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Reimagining public water: an intergenerational exploration of paradigms for future system design*

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ABSTRACT

Due to the life-span of infrastructure, the complexity of components and the tendency of institutional structures to reproduce themselves, infrastructural systems as a whole are seldom reimagined. In addition, strategic thinking about possible system innovations is mainly done by the generations with extensive work experience. This whilst challenges such as climate change trigger the need for system innovation and are inherently intergenerational. This paper examines a method for "intergenerational reimagination", facilitating reflexive learning within a generationally diverse subgroup of actors. This was done to explore paradigms for future system design. Building on the Advocacy Coalition Framework, descriptive, normative and explorative steps are developed. These steps include an intergenerational dialogue and carefully designed workshops, involving both young and senior professionals. The methodology was applied to reimagine the Dutch public water system, a design process which involved over 50 young professionals and resulted in three reimaginations. This process shows the potential for intergenerational development of possible paradigms for future system design. Moreover, throughout the process, policy-oriented learning was given substance. Finally, the study provided young professionals with a means to join strategic thinking at the semi-public level of water companies; a potential source of inspiration for other sectors and issues.

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1. Introduction

Public water systems provide an essential service to society, satisfying a basic public need and enabling most sectors of the economy directly or indirectly via multifarious interdependencies with energy and food systems. In turn, public water systems depend on

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natural resources and ecosystems that are being destabilized by anthropogenic greenhouse gas emissions, pollution, and habitat destruction. The stakes are high, and with diverse stakeholders, on both the public service side and the natural resource side, the design, realization and management of public water infrastructure is complex and requires constant maintenance and reconsideration. In the Netherlands, the public water network can be considered mature, with full coverage and stable supply (Agudelo-Vera et al. 2014; Coppens et al. 2006). Nevertheless, there is an increasing awareness that the stable and safe supply of public water is under pressure in the long term (Leerdam et al. 2023). Developments such as climate change, population growth and urbanization, as well as the ambition to produce water in a more climate neutral or circular manner are forcing water companies to rethink their current practices. However, adapting and rethinking mature infrastructure systems such as a public water network is challenging and it is proving difficult to change the system design without reinforcing current institutional and technical thinking (Barnett et al. 2015; Frantzeskaki and Loorbach 2010; Goldstein et al. 2023). This (social) path dependence is not surprising given that the costs of infrastructure developments are anchored in the future and are designed to last for decades (Savini, Majoor, and Salet 2015). In addition, the desire for efficiency often leads to the conviction that integration of systems is optimal. The trend towards system integration makes experimenting with or redesigning technical systems difficult (Goldstein et al. 2023). Besides this, practice shows that institutional structures tend to reproduce themselves, as this seems to optimize the control of the outcomes of the system (Van Dokkum et al. 2020). As a result, fundamentally rethinking systems is often considered too expensive, or too complicated (Goldstein et al. 2023). Even if it is obvious that the continuation of the status quo will lead to technical or institutional lock-ins and ultimately be detrimental to the core function of the infrastructure. In the case of public water this function is producing sufficient and high-quality (safe) public water to support public health. To break lock-ins, system innovation, which may lead to a switch to an alternative technology or system design, is needed. At the same time, this is difficult to put into practice, because a complex web of different system components is coordinated with each other and thus must be adapted as a whole. A first step to break through the compelling dynamics that reinforce existing systems is therefore to create space for open reconsideration and curiosity (Pahl-Wostl et al. 2008). Our thinking about current systems is determined, among other things, by paradigms that determine which problems are perceived and how, and thus shape the system design and perceived solution space. A paradigm can be defined as a "shared framework through which the world is viewed, based on socially maintained assumptions, values and practices" (Schoeman, Allan, and Finlayson 2014). Mapping paradigms can trigger a system innovation because it forces reflection on existing assumptions (Bason 2017; Guevara, Hemström, and Lorentzi 2021). Nevertheless, critically reflecting on and rethinking paradigms is not often done as they are subconscious and fundamental to our thinking about practice (Schoeman, Allan, and Finlayson 2014).

Moreover, initiatives to induce system innovation and sustainable development are still often performed by current generations, which are strongly anchored in these systems (Gupta, Pouw, and Ros-Tonen 2015; Nalau and Cobb 2022). This while challenges such as climate change are inherently intergenerational (transcending generations) and would benefit from long-term thinking beyond current generations

(Krznaric 2020). Moreover, the involvement of underrepresented stakeholder groups, such as younger generations of professionals, increases the justness and fairness of planned decisions (Neuhoff, Simeone, and Laursen 2023; Shi et al. 2016), also increasing the transformative capacity of planning endeavours (Pot 2023; Sloan Morgan et al. 2024). Achieving equal participation between generations is therefore seen as a core aspect of *inclusive governance* and *inclusive system innovation* (Gupta, Pouw, and Ros-Tonen 2015). Therefore, in order to achieve inclusive system innovation, the way in which the system is thought about, as well as by who, needs to be reconsidered.

The aim of this study was to develop a method that facilitates reflexive learning within a generationally diverse subgroup of actors. Building on the Advocacy Coalition Framework, similarities and differences in actors beliefs were identified, revealing underlying paradigms and constructs. The recognition of these (in)congruencies formed the basis for reimaginations. The assumption is that the proposed method, if further developed, could contributes to more inclusive system innovation.

This method was empirically tested in the context of the Dutch public water system by involving young professionals in the public water sector (age ≤35 years, working in research and practice). The intention of the project that serves as a case study in this paper, was to develop intergenerational reimaginations of the Dutch Water sector and grow a network of young professionals, continuing also beyond the scope of this particular case or paper. Therefore the individual case is positioned within a broader paradigm conceptual framework set out in the following chapter.

2. Conceptual framework

2.1. Mapping paradigms to allow reimagination

Examining paradigms is an exercise that is often described in the literature as a process of discerning patterns in the development of a particular sector or discipline over a period of time. The result is a reflection on the dominant principles that characterized the system design during a particular period (Cook and Bakker 2012; Pahl-Wostl et al. 2011). A paradigm can be seen as a frame concerning a specific structure or system, where its identification helps to understand the mechanism that structures reality. We are interested in how paradigms change as part of transformations. The perspective on paradigms of critical theory, and specifically a critical realistic view, is based on a reality that is analysed as a dynamic system. It is worth emphasizing that it is not only physical parts that structure this reality, but that the system is also made up of political and social structures. Reality is understood and analysed by making conceptualizations about the functioning of and interaction between these structures. These conceptualizations can eventually bring structural changes in reality because of actors acting accordingly. Through analysing the similarities and differences between multiple conceptualizations and mapping them based on their (collective) framing of a construct (i.e. a meta-paradigmatic approach (Gioia and Pitre 1990)), activities can be set up to adapt these structures (Archer 1982).

2.1.1. Advocacy coalition framework

One way to identify and analyse paradigms as partly shared cognitive constructs is through the "advocacy coalition framework" (ACF). Although the ACF does not

explicitly focus on mapping paradigms, this framework has been applied by a wide variety of authors in recent decades for this purpose (e.g. to identify paradigm development with regard to flood management (Albright 2011) and European policy development around the euro (Princen and Van Esch 2016)). The ACF was originally developed by Sabatier and Jenkins-Smith (1993) and updated and adapted several times over the last decades, both by the original authors and by others (see Weible et al. (2011)). The ACF assumes that individuals think and act from a belief system. In this belief system, three levels can be distinguished, namely (i) normative and ontological principles (*deep core beliefs*); (ii) normative and empirical principles that are central to a particular subsystem (*policy core beliefs*); and (iii) instrumental principles that serve the realization of the policy core beliefs (*secondary aspects of beliefs*) (Cairney and Weible 2015). When a belief system is shared between individuals a belief coalition is formed. Although not clearly articulated in the literature on the ACF methodology itself, some clear parallels can be drawn between the terminology used in thinking about paradigms and framing. The ambition of this paper is not to fully fathom the ontological and epistemological depths of these concepts, but to create a functional clarity that operationalizes them for practical use. With this in mind, a distinction can be made between terms such as ideology, worldviews and paradigms and the different levels of beliefs as defined in the ACF model. These levels differ according to the scope of the subject matter (general or specific) and according to whether it is shared or individual. Deep core beliefs touch on the first two and include general premises about the nature of reality. The policy core beliefs can be seen as a specification of an ideology for a specific topic or policy area. This is done through a certain conceptualization, manifested in a paradigm. The secondary aspects of beliefs are the instrumental principles and social constructs that are part of a particular conceptualization or paradigm. The distinction between individual belief systems and shared belief coalitions corresponds to the ontological distinction recognized by authors such as Dewulf et al. (2009), who distinguish between cognitive representations and interactional co-constructions. These can be considered to coincide with the views on individual and shared policy core beliefs and secondary aspects of beliefs (Figure 1).

In the ACF, the object of study is always a specific policy area. These policy areas are determined by a specific topic; a geographical demarcation; and the actors involved. They can take place locally, nationally or cross-nationally and cover both semi-autonomous policy areas and more overlapping policy areas. Actors involved (each with their own belief system) can come from different disciplines and subgroups linked to policy, strategy and research (both connected to governments, non-profit and private). In analysing these policy areas, the policy choices themselves are seen as a translation of the belief systems of a broader group (also called coalition) (Cairney and Weible 2015). The members of a coalition have a shared belief system and act (coordinated) accordingly (Albright 2011; Sabatier and Jenkins-Smith 1993). This shared belief system often focuses on the policy core beliefs, where the *deep core beliefs,* or the *secondary beliefs* can differ within a coalition (International Public Policy Association (IPPA) 2017; Albright 2011). In the ACF, a distinction is made between *advocacy coalitions* and *belief coalitions*. In a belief coalition, participants have a shared view or starting point,

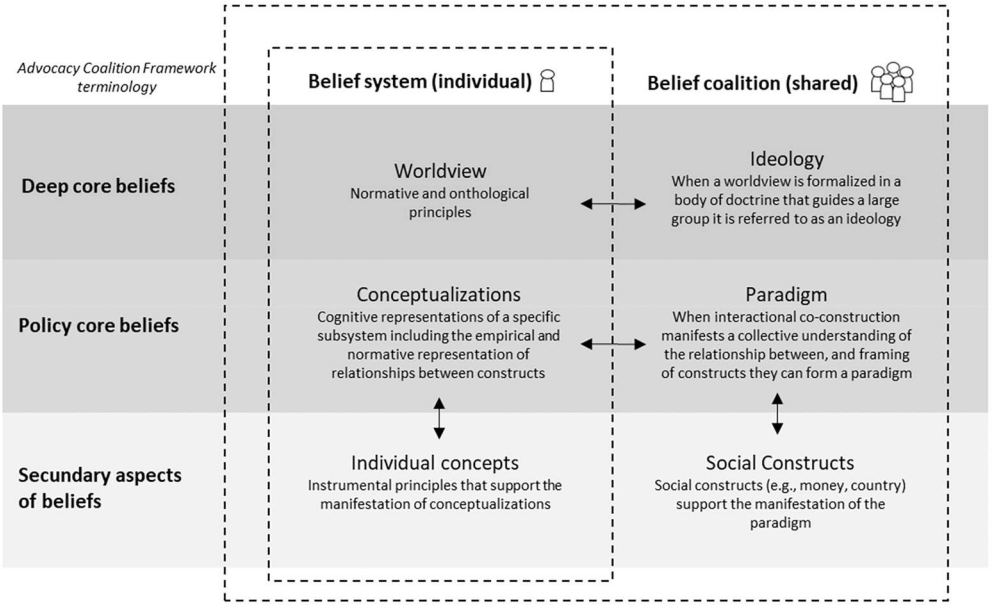

Figure 1. Relationship between different levels of beliefs and concepts used in paradigm thinking (figure created by authors).

but do not necessarily act in a coordinated manner to achieve goals, whilst this is the case in the former (Weible et al. 2020).

In applying the ACF, it is often assumed that an external shock situation – and specifically its effective exploitation by a marginal advocacy coalition – can bring about the greatest change in thinking. These force the dominant coalitions to reconsider and adjust their insights (Albright 2011). Other ways to change belief systems are also identified, although in practice it is often difficult to change the underlying *deep core beliefs* (Albright 2011). A widely discussed method for reconsidering policy core beliefs of belief or advocacy coalitions (or paradigms, see Figure 1) in the literature is *policy-oriented learning*. This method involves a group of actors collectively considering alternative values to achieve a goal and can be used to redefine the problem, the solutions and the strategies that fit it (Pierce et al. 2017). Despite the common conception that *policy-oriented learning* alone is not sufficient to realize change in belief systems or coalitions, it can be a necessary step to realize change of policy core beliefs (and possibly even deep core beliefs) (Pierce et al. 2017).

3. Methods

3.1. Building on the ACF: intergenerational reimagining

For the case study discussed in this paper a method was developed based on the premise that paradigms are shared conceptualizations that structure our thinking about reality, but which can coexist (critical realism). With the interpretation of paradigm as such a (partly) shared belief system, this study builds on the ACF approach, in which thinking about a specific subsystem can be clustered in different coalitions with a shared belief

system. It is important to emphasize that paradigms in this view are a coherent set of assumptions and starting points, but also a disciplinary framework (Smaling 2000). This framework is partly rational (cognitive), but is also formed by a much broader set of events (empirical) and judgments and values (normative) (Smaling 2000). In this case study, a paradigm was recognized as a coalition of beliefs around the *policy core beliefs* as identified in the ACF. Within a subsystem, several such belief coalitions can coexist, but a (limited number of) will be dominant.

The ACF method offers guidance in the both inductive and deductive analysis of coalitions within a policy subsystem. The case study aimed to build upon this approach and broaden it to allow the reconsideration and exploration of alternative futures, or "reimaginations". The development of these reimaginations builds on the characteristic analysis as commonly done when considering the *policy core beliefs* as part of applying the ACF. Yet, besides only describing these, this study aimed to also normatively reconsider them and explore the further interpretation of these reconsiderations into reimaginations. As the aim of this approach is to allow for inclusive system innovation, an intergenerational approach is chosen. The attached importance stems from the assumption that every individual can contribute to system change and that individuals from different generations offer valuable contributions to knowledge creation (Brugnach and Ingram 2012). This agency of the individual is mentioned as key component of the ACF (Cairney and Weible 2015), but often only implicitly integrated as the focus lays on the formation of coalitions. The latter is also the case in this study, yet through the involvement of generational diversity, the agency of particularly young professionals was emphasized. Combining these core design principles, this study proposes a methodology for "intergenerational reimagination", defining "intergenerational" as the inclusion of different generations in the current workforce and diverting from other definitions also including future generations (e.g. Gardiner 2006). This methodology is described, implemented and evaluated in the remainder of this paper.

3.1.1. Methodology designed for intergenerational reimagining

In applying and building on the ACF for the purpose of "intergenerational reimagination" the focus was on the subsystem of the Dutch "public water system". The public water system compasses only part of the Dutch water system. Dutch water governance is fragmented, with e.g. regional water authorities being responsible for regional water management and flood defense and municipalities responsible for urban drainage and sewage collection (for more information see OECD 2014). Public water companies in the Netherlands are entrusted to supply drinking water to households and firms. Shares of these semi-public organizations are owned by provinces and municipalities. Interpreting this subsystem in the disciplinary width it covers, including components such as chemical quality; customer satisfaction; etc. Young professionals (age $\leq$35 years) working in the public water sector were invited to participate in the case study. The invitation was distributed internally at the Dutch public water companies and also via a professional magazine and social media. A total of 59 young professionals participated in this study. These young professionals work at public water companies (76%), or in (public) water related research institutes or consultancy (24%). Participants enrolled via an online registration form. The invitation to participate was specifically tailored to young professionals working on all aspects of public water.

The developed methodology for "intergenerational reimagination" consists of three main steps: a descriptive step; a normative step; and an explorative step. As explained in the introduction, this study aims to contribute to inclusive system innovation through the inclusion of young professionals in futuring discussions. Although these young professionals are unavoidably influenced by the dominant ways of thinking in this subsystem, the aim is allow them to critically rethink and redesign the system by organizing two workshops (normative and explorative) for young professionals only. Through the organizing of a symposium, the results of these steps were shared with other generations. Due to the embeddedness of these younger generations in the professional field, this method contributes above all to more inclusive, rather than radically different reimaging. The focus on young professionals in this study might not be universally innovative, yet it is practical novel in the situation of the case study. The methods used to perform these steps are summarized in Table 1 and the following sections.

Descriptive step: In this study, the description of the current public water system was made based upon a dialogue between different generations. The aim of this intergenerational dialogue is multi-pronged: (i) to understand and describe the current public water system; (ii) to connect and exchange knowledge between different generations in the public water sector; and (iii) to involve young professionals in the acquisition of knowledge on this subject. Each young professional was asked to interview a senior colleague within their own organization (with a minimum of 10 years work experience in public water). In total 54 interviews were held over the period 22 February 2022 to 31 March 2022 that are regarded as "the intergenerational dialogue". A protocol was developed and provided to structure the conversation between the participants. In designing the protocol, lessons were taken from other studies in which the ACF method has been applied (e.g. Albright 2011). For the full protocol, see Appendix 1.

In the intergenerational dialogue professionals in the public water sector with over 10 years of work experience were questioned on (i) what the public water system looks like now (system design); (ii) the main challenges of the system; and (iii) what the main objectives of the current public water system are. In this manner, the participants inductively characterized the conceptualizations of the professionals working in the public water subsystem, specifically their cognitive representations (individual concepts) of what the public water system comprises. This step was performed autonomously by the

Table 1. Overview of the characteristics of the developed methodology for "intergenerational reimagination".

	1. Descriptive step	2. Normative step	3. Explorativestep
Practical purpose	Understand the design (criteria) of the current system	Formulate the design criteria for the future system	Create reimaginations of the future system
Means/approach	Semi-structured intergenerational interviews to describe the current public water system, as well as to deduce the underlaying design criteria	A workshop in which the problems are defined and design criteria for the future system are formulated	A workshop in which the future system is reimagined based on previously formulated design criteria
Design dimension	Define the baseline (problem space)	Define the solution space	Explore and concretize the solution space
Social dimension	Develop a sound and shared (inclusive) understanding of the current state and situation.	Collective consideration of boundaries for the future system design	Intergenerational and inclusive engagement with possible futures

participants following a standardized method that involved drawing a schematic flowchart of the public water system and answering a fixed set of questions. The young professionals involved shared the results of their interviews with the researchers by uploading a picture of the developed drawing and filling in a short survey. Questioning the public water system as such allowed for the identification of shared images that influence how we understand the world (SENGE 1990), which provide a further understanding of dominant conceptualizations (and paradigms) of Dutch public water sector professionals. The dialogue involved professionals working in different domains of the public water sector, including production, asset management, customer interactions, data management, innovations, strategy and research. Although not allowing for the identification of coordinated action (advocacy), the dialogue allows for identification of belief systems within the public water subsystem. As such, they were analysed and inductively clustered into shared beliefs. Although the chosen population is a subgroup of the relevant actors for water system innovation, they include enough diversity to warrant the use of the ACF.

Normative step: In this step a workshop was organized, in which young professionals were invited to reflect on the identified social constructs regarding the public water system and "public water practices" as collected through the intergenerational dialogue. This workshop took place on 7 July 2022 and lasted two hours. A total of 41 young professionals participated in the workshop, of which 38 had also participated in the intergenerational dialogue. The aim of the workshop was to reconsider (normatively) the principles and objectives of the public water system, and to formulate the design criteria for a system of the future. This was done by discussing the identified current objectives of the public water system in subgroups of 4–6 people. This has led to the objectives identified in the descriptive step being re-arranged and reformulated. In addition, elements were removed and new ones were added. As the "congruency or incongruency of meaning is what determines the degree to which artifacts (...) impede or facilitate joint action" (Grin and Van de Graaf 1996, 304), we have ordered the design criteria based on the congruency across subgroups in the case-study population.

Explorative step: For the exploratory part of this study, a second workshop was organized for young professionals in the public water sector. This workshop was aimed at reimagining the future public water system by creating coherent elaborations of the formulated design criteria (normative step). This workshop took place on 11 October 2022 and lasted three hours. There were 29 participants, of which 27 took part in the intergenerational dialogue or the first workshop. As in the descriptive phase, drawings of the public water system were made, this time reimagining the future system. This was done collectively in 7 groups, of which the results were analysed using a "morphological field analysis". This analysis makes it possible to build scenarios in a consistent and structured way while recognizing the variety of variables and states that possible futures consist of (Johansen 2018). The use of the morphological field analysis is further elaborated upon in Appendix 2. None of these reimaginations formed a complete vision of the future, but together they provided a basis for three reimaginations of the public water system. In clustering the reimaginations, the aim was not to create reimaginations that were mutually exclusive or that cover all possible options. Yet, a good representation of the conceptualizations of the young professionals was strived for. As such, the developed reimaginations do not give a complete picture of

all possible options, yet provide insight into possible reimagined paradigms for future system design.

The created reimaginations were discussed during a final symposium on the 15th of March 2023. All young and senior water professionals involved in one of the steps of this study were invited to the symposium. A total of 61 professionals joined the symposium.

4. Results

4.1. Descriptive step

In this section, we report on the results of the intergenerational dialogue. The collected drawings of the public water system allowed for the description of the current belief systems and coalitions. Insights on (1) the core system components; (2) the central objective of the public water system; and (3) perceived core challenges provide a glimpse of the current paradigm(s) in Dutch public water.

4.1.1. Belief coalitions regarding the system components

As described, the construct of a "public water system" was adopted as a generic starting point to delineate the substantive focus of the exploration and to communicate this demarcation with others. However, different individual concepts and conceptualizations are possible and the similarities and differences between these conceptualizations have been analysed inductively, resulting in three types of "systems" identified within the general conceptualizations made by interviewees. These systems can be described as part of belief coalitions, potentially providing insight into the prevailing paradigms (see Figure 1) regarding the system design. These are a *linear system;* (ii) a *network system*; and (iii) a *circular system* (Figure 2). These systems represent belief coalitions, as they are representations of different, coexisting, realities. Both physical elements and social and political structures are part of these systems. In the *linear system* (n = 29), the public water system has a linear structure of successive steps, in which water extraction, purification, distribution are the primary components. Thinking from "source to tap" is decisive in organizing the steps in the system and the participants with this type of perspective tended to focus on the capacities of the water company itself in their explanation of the public water system. Purification steps are extensively included in this type of sketch of the system. There is an emphasis on the physical (technical and infrastructural) parts of the system. In the *network system* (n = 9) other parts in the business operations of public water companies and related actors are also added to the classic extraction, purification, and distribution steps. Components such as area-oriented management and ICT are included. In this construct, there is relatively more emphasis on the socio-political aspects of the system, for example by naming the governance of the public water system. Finally, the *circular system* (n = 16) considers the public water system as a water cycle, i.e. it does not end at the tap. After consumption, waste water is collected and purified and the water is returned to the aquatic systems that count as sources for public water. Attention is often paid to other actors in the cycle, such as nature managers and municipalities.

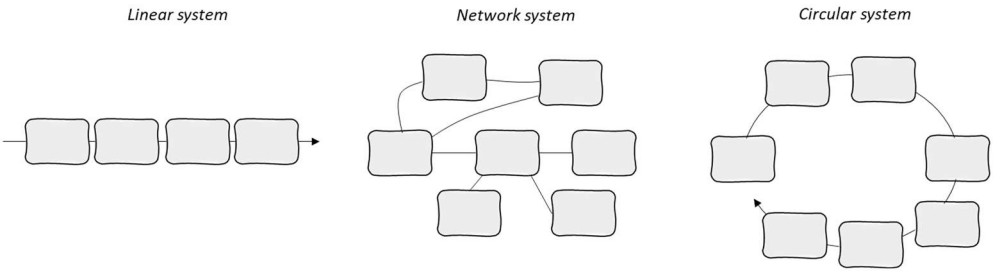

Figure 2. Illustration of the linear ($n = 29$), network ($n = 9$) and circular ($n = 16$) system. These social constructs have been identified based on the intergenerational dialogue.

Additional interesting differences were identified, both between as well as within these belief coalitions. These differences depended on the expertise of the beholders, the central objectives they identified for the public water system, as well as the most important challenges they perceived. Yet, due to the small group size and limited use for illustrating the subsequent steps in the proposed methodology, they are not further elaborated upon in this paper. These results do however support the choice for the ACF, as they show diversity in beliefs within the chosen population.

4.1.2. Objective of the public water system

The participants of the intergenerational dialogue were asked to formulate the central objective of the public water system (in one sentence). These formulations were analysed by splitting the sentences into different "elements". These elements are inductively drawn up based on the data and detailed in Table 2.

The 11 elements in Table 2 can be reformulated into a sentence, combining all of the objectives together. This sentence represents a synthesis of the current purpose of the public water system based on the intergenerational dialogue:

> Supplying high-quality water that is always sufficiently available at a good price to the customer. This will ensure public health and a sustainable natural system.

4.1.3. Challenges for the public water system

In the intergenerational dialogue, participants were asked to identify (up to three) challenges for the public water system. These challenges provide insight into the bottlenecks that various public water professionals experience in their work. In the analysis, these challenges are categorized and clustered into five categories (see Table 3). These categories cover a variety of topics. In case a challenge fell into multiple categories, the best fit was chosen.

4.2. Normative step

In the normative stage of the case study, the young professionals discussed and reconsidered the core aspects of the public water system as collected through the intergenerational dialogue. In the following sections, the results of this step are reported, including a reformulated system design objective and design criteria for a future system. These aspects are

Table 2. Central objectives of the public water system as formulated in the intergenerational dialogue ($n = 54$).

The objective of the public water system consists of the following elements:	Number (and %) of times mentioned	
High water quality	30	(55%)
Always available (reliable)	22	(41%)
For the customer	16	(30%)
Delivery (distribution in order)	14	(26%)
For a good price (cheap)	11	(20%)
Sufficient water	11	(20%)
Public health	10	(19%)
In a sustainable natural system (nature management)	9	(17%)
Trusted by customers (customer awareness/perception)	4	(7%)
With sufficient water pressure	2	(4%)
Comply with legal/government requirements	2	(4%)

Note: Multiple categories per answer were possible. All elements with at least two answers are included in the overview.

considered formative for the reimaginations that ought to be developed. The nature of these objectives and design criteria in the case study are specified to illustrate their importance for futuring in general.

4.2.1. Reconsidering public water system

During the normative workshop, young professionals reconsidered the current objectives of the public water system (Table 2). This resulted in an extension of the objectives listed in Table 2 with elements such as "being a pleasant workspace" and "realizing an agile system design", as well as a reformulation of the existing elements, e.g. "high quality" is reformulated by one group as "right quality for the right purpose". In addition, each subgroup also rearranged the elements, scoring them from most, to least important. An analysis of the (in)congruency of these discussions shows that the young professionals distinguish between objectives ("why") and the ways to achieve them ("how"), resulting in a need to make the objective more compact and further elaborate on the underlying design criteria. *Public health* and *ensuring a sustainable (natural) system* are mentioned by the majority of subgroups as the central objective of the public water system, whereby these are also connected – striving for a sustainable (natural) system contributes to public health. Where other aspects of the central objective, such as "high water quality" and "always available" are given high importance, yet being subject to normative dilemmas. As such, the strongest congruence of meaning regarding the objective formed the base for a reformulation of the central objective as: *Safeguarding public health in a sustainable natural system.* Allowing for further elaboration of elements supporting this through the formulation of design criteria (paragraph 4.2.2).

4.2.2. Design criteria

Besides the central objective, also additional design criteria for the future system were considered during the normative workshop. This was done by asking the participants for criteria that the public water system must meet in order to fulfil the central objective (see 3.2.1) and cope with the identified challenges (see Table 3). For example, one subgroup, focusing on the limited availability of public water sources (challenge), drafted the following design criteria; "actively focus on water retention", "strict protection of water sources from pollution" and "public water is only available for high end functions".

Table 3. Most important challenges for the public water system as mentioned in the intergenerational dialogue ($n = 54$).

Category	Challenges	Sub-topics	Number of times mentioned
Availability of public water sources	The availability of public water is determined by both the quantity and the quality of the water sources. This is impacted by climate change and the emergence of anthropogenic contaminants.	• Quality of sources • Water availability • Impact of climate change • Emerging contaminants	62
Social trends and public values	Realizing sustainability transitions (water transition, heat transition, energy transition), as well as the political attention and support that exists for measures regarding public water. In addition, ensuring and influencing customer trust and behaviour for more water awareness and managing developments in public water demand.	• Development in public water demand • Sustainability transitions • Political attention and support • Behavioural change • Public water price • Consumer satisfaction • Public health	37
Governance and environment	Coordination with partners in the water cycle and other actors in the environment. This category also concerns both legislation and permits, as well as new developments in the environment and subsurface that water companies must take into account.	• Legal and standards • Coordination of parties • Tuning actors in the environment • Space in the subsurface • Pressure on available space • Control of the water system	19
Business	Recruiting and retaining qualified personnel despite challenges such as the aging population and the increasing need for cybersecurity. The lack of long-term vision and poor knowledge transfer are also cited as causes.	• Knowledge and personnel • Organization and strategy development • Cybersecurity	17
Manage technical systems and infrastructure	Replacing and innovating assets in a timely manner. This concerns both the management and maintenance, as well as the (re)design of technical systems and infrastructure under the pressure of transitions and developments.	• Protect and renew infrastructure • Optimizing technology • (Re)design of the pipeline network • Maintenance and management	17

Note: A total of 150 challenges (max 3 per interview) are grouped in five categories.

These were motivated by the statement that high quality public water sources are only limited available and the costs of additional purification are high. Therefore better protection of sources is deemed appropriate by this subgroup. In a similar manner, all challenges addressed in Table 3 were discussed in subgroups and design criteria were formed.

An inductive analysis of these design criteria resulted in five categories, besides the central objective. These categories are: (1) the type of product; (2) consumer identity; (3) role of water company in society; (4) business operations; and (5) design of the public water system (Table 4). These design criteria are considered normative principles that guide design of the reimaginations, as elaborated in the following paragraph.

4.3. Explorative step

4.3.1. Reimaginations of future public water systems

Based on the design criteria described in the previous section, the explorative workshop focused on the development of reimaginations of the future public water system. The drawings of the future public water system made by the seven subgroups in this workshop were analysed using a morphological field. The morphological field is listed in Appendix 3. This analysis has led to three reimaginations of the future. The reimaginations of the future represent a possible reality and are not complete or comprehensive. In "Tailor-made water", the water company supplies high-quality public water to household users, but only for human consumption. Local cycles have been set up for lower-value applications (flushing of toilets, greenery). In "Dischargers are dismissed", the protection of public water sources is central. Public water is available for various applications, both domestic and business, but water must also be returned to the system in high quality. In the "Collective chain", guaranteeing the water supply is central, regardless of one's geographical location. Water companies are interconnected via a raw water network and thus share their sources. How these reimaginations relate to the formulated design criteria is summarized in Table 5. Appendix 3 contains a description of each of these three reimaginations. The titles of these reimaginations stem from the workshops and the input of the young professionals.

4.3.2. Reimaginations based on design criteria – interpretations and trade-offs

The reimaginations show that (1) the formulated "design criteria" contain normative principles that can be met in several ways and that (2) an elaborated vision of the future entails various normative choices. With the concretization of these design criteria in a reimagination, choices are made with regard to the envisaged transition pathways. Choices concerning normative starting points sometimes exclude certain solutions.

Table 4. Description of design criteria for a future system ($n = 41$, aggregation of results of discussions in 9 subgroups).

Category	Design criteria
Central objective public water system	Safeguarding public health in a sustainable natural system.
Type of product	Water usage function matches the water quality. For a fair price.
Consumer identity	Both humans and natural systems are seen as clients/consumers. Reliability for the consumer. Awareness of water consumption and usage.
Role of water company in society	Multiple value creation. Ensuring sustainable distribution of public water. In coordination with the social and institutional environment. Recognizing the social value of water.
Business operations	Digital skills staff; career opportunities.
Design of the public water system	Agile, modular system design.
	Actively focus on water retention throughout the water system; protection of resources.

Table 5. Overview of the different interpretations of the defined design criteria in the three reimaginations.

	Design criteria for the future system	Reimagination 1: Tailor-made water	Reimagination 2: Dischargers are dismissed	Reimagination 3: Collective chain
Central objective	*Safeguarding public health in a sustainable natural system*	Customization, local responsibility for collection, (purification) and (re)use of low-grade water	Environmental (and source) protection	Equality, inclusion and safety
Type of product	*Water usage function matches the water quality*	High quality water is available for human consumption. For low-grade purposes, low-grade water is used	Water is supplied for various uses, but above all must be returned to the water system in high quality	Raw water is distributed between water companies via a ring pipe
	For a fair price	Affordable, yet cost-effective	Polluter pays	Tiered rate
Consumer identity	*Both humans and natural systems are seen as clients/ consumers*	Providing household and small business customers through public water networks	Environmental protection as a core value, delivery to customers should not be at the expense of natural values	Households and small businesses are provided through shared sources
	Reliability for the consumer. Awareness of water consumption and usage	Reliability for the consumer: public water is aways available	Water awareness of the consumer is promoted. The consumer is stimulated to take own responsibility	Reliability for the consumer: public water is aways available
Role of water company in society	*Multiple value creation*	Focus on recovering minerals from public water production and local cycles	Multiple values with regard to ecosystem services (such as biodiversity) and recreation	Recover raw materials
	Ensuring sustainable distribution of public water	Water company acts as a supplier of a scarce product. Focus on reliable supply of water for human consumption	Water sector acts as water distributor. Water company and water board work closely together to optimize the distribution of water and the return to the water cycle	Public water sector acts as a (raw) water distributor. Within the public water sector, resources are shared to enable equal distribution and access to water
	In coordination with the social and institutional environment	Coordination with local parties on cycles. Water company mainly responsible for supplying high-quality public water for human consumption	Water company works closely with the water board and the municipality. Strict laws and regulations regarding discharges are introduced	Further integration of the public water sector
	Recognizing the social value of water	Value of water is recognized through high-quality use	The value of water is recognized through the valuation of the water cycle	The value of water is recognized by ensuring equal access to water
Business operations	*(Digital) skills personnel and career opportunities*	New business concepts for local cycles: Advice and leasing of systems. Training and attracting staff with skills focused on consultancy and sales	Expansion of the source protection division with personnel focused on knowledge about the regulations and the legal system	(Collective) digitization for a fair distribution of water. Narrowing business operations with more central focus on joint technological assets

(*Continued*)

Table 5. Continued.

	Design criteria for the future system	Reimagination 1: Tailor-made water	Reimagination 2: Dischargers are dismissed	Reimagination 3: Collective chain
Public water system design	*Agile, modular system*	Local responsibility for smaller cycles. Focus on technology and purification	Focusing on natural dynamics and capacities (nature-based solutions).	Loop provides a buffer for public water companies.
	Actively focusing on water retention	Local chains ensure shorter water cycles and less discharge of water	Water cycle is central, the return of high-quality water in the water system.	Shared responsibility for public water sources
	Protection of resources	Dependence on resources reduced by technical solutions	Protection sources against pollution	Protect sources from exhaustion by sharing resources: overloaded resources can be relieved

Note: Descriptions are based upon the morphological field analysis and substantiation of the reimaginations by the researchers (n = 29, aggregation of results of discussions in 7 subgroups).

This can be due to physical limitations, such as a shortage of high-quality water or lack of physical space, but also due to socio-political factors, such as a shortage of sufficient staff to carry out the activities. Differences between reimaginations in the interpretation of the design criteria, as well as the priorities on potential trade-offs, give substance to a spectrum of possibilities for the future of the public water system. These reimaginations illustrate the potential of the proposed method for identifying possible paradigms for future system design. Below a number of examples of these differences in interpretation of design criteria and trade-offs are given. A more elaborate reflection on the proposed methodology is provided in chapter 5.

The differences between the design criteria, are visible in the interpretation of *modular and agile* public water system. The physical construction of a loop (Collective chain) enables the modular and agile usage of resources, preventing overexploitation and exhaustion. However, the construction of such an infrastructural connection can also be seen as a structure that fixes the state of the public water system and makes water companies less flexible (technical lock-in). Organizing local urban water cycles (Tailor-made water) allows optimal use of local conditions and opportunities, with far-reaching consequences for the water system. However, the responsibility for the implementation/enactment of this new design is unclear, risking responsibility to be diffuse and (inexplicitly) placed on local parties or citizens, since the water company focuses primarily on the central supply of public water. With the reimagination "Dischargers are dismissed", this *modular and agile* design can be realized thanks to the local retention of water. However, the potential for switching between water sources if necessary (agility) depends on the ecological resilience of the sources and the natural systems. The effectiveness of source protection is therefore crucial for this reimagination. All in all, it can be said that the different interpretations of the design criteria *modular and agile system design* require different interventions. These interventions concern physical space, management, investments and supporting regulations. Focusing on all three reimaginations simultaneously is therefore not feasible and a fundamental choice needs to be made with regard to the physical-spatial interventions and the system design to allow for any of these reimaginations to be realized.

In addition, the interpretation of design criteria can also lead to tensions between them. These situations lead to trade-offs being exposed. In these cases, a value-based choice must be made, as both design criteria cannot be fully met. An example in which a trade-off becomes clearly visible is the interpretation of the design criteria *water usage function matches the water quality*. In the reimagination "Tailor-made water", it was decided not to supply public water for usages for which low-quality water also suffices. This choice was made to make effective use of high-quality water, but may also have consequences for the accessibility of water for purposes other than human consumption. This can be interpreted as a trade-off with the design criteria *reliability for the customer*.

Besides differences in interpretation of the design criteria, also different institutional and spatial scopes of the transition pathways in each reimagination can be recognized. Regarding the institutional scope, a distinction is visible between an internal focus on the activities of the water company and a broader focus in which the environment and other actors play an important role. This distinction was already visible in the elaboration of the (current) system (paragraph 4.1.1). The reimaginations "Tailor-made water" and "Collective chain" focus strongly on the activities of the water company(s) and it's interactions with actors from other domains or within the sector. In these reimaginations, the linear and network system can be recognized. On the other hand, the reimagination "Dischargers are dismissed" focuses on the entire water cycle and is therefore more in line with a circular system. Finally, also a difference in geographical scope can be observed: "Collective chain" focuses on regional, national or even international integration and therefore assumes a different scale than "Tailor-made water" in which the water system at district level is central. As with the current social constructs regarding the system components described in 4.1.1, these reimaginations for future system design show the different institutional and spatial scopes of different beholders.

5. Discussion and conclusion

With a view to using the method developed for "intergenerational reimagining" in future projects, several methodological insights and reflections are shared and discussed below.

The method developed for "intergenerational reimagining", following descriptive, normative and explorative steps, allowed the participants to identify, process and present substantive insights in an inclusive manner. A new network of young public water professionals was yielded concurrently with designing the substantive reimaginations. For the authors, the case study was a first step in developing both the social network and the method. The method developed (1) allows for new involvement of young professionals in a policy network and (2) combines core aspects of the ACF with futuring techniques.

Firstly, the involvement of young professionals aims to address the commonly overlooked relevance of diversity in futuring and visioning approaches (Barendregt, Bendor, and Van Eekelen 2024; Nalau and Cobb 2022; Neuhoff, Simeone, and Laursen 2023). Futuring studies often dismiss questions regarding diversity, hindering the understanding of power dynamics across these studies (Barendregt, Bendor, and Van Eekelen 2024; Nalau and Cobb 2022). This study focusses on intergenerational diversity, using age and occupation as determining factors for our subgroup. In literature, intergenerational approaches are often targeted at the inclusion of perspectives of future generations

(Rose 2024). The method developed in this study applies a more limited interpretation of intergenerationallity by focusing on the inclusion of younger generations. As such, the inclusion organized through the method developed cannot be seen as a proxy that institutionally represents future generations. By asking the subgroup to represent a broader cohort (i.e. represent also future generations) beyond their own (young professionals), and by allowing the subgroup of young professionals further tools for the implementation of the developed reimaginations in practice (i.e. key elements of such proxy representation as set out by Rose (2024)), the intergenerational component of the method developed could be further expanded.

Secondly, expanding on the standard applications of ACF, the method developed provides an outline for its application in both futuring and social learning endeavours. As set out in Figure 1, the ACF provides a practical framework and terminology to elucidate (different) conceptualizations, social constructs and paradigms that can be identified in a policy subsystem, such as public water. The method developed, and the application in the case study, illustrate how this practical framework can be applied to foster system innovation, as well as to allow specific groups (in this study young professionals) to be included in discussions regarding the policy core policy preferences. Through normative and explorative discussions, participants were enabled to evaluate and develop their policy core beliefs and preferences through reimaginations. By making these multidimensional reimaginations explicit, and discussing them within a broader policy network during the final symposium, they have been introduced into existing policy networks. These reimaginations also fed into the development of scenarios for new policy (preference) networks or paradigms for the Dutch public water system.

The underlying goal was to disclose existing policy core beliefs and to develop generationally inclusive reimaginations around new beliefs. As Sabatier and Weible (2019) describe, debates between coalitions are based on divergent preferences regarding policy proposals. In literature, these are referred to as policy core policy preferences (Sabatier 1998). *Policy core policy preferences are normative beliefs that project an image of how the policy subsystem ought to be, provide the vision that guides coalition strategic behaviour, and helps unite allies and divide opponents* (Sabatier and Weible 2019, 195). Major policy change is understood to reflect alterations in the policy core beliefs and preferences of coalitions, which we consider to coincide with the paradigms in a policy subsystem (reflecting the problem definition, as well as policy objectives). As described in chapter 2, such changes can come about in different ways, including via *policy-oriented learning* among and between coalitions. Learning in this case refers to lasting changes in belief systems (Pierce et al. 2022). As such the ACF has been used extensively to explain policy change (Pierce, Peterson, and Hicks 2020).

Reimaginations of this type are important for long-term (governmental) decision making because they allow considerations and choices concerning possible and preferred futures to be made explicit, thus increasing insight into the deeper consequences of decisions. In the case of the public water system, the method developed helped to enrich the conversations about futures by paying attention to values and beliefs. Such conversations are conventionally focused on possible limitations (financial, technical, or practical) or difficulties experienced in the present. As such, the developed method could be used to structure public design processes and introduce transformative knowledge about (the congruency or incongruency) of meanings and values concerning the

policy subsystem. The extent to which the results of this case study influence policy making and behaviour could be evaluated in an ethnographic manner, focusing on the actual application of the introduced reimaginations. First signs of application became visible in the months following the case study, for example in their inclusion in board room discussions at public water companies.

Moreover, the inclusion of perspectives on values and beliefs, as were included in the developed reimaginations, made it possible for policy makers to explore the future design space with a view to potential political support for the alternative scenarios. This indicates how the developed method for intergenerational reimagination seems particularly suited to feed into the agenda-setting phase of policy-making. The policy cycle is often depicted as phased; progressing from agenda-setting, to policy formulation and decision-making, to implementation, to evaluation and termination (Jann and Wegrich 2017). The descriptive, normative and explorative steps are designed to promote open reconsideration and curiosity and the explication of values and beliefs, as a means to break through the compelling dynamics that reinforce unconscious reproduction processes (Pahl-Wostl et al. 2008). The intergenerational aspect of this approach aims to foster the development of more inclusive reimaginations of systems (agenda setting). In addition, even when a less top-down, positivistic outlook on the policy making process is taken, the developed method for intergenerational reimagination can be seen as contributing to transformation. The proposed steps allow for improved and structured reflexivity of actors. Taking a more constructivist perspective, the method can be seen as a means to identify (in)congruency of meaning, and fostering and enabling learning in order to produce a new congruency of meaning between policy network actors (Grin and Loeber 2007).

Yet, despite its potential, several limitations can also be mentioned, both regarding the structure and practical application of the method developed. An inductive approach was chosen for analysing various results of the steps in the method. As mentioned in the introduction, it is challenging to avoid reinforcement of current institutional and technical constructs and paradigms, while critically rethinking systems, because (assumed) criteria for rethinking alternatives are often embedded in the historical system design (Goldstein et al. 2023), and simultaneously subconsciously reinforced by their beholders (Schoeman, Allan, and Finlayson 2014). As such, an inductive approach can introduce a potential reporting bias. Components that have been identified inductively include the categories for the developed design criteria and the analysis of social constructs of the current public water system. To minimize the risk of reporting bias, research triangulation was used by involving several parties in the analysis of the results. This was done by discussing the analysis and results with the co-researchers (steps in the analysis), an external project group consisting of young employees from four water companies (at methodical and substantive level), and with the network of young professionals (at the level of general outcomes). The methodological premise is that intersubjective iterations increase the validity of the outcomes, yet the inductive approach may still have hindered the development of radically alternative reimagined paradigms. Involving participants with more alternative viewpoints in the process would also likely promote the generation of more radically alternative reimaginations.

A second, more practical limitation that must be noted is the focus on *the public water system*, or in Dutch *de drinkwaterketen* as analysed subsystem. The Dutch word *keten* refers to a series of successive events or processes (dictionary description) and is

mainly used here to describe the entire public water system. This term is used in a Dutch context to describe both process steps, actors, or legislation (e.g. medicine, criminal justice, financial, information or technical *ketens*). The term *drinkwaterketen* was deliberately chosen, but the study itself raised the question of whether this demarcation gives too much priority to an engineering perspective and excludes other perspectives. Despite the fact that the term *keten* is used in several fields, the term has a technical focus in a public water context. It is also a term that invokes the image of a series of links connected in a sequence, thus prompting the participants to illustrate their conceptualizations following this form. It could be interesting to explore in a future study whether a different, more neutral term leads to other coalitions and paradigms by, for example, mapping out the images that professionals have of the term "public water".

In conclusion, the creation of a network around a common goal (developing reimaginations) has proven to be an inspirational manner to practice intergenerational public design. It has enabled young professionals to join strategic discussions, going beyond a "mentor-learner" division of roles. The method developed can be further refined and continued within the (public) water sector. An interesting avenue for further research would be the an expansion of the current scope to include other actors within, or in competing, policy networks, such as policy-makers or end-user groups. Involvement of these groups could allow for the further enrichment and development of reimaginations, including aligning and/or overarching subsystems (Sabatier and Weible 2019). For example, the public water subsystem is nested within, among other system levels, the broader Dutch water system, and could be better aligned with policy for the surface water system. The involvement of policy actors from these systems could promote the development of policy networks regarding reimaginations surpassing the boundaries of existing subsystems. In addition, the developed methodology seems to be effective in stimulating social learning between generations of professionals, with the aim of realizing change (of belief coalitions and paradigms).

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