water-using sector in the region; (b) interdisciplinarity stakeholders with varying visions on water management; (c) stakeholders with membership of the established regional Robust Water System network (Robuust Watersysteem Zeeuws-Vlaanderen 2017), in the belief that these long-standing collaborations would encourage trust and stakeholder commitment.

Subsequently, the stakeholder values were identified in two steps: first, a systematic literature review was used to create a values inventory and second, stakeholders were brought together in a workshop setting to validate the inventory.

Values identification: Literature

A systematic literature review was used to create two separate values inventories: one for values related to water in general and one for values related to water banking.

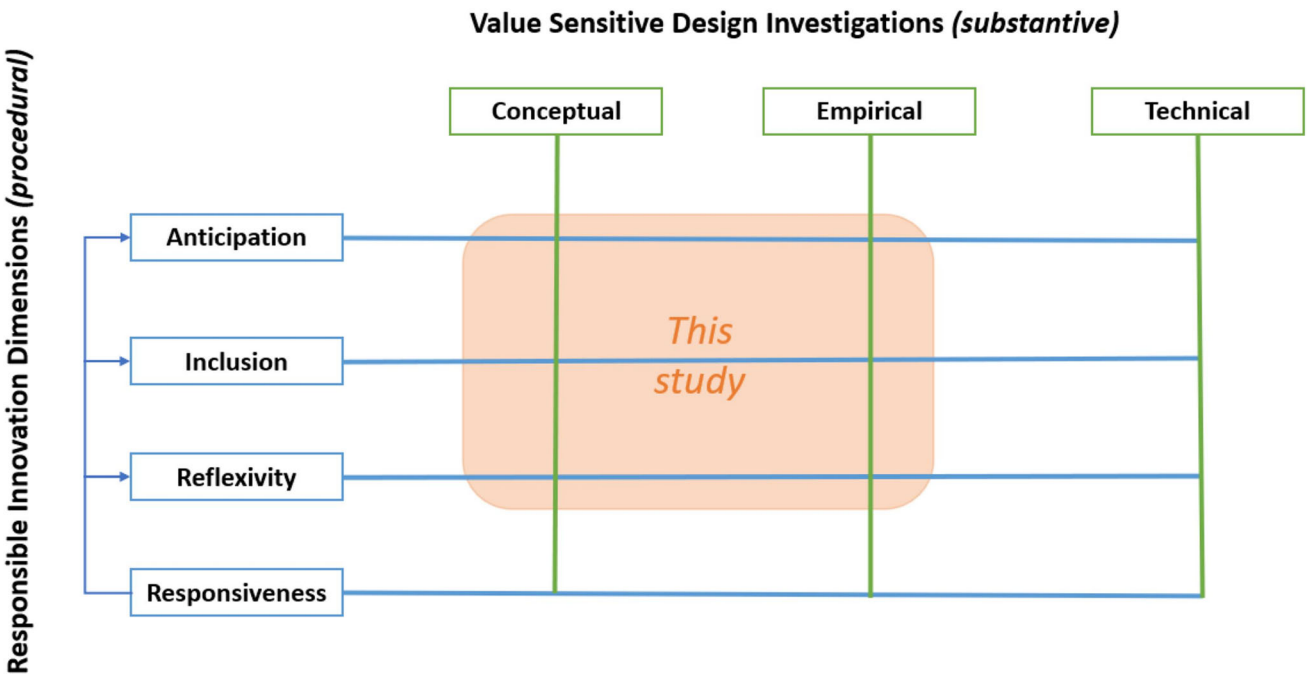


Fig. 1 Position of this study within the RI–VSD synthesis: covering Anticipation, Inclusion and Reflexivity and (partial) Conceptual and Empirical investigations

Web of Science was used to access a wide range of interdisciplinary research and a number of search chains were used to find a representative yet manageable literature set for analysis. The exact search chains used are shown below:

1. Water: TITLE: (value* AND ethic* AND water) AND TITLE: ((public value OR social value) AND water)
2. Water banking: TITLE: (governance AND water AND value*) AND TITLE: (water management AND value) AND TITLE: ((value* OR ethic*) AND water management) AND TITLE: ((value* OR ethic*) AND water bank) AND TITLE: "water bank"

All subject areas were searched, and no limit was placed on the timeframe of publication. Figure 2 shows the four-phase flow diagram adapted from Moher et al. (2009) used for the selection of relevant literature for both inventories combined. Literature was excluded if the body of text was not in English, if the text did not discuss water or the broader subject of ethics and finally if the text only referred to value as economical value.

The created values inventories were then compared to ethical values frameworks to address prior criticisms of VSD's lack of commitment to ethical theory (see "Methodological discussion" section).

Values identification: Workshop

The workshop constituted the conceptual investigations of VSD (i.e. the stakeholders affected and values implicated) as well as the empirical (i.e. how stakeholders behave and how they prioritise values). To achieve this, the joint value creation tool of Bos-de Vos et al. (2024) was used. The tool was designed to enable stakeholders to develop a shared vision on collaboration and understand value within their project, thereby jointly specifying values. Comprising a large canvas for working in groups, the tool uses accessible value language for stakeholders from all backgrounds and can be applied to projects in all contexts. The tool was tailored to the context of water banking by incorporating the predefined values inventories to guide discussions. Furthermore, the use of four different rounds, alternating between working individually and in groups, enabled both personal reflection and the development of a joint water banking vision.

Round one asked participants to individually reflect on the question "What kind of world do I want to live in?" and to then pick the value which resonated with them the most from the values of water inventory. When thinking about this question, participants were asked to step away from their role in the water sector as best they could and to

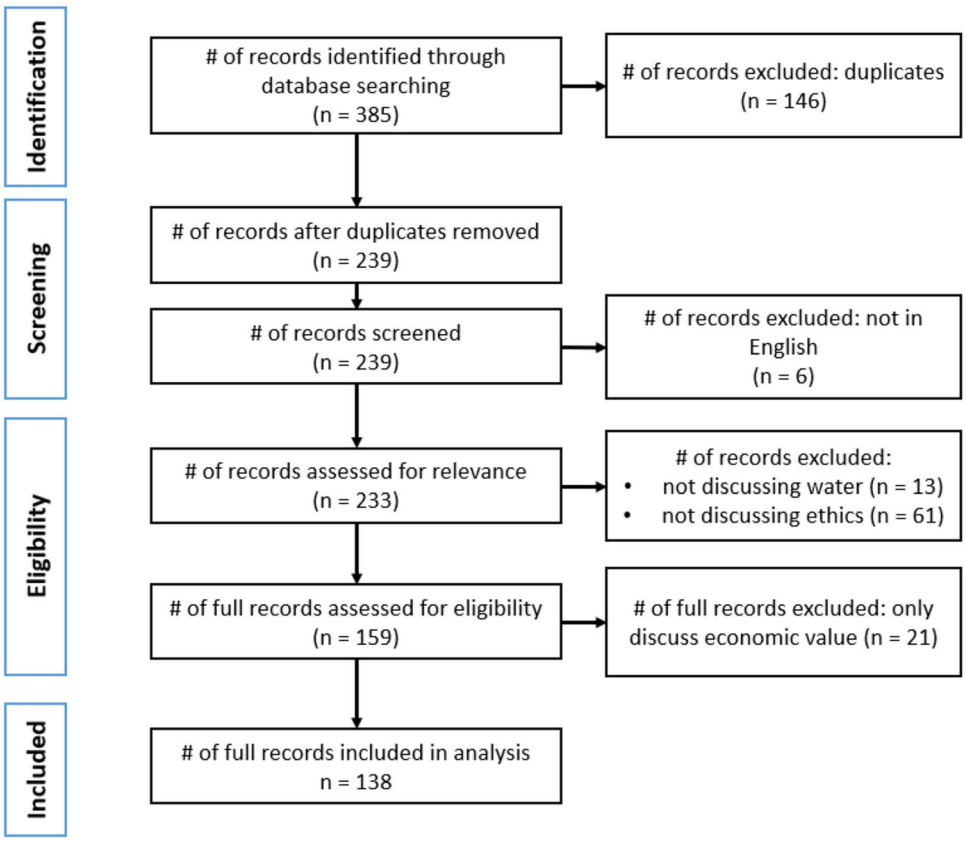


Fig. 2 Flow diagram of literature selection process, adapted from: (Moher et al. 2009)

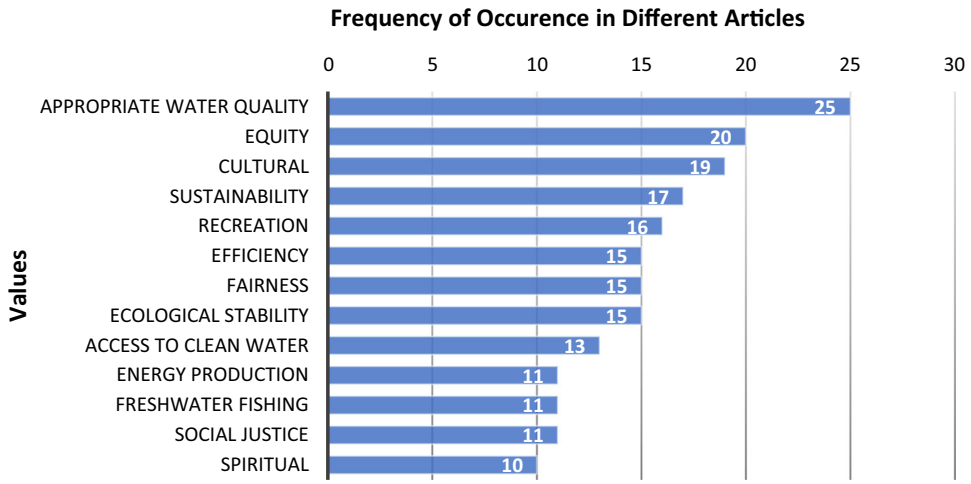


Fig. 3 Values occurring most frequently in literature: found 10 times or more in different articles

answer from a personal perspective. If participants found it too difficult to choose just one value, they were permitted to choose up to a maximum of three. Each participant then introduced themselves to the group and explained why they had chosen the value(s) they did. This round incorporated the Reflexivity dimension of RI which requires that actors reflect on their own assumptions and knowledge limitations and how their personal position might influence the design process (Stilgoe et al. 2013; Wiarda et al. 2022).

For round two, the participants were placed in pre-formed groups which had balanced representation of water system users. During this round the joint value creation tool (Bos-de Vos et al. 2024) was used to create a vision for water banking by together answering the questions "What should the water bank realise?" and "How will we collaborate within the water bank?". Participants were asked to consider all relevant stakeholders and to reflect on what should be achieved over various time horizons, including now, 5 years from now, and 50 years from now. This round merged the Anticipation dimension of RI, requiring that actors consider impacts of design for now and in the future (Stilgoe et al. 2013) with the Inclusion dimension, involving diverse stakeholders throughout the design process to ensure varied input (Wiarda et al. 2022).

Round three enabled core values of water banking to be selected. Initially, participants acted individually to assign values from the water banking inventory to the group's water banking vision from their own perspective. Afterwards, the group discussed their choices and agreed together upon a maximum of four core values (including definitions), which would represent that group's water banking vision. By placing participants in pre-formed groups, each with a representative from every water-using sector, the groups reflected diverse social, technical, and ecological perspectives.

In round four, the two values inventories produced from the literature review were validated. The most commonly occurring values in literature and the workshop were compared, differences were discussed and stakeholders made suggestions for irrelevant or missing values.

RESULTS

Results: Values inventory

The literature review identified 126 values in total; there were 70 values associated with water and 56 values of water banking. The complete inventories can be found in Appendices S1 and S2. Some of the values found in the inventories could perhaps better be classified as water uses, broad value categories, or norms. However, in order to keep the inventories as accessible and tangible for stakeholders with no prior "values language" experience as possible, all values found in literature were accepted literally without further conceptual analysis. Nevertheless, in order to have visually manageable values inventories for the workshop, each was organised into provisional categories, as shown in Appendices S3 and S4. Figure 3 gives an overview of the values found at least 10 times or more in different articles.

Results: Workshop validation

The workshop took place in March 2025 and was attended by 28 participants representing national, provincial, and municipal government; petrochemical and food industries; industrial water providers; arable agriculture; nature conservation; a port authority and researchers from various disciplines.

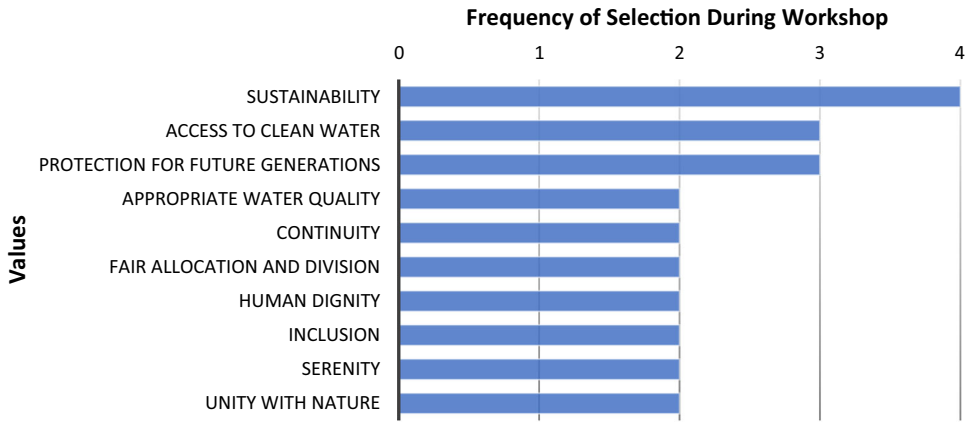


Fig. 4 Values chosen more than once by 28 participants when asking themselves the question "What kind of world do I want to live in?"

Table 1 Participant answers (Group 1 and Group 4) to the question "What should the water bank realise?"

	Now	In 5 years	In 50 years
Group 1	We should try to:	The following has been realised:	The following has been realised:
	Define the scope of water quantity handled by the water bank	A concrete plan for implementation of a water bank	A sustainable delta
	Create an overview of water demand and supply	Allocated responsibilities within the water bank	Fair division of water across all users
	Be transparent	A clear overview of demand and supply	A fully operational water bank
			Well educated professionals who can tackle water issues
Group 4	We should try to:	The following has been realised:	The following has been realised:
	Gain insight into demand and supply	Pilot water bank	Operational water bank
	Start essential collaboration	Contracts set up	Legislation supporting the water bank
	Add a financing partner to the consortium	Legislative frameworks established	Necessary infrastructure in place
	Review current legislation	Roles and ownership determined	
		Insight into finance options	

Round one: Values of water

Figure 4 shows all values which were chosen more than once by different participants in this individual round.

Round two: Water banking

Answering the water banking questions as a group, considering a 50-year timeline, provided the answers in Tables 1 and 2.

Round three: Values of water banking

Each group's four core values can be found in Table 3.

As values could be interpreted ambiguously, each group added definitions so that their intention was clear. The participants indicated that **efficiency** includes economic efficiency as well as finding sustainable solutions; **distributive justice** includes distribution to nature; **resilience** of both the water system and the community; and **respect** for nature, communities, and policy.

Round four: Validation

In order to assess how closely the values chosen during the workshop reflected the values identified in literature, the results of both were compared. Surprisingly, the workshop identified core values that did not occur most often in the literature and vice versa. Literature's highest-ranking values had five values in common with the workshop (Fig. 5).

Freshwater fishing was found frequently in the literature, often as an income source for Indigenous groups. However, as there is little freshwater fishing in the Southwestern Delta outside of recreational, it was deemed as less relevant for this case. The values *cultural* and *spiritual* were frequently found in the literature but not selected once during the workshop. This could point to a lack of representation of different social perspectives during the workshop or to differences in interpretation of each value. Upon reflection, the workshop participants agreed that despite not being identified, cultural and spiritual values are of great importance considering the Southwestern Delta's historical battle against flooding. This

Table 2 Participant answers (Group 2 and Group 3) to the question "How will we collaborate within the water bank?"

	Now	In 5 years	In 50 years
Group 2	We should try to:	The following has been realised:	The following has been realised:
	Respect each other's perspective	Everything we have learned has been implemented and we share our knowledge with other fields	We are no longer reliant on external supply of fresh water
	Ensure that each person has their own responsibility and feels responsible, otherwise they will not act	Strong shoulders to carry the heavy load	A circular system
	Build trust	Collaboration based on knowledge of the system	
	Understand each other's interests	Clear agreements on water sharing	
Group 3	We should try to:	The following has been realised:	The following has been realised:
	Build trust	Results are structured	Profit
	Secure commitment	A follow-up plan is in place	
	Share information	Nature has been included	
	Map the needs for each organisation	Knowledge and solutions shared with others	
	Share data on quantity and quality		

Table 3 A total of 16 core values of water banking chosen by the groups

What should the water bank realise?		How will we collaborate within the water bank?	
Group 1	Group 4	Group 2	Group 3
Water security	Collaboration	Community engagement	Respect
Efficiency	Ecosystem integrity	Resilience	Sustainability
Distributive justice	Appropriate quality	Trust	Transparency
Collaboration	Fair pricing	Protection of future generations	Fair pricing

history has created a respect for water and its power that is reflected in the motto of the Province of Zeeland: *Luctor et emergo* (I struggle and emerge). In a similar discussion, it was confirmed that even though *recreation* was not selected during the workshop, it is an important value in the region which has tourism and coastal leisure activities embedded in its identity. This indicates that even though some values were not selected, it does not mean that they are irrelevant.

The validation session also identified six values missing from literature which were considered important for the case region specifically. These included *honesty, fit for use, scope, broad prosperity, liveability*, and *transdisciplinarity.*

DISCUSSION

Despite an overlap of five values, the global focus of the literature review compared to the regional focus of the workshop could explain noticeable differences. Some values found in the literature could be perceived as relating more to seawater than freshwater explicitly (e.g. *flood control, tourism, aquaculture, navigation*) and as the stakeholders are mainly concerned with freshwater resilience, these types of values can lose precedence.

The recurrence of *access to clean water* as an important value in literature came from cases in countries where access to clean water and sanitation is not guaranteed. It is interesting to point out that despite this value not being highlighted during the workshop, the value of *water security* was and one could argue that although the two values are not the same, they are in a way connected. They both concern different levels of the same burden: ensuring access to clean water and ensuring access to enough water of an acceptable quality. In terms of *access to clean water*, stakeholders considered *clean* a complex term due to the challenges of meeting the European Framework Directive goals and the difficulties faced when removing forever chemicals from water.

Equity is another value that appeared often in the literature, prompting stakeholders to doubt if water provision in the Netherlands really is equitable. They referenced a recent ruling in The Hague Court of Appeal which declared disconnecting households with children from drinking water, due to unpaid bills, to be unlawful (de Rechtspraak 2024). The fact that this ruling took place in 2024 and only applies to households with children, raised doubts on equitable water supply.

When comparing the values inventories with the workshop results, stakeholders noted that the values chosen

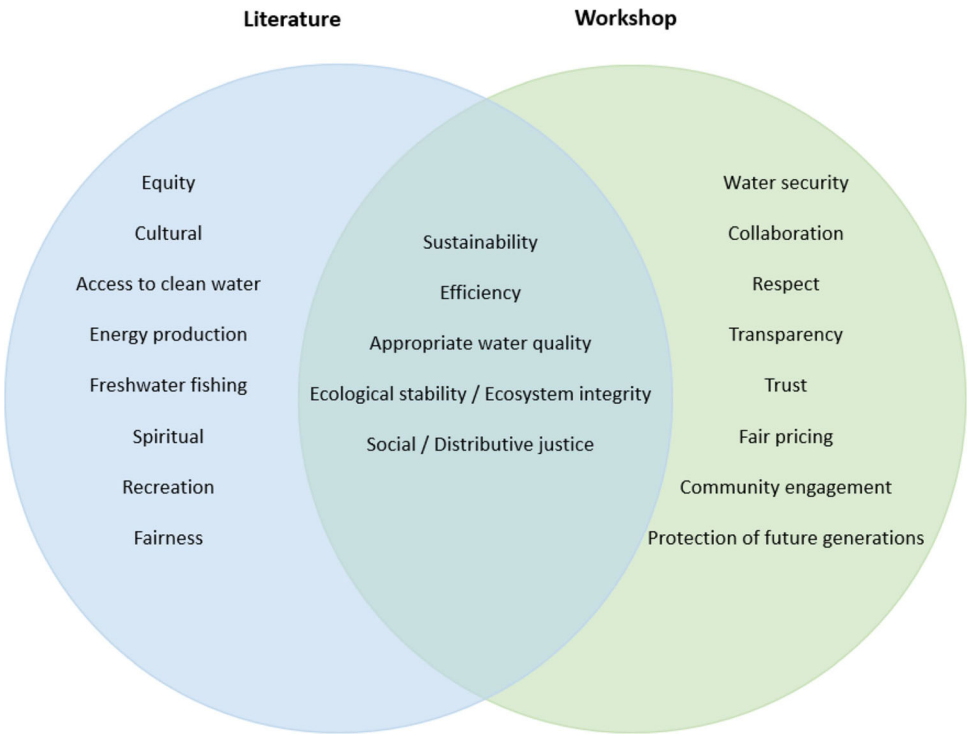


Fig. 5 A comparison of the most frequently occurring values in literature and the core values chosen during round three, with values in common shown in the overlapping section

during the workshop were not definitive. The discussion surrounding the dynamic nature of values mentioned that values are likely influenced by water availability and technology development; if new treatment options result in more water availability, then the pressure felt about freshwater scarcity reduces and values could change.

The validation session concluded by addressing potential value tensions that could arise during the course of the STURDI-Water project. The value tension of most concern seemed to be between nature and what was defined as *regional economy*. A noticeable synergy emerged among stakeholders who acknowledged that while important, nature alone is not enough to sustain a vital region. Employment, economy, well-being and health were identified as essential elements of regional liveability, which could be compromised by the value tension of nature and regional economy. Prioritising nature could jeopardise other water-using sectors such as industry and agriculture. The delicate nuance of this value tension, framed by stakeholders as the *broad prosperity* of the region as a whole, will be explicitly addressed in the next steps of the project.

Methodological discussion

This study addressed the concerns of Boenink and Kudina (2020) and De Hoop et al. (2016) who feared that a simplification of values work would not lead to substantial values identification, for two reasons. First, the stakeholders involved comprised water experts who are already extremely knowledgeable about the context and the case. Second, the extensive literature research provided two solid values inventories from which to work during the workshop. These two points combined with the use of the joint value creation tool (Bos-de Vos et al. 2024) and structuring the workshop over several rounds with different value goals, provided a thorough methodology for values identification.

The involvement of all STURDI-Water stakeholders in the workshop in general combined with the anticipatory nature of round two specifically, lays the foundations for alleviating the criticism of Silva et al. (2019) that stakeholders are often involved too late in the RI process, miss the Anticipation phase, and have minimal impact on design.

Round one of the workshop allowed the stakeholders to reflect on their own personal values of water before re-assuming the identity of a water bank stakeholder, thereby incorporating the recommendations of De Reuver et al. (2020) and Timmermans and Mittelstadt (2014) for reflexivity on personal influence in the VSD process. The notions that VSD is only focussed on technological design and has temporal limitations are refuted by the application of this synthesis approach to the design of a socio-techno-

ecological system in the form of a water bank and the use of a time horizon of up to 50 years during round two.

This RI–VSD synthesis meant that three of the four RI dimensions and two of the three VSD investigations could be (partially) applied during the workshop. The synthesis not only led to a clear and structured process to ensure that stakeholders are involved, look forward, and reflect personally but also meant values were thoroughly examined and discussed. The last RI dimension of Responsiveness could not be applied during the workshop but will be applied later in the project, along with an investigation into what is needed for long-term implementation of a water bank beyond the project's timeline and how to foster commitment to its value-sensitive nature. It is expected that long-established partner relationships and local and geographical factors will play a role here. The VSD analysis of potential value conflicts in conceptual investigations and prioritisation of values in empirical investigations, will also follow in the next research phases. VSD technical investigations will be later utilised to investigate the use of technology in resolving value conflicts.

As with any research, our study is not without limitations. As already mentioned, the STURDI-Water project was taken as a starting point, meaning that the stakeholders were already defined. Despite the belief that this group was representative of the regional water system, a retrospective analysis reveals that citizens were under-represented in the consortium. Even though each stakeholder is in theory also a citizen and was given the opportunity during round one of the workshop to respond as a citizen, it was contested that a researcher from a different part of the country might not have the same values as someone living in the area and potentially directly impacted by the design. A limitation is therefore that the consortium represents those in the water system who are already well educated on water, with their values likely reflecting their background. Consequently, the results of the workshop embody the values of all stakeholders present on the day, but if a stakeholder group was not represented, then their values could be missing. In order to capture broader societal perspectives on water values, it is recommended to include citizens living in the case area and with no prior link to the water sector in the next phases of the research. This is in line with the recommendation of Silva et al. (2019) who maintain that involving citizens can lead to a more balanced view and provide input from those who can help the design better meet their own needs.

The produced values inventories could also be criticised for not resembling a conceptually analysed values taxonomy. As the goal of this research phase was instead to introduce stakeholders to values for the first time while attempting to ascertain their most important values, it was decided to keep the values inventories as tangible and recognisable as possible by keeping any reference from literature unchanged, be they widely accepted values or not. Despite this, in an attempt to tackle the VSD critique of Manders-Huits (2011) and Jacobs and Huldtgren (2021) regarding grounding in ethical theory, the collected values were compared to generally recognised ethical values frameworks and ethical values frameworks specific for the water domain. For this, the fundamental principles for water ethics (Liu et al. 2011), Friedman et al.'s list of Human Values with Ethical Import (Friedman et al. 2006), Schwartz's theory of basic values (2012), and Schulz et al.'s (2017) conceptual framework for values in water governance were used. All values selected by the stakeholders appeared in at least one of these frameworks and, vice versa, most of the values listed in these frameworks also emerged in the discussions. This shows both a wide representation of ethical values throughout the inventories and a solid ethical grounding of stakeholder values in the existing ethical theory, lessening the concern about being guided by mere stakeholder desires.

A further limitation of not performing a conceptualisation is that when ranking the most commonly occurring values found in the literature for Figs. 2 and 5, synonyms were not considered. By accepting value references used in the literature regardless of further conceptualisation of that value within a particular study, the ranking shown in Fig. 2 is not infallible. It does, however, indicate which terms are considered important and provided a starting point for the workshop discussions.

This study produced two values inventories and a list of 16 core values for water banking in the Southwestern Delta. A limitation of such values lists is that not all stakeholders interpret them in the same way, with one value possibly having different meanings for different people. Dignum et al. (2016) noted a problem during their study with intra-value conflicts where the same value was interpreted differently by stakeholders. In order to combat this multi-interpretability, round three of the workshop required the stakeholders to add definitions to better define ambiguous values for a wider audience.

CONCLUSION

This study attempted to overcome the limitations of Responsible Innovation and Value Sensitive Design by using an exploratory synthesis of both within a case of a regional water bank in the Dutch Southwestern Delta, thereby reconciling procedural and substantive values and contributing to the design of inclusive water banking. The 126 values identified by a systematic literature review were divided across two values inventories: 70 values of water and 56 values of water banking. A joint value creation tool

was used in a stakeholder workshop to identify stakeholder values and validate the produced values inventories. Stakeholders considered the inventories to be complete apart from six values: *honesty, fit for use, scope, broad prosperity, liveability* and *transdisciplinarity*. Despite the similarity in the values occurring in the literature and those chosen by stakeholders, stark differences proved that the effect of context specificity (i.e. global literature review versus regional workshop) must be considered when working with values. Stakeholders also emphasised that values are dynamic, influenced by factors such as water availability and technology development, as well as regional specifics like a history with flooding in the Southwestern Delta.

By using an RI–VSD synthesis, the limitations of the independent methods could be alleviated, including applying a thorough method for the values work needed to elicit stakeholder values; involving all stakeholders early in the design process; allowing opportunity for reflexivity; applying VSD to a design other than that of a technology; and considering a time horizon beyond the design phase. Although not all of the dimensions of RI and the investigations of VSD were taken into consideration for this study's synthesis, the dimensions and investigations which were applied helped to produce a thorough and validated values inventory for this project.

The application of the RI–VSD synthesis to STURDI-Water, a real-life case with real stakeholders and actual concerns, contributes empirical evidence to the limited and emerging literature on reconciling procedural and substantive values. In doing so, this study marks an important step in the journey towards responsible water banking for inclusive water management.

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Data availability The authors confirm that all data generated or analysed during this study are included in this published article and its supplementary material.

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REFERENCES

Blok, V., and P. Lemmens. 2015. The emerging concept of responsible innovation: Three reasons why it is questionable and calls for a radical transformation of the concept of innovation. In *Responsible innovation 2: Concepts, approaches, and applications*, ed. B.-J. Koops, I. Oosterlaken, H. Romijn, T. Swierstra, and J. Van den Hoven, 19–36. Cham: Springer.

Boenink, M., and O. Kudina. 2020. Values in responsible research and innovation: From entities to practices. *Journal of Responsible Innovation* 7: 450–470. https://doi.org/10.1080/23299460.2020.1806451.

Bos-de Vos, M. 2020. A framework for designing for divergent values. In *Design Research Society Conference 2020, Brisbane Australia*.

Bos-de Vos, M., S. de Jager, and I. Mulder. 2024. Project value modeling for societal transitions. *Project Value Modeling*. Website https://projectvaluemodeling.com/tools/project-value-modeling-for-societal-transitions.

Care, O., J.G. Zaehringer, M.J. Bernstein, M. Chapman, C. Friis, S. Graham, L.J. Haider, M. Hernández-Morcillo, et al. 2025. Reaping what we sow: Centering values in food systems transformations research. *Ambio* 54: 226–238. https://doi.org/10.1007/s13280-024-02086-5.

Correljé, A., E. Cuppen, M. Dignum, U. Pesch, and B. Taebi. 2015. Responsible innovation in energy projects: Values in the design of technologies, institutions and stakeholder interactions. In *Responsible innovation 2*, ed. I. Oosterlaken, H. Romijn, T. Swierstra, and J. Van Den Hoven, 183–200. Cham: Springer.

De Hoop, E., A. Pols, and H. Romijn. 2016. Limits to responsible innovation. *Journal of Responsible Innovation* 3: 110–134. https://doi.org/10.1080/23299460.2016.1231396.

De Jong, M., F. Kupper, A. Roelofsen, and J. Broerse. 2015. Exploring responsible innovation as a guiding concept: The case of neuroimaging in justice and security. In *Responsible innovation 2*, ed. B.-J. Koops, I. Oosterlaken, H. Romijn, T. Swierstra, and J. Van Den Hoven, 57–84. Cham: Springer.

de Rechtspraak. 2024. Cutting off water to minors is unlawful (In Dutch). *de Rechtspraak*. Website https://www.rechtspraak.nl/Organisatie-en-contact/Organisatie/Gerechtshoven/Gerechtshof-Den-Haag/Nieuws/Paginas/Afsluiten-van-water-bij-minderjarige-kinderen-is-onrechtmatig.aspx. Accessed 30 Oct 2025.

De Reuver, M., A. Van Wynsberghe, M. Janssen, and I. Van De Poel. 2020. Digital platforms and responsible innovation: Expanding value sensitive design to overcome ontological uncertainty. *Ethics and Information Technology* 22: 257–267. https://doi.org/10.1007/s10676-020-09537-z.

Dignum, M., A. Correljé, E. Cuppen, U. Pesch, and B. Taebi. 2016. Contested technologies and design for values: The case of shale gas. *Science and Engineering Ethics* 22: 1171–1191. https://doi.org/10.1007/s11948-015-9685-6.

Dreyer, M., L. Chefneux, A. Goldberg, J. Von Heimburg, N. Patrignani, M. Schofield, and C. Shilling. 2017. Responsible innovation: A complementary view from industry with proposals

for bridging different perspectives. *Sustainability* 9: 1719–1744. https://doi.org/10.3390/su9101719.

Fazeli, S., O. Bozorg-Haddad, M. Randall, and R.P. Berrens. 2021. *Introducing water banks: Principles and importance. Economical, Political, and Social Issues in Water Resources*, 83–102. Amsterdam: Elsevier.

Fraaije, A., and S.M. Flipse. 2020. Synthesizing an implementation framework for responsible research and innovation. *Journal of Responsible Innovation* 7: 113–137. https://doi.org/10.1080/23299460.2019.1676685.

Friedman, B., P.H. Kahn, and A. Borning. 2006. Value sensitive design and information systems. In *Human-computer interaction in management information systems: Foundations*, ed. P. Zhang and D. Galletta, 347–372. New York: M.E Sharpe.

van den Hoven, J., P.E. Vermaas, and I. van de Poel. 2015. *Design for values: An introduction. Handbook of ethics, values, and technological design*, 1–7. Dordrecht: Springer.

Jacobs, N., and A. Huldtgren. 2021. Why value sensitive design needs ethical commitments. *Ethics and Information Technology* 23: 23–26. https://doi.org/10.1007/s10676-018-9467-3.

Jakku, E., S. Fielke, A. Fleming, and C. Stitzlein. 2022. Reflecting on opportunities and challenges regarding implementation of responsible digital agri-technology innovation. *Sociologia Ruralis* 62: 363–388. https://doi.org/10.1111/soru.12366.

Jenkins, K.E.H., S. Spruit, C. Milchram, J. Höffken, and B. Taebi. 2020. Synthesizing value sensitive design, responsible research and innovation, and energy justice: A conceptual review. *Energy Research & Social Science* 69: 1–14. https://doi.org/10.1016/j.erss.2020.101727.

Lalawmpuii, and P.K. Rai. 2023. Role of water-energy-food nexus in environmental management and climate action. *Energy Nexus* 11: 100230. https://doi.org/10.1016/j.nexus.2023.100230.

Liu, J., A. Dorjderem, J. Fu, X. Lei, H. Liu, D. Macer, Q. Qiao, L. Yu, et al. 2011. *Water ethics and water resource management*. Bangkok: UNESCO.

Lowe, E.C., N.J. Butterworth, A. Austin, C. Webb, and T. Latty. 2025. Stakeholder co-design of sustainable urban pest management strategies. *Ambio* 55: 101–114. https://doi.org/10.1007/s13280-025-02204-x.

Manders-Huits, N. 2011. What values in design? The challenge of incorporating moral values into design. *Science and Engineering Ethics* 17: 271–287. https://doi.org/10.1007/s11948-010-9198-2.

Moesker, K., U. Pesch, and N. Doorn. 2024. Public acceptance in direct potable water reuse: A call for incorporating responsible research and innovation. *Journal of Responsible Innovation* 11: 2304382. https://doi.org/10.1080/23299460.2024.2304382.

Moesker, K., and M. Wiarda. 2025. Value-sensitive design of potable water reuse: Aligning academic research with societal concerns. *Science and Engineering Ethics* 31: 18. https://doi.org/10.1007/s11948-025-00542-3.

Moher, D., A. Liberati, J. Tetzlaff, and D.G. Altman. 2009. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *International Journal of Surgery* 8: 336–341. https://doi.org/10.1136/bmj.b2535.

Montilla-López, N., C. Gutiérrez-Martín, and J. Gómez-Limón. 2016. Water banks: What have we learnt from the international experience? *Water* 8: 466. https://doi.org/10.3390/w8100466.

O'Donnell, M., and B. Colby. 2010. *Water banks: A tool for enhancing water supply reliability*. Tucson: University of Arizona.

Opola, F.O., S. Langan, I. Arulingam, C. Schumann, N. Singaraju, D. Joshi, and S. Ghosh. 2025. A multi-dimensional framework for responsible and socially inclusive digital innovation in food, water, and land systems. *Agriculture and Human Values* 42: 1829–1846. https://doi.org/10.1007/s10460-025-10731-2.

Provincie Zeeland. 2021. Zeeland Delta Plan Fresh Water (In Dutch). Provincie Zeeland, Middelburg.

Prutzer, E., A. Patrick, A. Ishtiaque, S. Vij, R. Stock, and M. Gardezi. 2023. Climate-smart irrigation and responsible innovation in South Asia: A systematic mapping. *Ambio* 52: 2009–2022. https://doi.org/10.1007/s13280-023-01895-4.

Robuust Watersysteem Zeeuws-Vlaanderen. 2017. Robust Water System Zeeuws-Vlaanderen (In Dutch). *Robuust Watersysteem Zeeuws-Vlaanderen*. Website www.robuustwatersysteemzeeuwsvlaanderen.nl.

Schulz, C., J. Martin-Ortega, K. Glenk, and A.A.R. Ioris. 2017. The value base of water governance: A multi-disciplinary perspective. *Ecological Economics* 131: 241–249. https://doi.org/10.1016/j.ecolecon.2016.09.009.

Schwartz, S.H. 2012. An overview of the Schwartz theory of basic values. *Online Readings in Psychology and Culture* 2: 11. https://doi.org/10.9707/2307-0919.1116.

Silva, L.M.D., C.C. Bitencourt, K. Faccin, and T. Iakovleva. 2019. The role of stakeholders in the context of responsible innovation: A meta-synthesis. *Sustainability* 11: 1766. https://doi.org/10.3390/su11061766.

Sjøtun, S.G., and M.C.W. Solheim. 2023. Exploring the geographies of responsible innovation. *Norsk Geografisk Tidsskrift - Norwegian Journal of Geography* 77: 1–9. https://doi.org/10.1080/00291951.2023.2204867.

Stilgoe, J., R. Owen, and P. Macnaghten. 2013. Developing a framework for responsible innovation. *Research Policy* 42: 1568–1580. https://doi.org/10.1016/j.respol.2013.05.008.

Thapa, R.K., T. Iakovleva, and L. Foss. 2019. Responsible research and innovation: A systematic review of the literature and its applications to regional studies. *European Planning Studies* 27: 2470–2490. https://doi.org/10.1080/09654313.2019.1625871.

Thissen, W., J. Kwakkel, M. Mens, J. van der Sluijs, S. Stemberger, A. Wardekker, and D. Wildschut. 2017. Dealing with uncertainties in fresh water supply: Experiences in the Netherlands. *Water Resources Management* 31: 703–725. https://doi.org/10.1007/s11269-015-1198-1.

Timmermans, J., and B. Mittelstadt. 2014. Reflexivity and value-sensitive design. *CEPE 2014 Proceedings*.

Timmermans, J., Y. Zhao, and J. Van Den Hoven. 2011. Ethics and nanopharmacy: Value sensitive design of new drugs. *NanoEthics* 5: 269–283. https://doi.org/10.1007/s11569-011-0135-x.

UN-Water. 2020. Water and climate change. United Nations Educational, Scientific and Cultural Organization, Paris.

van de Poel, I., L. Asveld, S. Flipse, P. Klaassen, Z. Kwee, M. Maia, E. Mantovani, C. Nathan, et al. 2020. Learning to do responsible innovation in industry: Six lessons. *Journal of Responsible Innovation* 7: 697–707. https://doi.org/10.1080/23299460.2020.1791506.

Van De Poel, I., and M. Sand. 2021. Varieties of responsibility: Two problems of responsible innovation. *Synthese* 198: 4769–4787. https://doi.org/10.1007/s11229-018-01951-7.

Veraart, J.A., R. van Duinen, and J. Vreke. 2017. Evaluation of socio-economic factors that determine adoption of climate compatible freshwater supply measures at farm level: A case study in the Southwest Netherlands. *Water Resources Management* 31: 587–608. https://doi.org/10.1007/s11269-016-1399-2.

Von Schomberg, R. 2011. Prospects for technology assessment in a framework of responsible research and innovation. *SSRN Electronic Journal*. https://doi.org/10.1007/978-3-531-93468-6_2.

Wiarda. 2023. Responsible Innovation for Wicked Societal Challenges: An Exploration of Strengths and Limitations. Delft University of Technology, Delft.

Wiarda, M., G. Van De Kaa, N. Doorn, and E. Yaghmaei. 2022. Responsible innovation and De Jure standardisation: An in-depth

exploration of moral motives, barriers, and facilitators. *Science and Engineering Ethics* 28: 65. https://doi.org/10.1007/s11948-022-00415-z.
Winner, L. 1980. Do Artifacts have politics? *Daedalus* 109: 121–136.

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