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Published in:
Urban Water Journal

Link to article, DOI:
10.1080/1573062X.2020.1748204

Publication date:
2020

Document Version
Peer reviewed version

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Acknowledgement

This project was funded by Innovation Fund Denmark through the Water Smart Cities Project (Grant no. 5157-00009B). We wish to thank Odense municipality, VandCenter Syd (VCS Denmark), Ramboll and KLIKOVAND for aiding us in the data collection. We would also like to thank Shane Carnohan and Ursula S. McKnight from DTU Environment, for their valuable feedback on our manuscript. We declare no conflict of interest.

Incorporating objectives of stakeholders in strategic planning of urban water management

Urban water management (UWM) strategies are difficult to implement in the urban space due to conflicting professional objectives and lack of communication tools. We explore stakeholders, objectives and indicators for urban water management and urban planning to make UWM relevant for other urban disciplines. Stakeholder analysis was applied to systematically identify stakeholders and their objectives by screening literature published in professional journals and conference proceedings. The literature study was supplemented with three workshops. Similar sets of planning objectives and stakeholders were identified in the two analyses. 14 stakeholders were identified, from the utility to legal stakeholders. We identified 17 objectives and nine sub-objectives, that can be divided into four overall groups; welfare for citizens, environmental protection, economic growth and technical objectives. Our results are relevant for a variety of UWM projects, providing a common terminology when discussing objectives between stakeholders and enabling an exploration of multifunctional UWM strategies.

Keywords: stakeholder analysis; planning objectives; structured decision-making; urban water management; urban planning

Introduction

Urban water management (UWM) is challenged by climate change and urbanization (Fratini et al., 2012b; Stahre, 2006). Climate change increases the frequency and intensity of rain events in Northern Europe (Arnbjerg-Nielsen, 2012; Larsen et al., 2009) and urbanization decreases the permeability of the city and increases the density of people (Kaspersen et al., 2017). The result is decreasing water quality, increasing flood risk and decreasing treatment efficiency at the WWTP, threatening the environment and well-being of urban populations.

The 1992 Rio Declaration recognized integrated and holistic approaches as a promising pathway to sustainable solutions. Such approaches have been applied to

water management (Casal-Campos et al., 2015; Makropoulos et al., 2008), with terms like “Livability” and “Resilience” emerging (Hansen et al., 2019), based on the UN’s Sustainable Development Goals (UN, 2015). Strategies have shifted from having one objective (e.g. reduce risk of flooding), to multiple objectives (e.g. recreation and biodiversity) and have taken on names such as Sustainable Urban Water Management (SUWM) (Belmeziti et al., 2015; Larsen and Gujer, 1997). This shift has emphasized the potential benefits UWM provides for external stakeholders (Fletcher et al., 2015). Multi-functionality of strategies is thus seen as a means for obtaining resilience, sustainability and liveability in urban areas, which can be enhanced through spatial planning (Hansen et al., 2019; Meerow and Newell, 2017).

Planning in urban areas is complex. Space is a limited resource (Fratini et al. 2012), where many stakeholders with different objectives act under different funds and legislation (Yazdanfar and Sharma, 2015). Several studies report on the importance of including stakeholders in planning to increase the possibility of a successful project (Fratini et al., 2012b; Gregory et al., 2012; Huntjens et al., 2012; Lienert et al., 2013; Tompkins et al., 2008; Yazdanfar and Sharma, 2015). Thus, an interdisciplinary planning process with active stakeholder involvement is required (Geldof and Stahre, 2004). However, this process is jeopardized by communication problems, including both a lack of agreement on objectives and terminology, and a frame for discussing risk levels and uncertainty (Ferguson et al., 2013; Refsgaard et al., 2013). This results in stakeholders choosing different types of technology and hinders or delays the execution of projects (Fratini et al., 2012b; Madsen et al., 2018).

Objectives for UWM as part of the urban planning process are often defined either as quantitative fixed frameworks using monetary valuation or holistic qualitative frameworks using narratives as a guiding principle. Examples of monetary valuation

include BeST (Horton et al., 2019), the green infrastructure valuation toolkit (Green Infrastructure Valuation Network, 2013), and the INFFEWS Value tool (Iftekar et al., 2019). These tools help to convey information to many different stakeholders (Chan et al., 2012; de Groot et al., 2010; Gómez-Baggethun and Barton, 2013; Turner and Daily, 2008). However, it is often difficult to identify how objectives were derived and connected to relevant stakeholders. Examples of qualitative frameworks include One Water (US Water Alliance, 2016) and Water Wise Cities (IWA, n.d.). While holistic in their formulation, such frameworks may be difficult to apply on specific projects. This is due to their formulation as water strategies, rather than objectives reaching stakeholders that are not interested in water. There is a need to bridge between these two approaches, by revisiting stakeholders, objectives and indicators for urban water management. The goal should be to create a common problem framing that can be used as a basis for economic assessments while simultaneously recognizing the differences between stakeholders (Ferguson et al., 2013).

Literature linking stakeholders and objectives of UWM exists (Fratini et al., 2012a; Madsen et al., 2018). However, these studies did not focus on systematizing the identified objectives. In some cases means were not distinguished from ends, and some important stakeholders, representing different departments of the municipality with competing objectives, were not identified. Generally, in water management only very few studies have connected stakeholders, objectives and indicators for quantification (e.g., Horton et al. (2019); Lienert et al. (2015)), and to our knowledge, no such studies exist that specifically address the interference and synergy of UWM with urban planning.

We were inspired to explore this research gap by the work Lienert et al. (2015). They used a systematic framework to find stakeholders, objectives and indicators (to

quantify objectives) related to water supply and wastewater disposal infrastructure in Switzerland (Lienert et al., 2015). Objectives and indicators were found through several face-to-face interviews and a workshop. The study provided a comprehensive overview of objectives in a transparent manner, but there was no link to broader urban planning, flood risk management objectives, or multifunctional spaces. These are the key reasons why SUWM are favoured by stakeholders with little interest in water, as discussed by Fletcher et al. (2015).

The aim of this article is to explore the diversity of stakeholders, objectives and indicators within urban water management and urban planning. We aim to lay out a reproducible and transparent method that can connect stakeholders with planning objectives to assist the identification of potential stakeholders and collaborations in the development of multifunctional UWM strategies. Results will be generic and are expected to form a basis for stakeholder assessments in a wide range of UWM projects, which can then be adapted to a specific project.

Methodology

Scope of study

Our aim was to extend the work of Lienert et al. (2015) both in terms of focus area and methodology. In terms of focus, we identify the stakeholders and objectives that should be considered in a context where urban water management is increasingly embedded into more general urban planning. In terms of method, we differ from Lienert et al. (2015) by suggesting an explicit method for liturature screening instead of face-to-face interviews.

The work of Lienert et al. (2015) used elements of structured decision making (SDM) (Gregory et al., 2012) to derive stakeholders and planning objectives. SDM is a

157 way of organizing and understanding complex problems. It is a transparent, inclusive
158 and organized approach of generating and evaluating different strategies with respect to
159 values of stakeholders and potential consequences. This distinguishes SDM from other
160 decision frameworks, e.g., solely scientific or consensus-based. SDM guides decision-
161 makers (DMs) by giving input to "what matters" and to whom, as well as consequences
162 of implementing a given strategy. It furthermore supports development of a common
163 understanding of the problem at hand (Gregory et al., 2012), aiding in solving several of
164 the challenges listed in the introduction, including neglect of important stakeholders and
165 miscommunication.

166 Objectives and indicators are important elements in the context of SDM and are
167 used to identify and evaluate strategies. Objectives are essentially the outcomes that
168 stakeholders seek in the decision context, while indicators quantify objectives and make
169 them measurable. Objectives are often formulated as concise statements of interest,
170 informed by one or more stakeholders, that might be affected by strategies (Gregory et
171 al., 2012). Bond et al. (2010) states that an objective template, or list of objectives,
172 should be consulted (if it exists) to ensure a more holistic identification of objectives.

173 There are six core steps of SDM (Figure 1) but in this paper we focus on the
174 second step of SDM, where stakeholders, objectives and indicators are identified and
175 defined. The generated results are used as direct input for the second step of SDM
176 (Figure 1-A) and provide a foundation for DMs to identify relevant stakeholders and
177 planning objectives. Our method (Figure 1-B) can be replicated within any field of
178 interest, where a foundation for discussing stakeholders and objectives is needed.
179 [Figure 1 placed around here]

Research design

Our research design is rooted in qualitative research and combines stakeholder analysis (following the key steps suggested in Reed et al. 2009), with a systematic literature screening validated with workshops (Figure 2).

[Figure 2 placed around here]

Our study utilized literature published by practitioners, because we wanted to focus on work where practitioners actively participated, to ensure the research will find practical application. Furthermore, practitioners are in an advantageous position to identify stakeholders (Colvin et al. 2016) . We chose a confined geographical area (Denmark) and time period (2016-2017) for our primary data, to ensure relevance for current practice and a better foundation for interpreting implicit objectives and stakeholder dynamics using our local knowledge.

We applied a predefined coding scheme, which coded the literature into standardized names for stakeholders and planning objectives, ensuring consistent naming and condensed data. The predefined coding scheme was based on our experience and literature. Besides stakeholders and objectives, the scheme consisted of; (1) initial codes for project types, (2) scales (time and space), and (3) planning contexts to see how these affected objectives and stakeholders. Objectives are context specific (Madsen et al., 2016) as preferences change in time and space as society develops and different areas struggle with unique problems. The time scale was chosen to distinguish between short-term projects and long-term projects. The spatial scale captured the extent of each project, distinguishing between local, city, regional and national levels. The coding scheme was allowed to evolve as new data was discovered through the literature screening process (Figure 2). The literature screening stopped when no new

information was obtained. The coding scheme is available in Skrydstrup and Madsen (2019).

Stakeholders and objectives identified through the screening process were subsequently validated through a set of workshops (primary data). In addition, we cross-compared with national and global literature to avoid blind-spots (secondary data) (Figure 2). Finally, we tried to interpret our results by predicting stakeholder alliances based on their link to objectives. The following sections will give a more detailed description of data and the different steps.

Data description

In this study we worked with primary and secondary data (Figure 2). We gathered primary data first hand through literature screening and workshops (Table 1). We compared our results from the primary data to already published literature, being both national and global, and denote this secondary data (Table 2). Validation thus consisted of both primary data (workshops) and secondary data (journal articles and existing tools).

Primary data

We identified journals with a focus on exchange of planning experience and knowledge. We identified EVA-bladet (EVA-B) and Dansk Vand conference proceedings (DVC) to cover the UWM dimension, and Byplan Nyt Magazine (BPN) to cover urban planning (Table 1). We chose these groups of literature, because they are published by well-established organisations, are far-reaching and cover many different issues within UWM and urban planning. We facilitated three workshops to validate literature results.

[Table 1 placed around here]

227 *Secondary data*

228 We chose literature themes that represented different aspects of UWM including
229 drinking water, wastewater and climate change adaptation. These themes included more
230 specific aspects, such as rainwater harvesting and stormwater management. Literature
231 pertaining to urban planning aspects was prioritized (Table 2). The selected literature
232 overlaps with some of our work, but none of them covers the link between objectives
233 and stakeholders for UWM within the urban planning domain. More details are
234 available in the Supplemental Material (S4).
235 [Table 2 placed around here]
236 The process of extracting, systematizing and interpreting the data was done as
237 suggested by Creswell (2013). Several layers of interpretation were applied. Initially,
238 text sections were extracted with a low degree of interpretation. Text segments were
239 extracted if they contained at least one code or if they contained a new stakeholder or
240 objective (new codes). Subsequently, the data were aggregated through several rounds
241 of coding with increasing degrees of interpretation. Even though we allowed higher
242 degree of interpretation, we still tried to keep as close to the source as possible. As such,
243 the coding was an iterative process, going back and forth between the different degrees
244 of interpretation, securing internal validation.
245 In EVA-B, DVC and BPN (Table 1) we screened 42 articles in total, published
246 in 2016 and 2017 (Dansk Byplanlaboratorium, 2016-2017; DANVA, 2016; EVA, 2016-
247 2017). In addition to stakeholders, objectives and indicators, auxiliary information (e.g.
248 project types, spatial scales, time scales and stakeholder roles) was collected, because
249 we expected impacts on the results.
250 Articles were not considered if they described a technology, focused on
251 calculations, or if the project was already screened and no new information could be

obtained. Additionally, we excluded papers authored solely by researchers to ensure stakeholders and their objectives were grounded in practice.

The screening stopped when no additional objectives or stakeholders could be identified. Objectives were structured in a hierarchy to give an overview of objectives, sub-objectives and indicators and thus provide a good foundation for discussions (as in Lienert et al. (2015)) (Figure 3). The hierarchal structure is based on the level of abstraction, where groups/objectives are the highest level of abstraction and indicators the lowest, i.e., they are more detailed and quantifiable (Gregory et al., 2012). The objectives hierarchy was created through an iterative process, with the aim of disentangling and unifying stakeholder's often ambiguous and/or implicit formulation of objectives. We did several rounds with sorting (i.e. removing objectives that were not potential project outcomes, but instead means), condensing (i.e. merging objectives with similar meaning) and grouping the coded data (based on objectives with similar aim) (Supplemental Material, S1). Subsequently, the final set of objectives were structured according to their level of abstraction within the identified groups (Figure 3).

[Figure 3 placed around here]

Simultaneously, the stakeholders were grouped according to their role in society based on internal group discussions. After the screening we categorized the stakeholder's role in planning based on our own experience and looked for evidence in the final results.

Workshops

The diversity of the objectives hierarchy and connections between stakeholders and objectives were validated through three workshops (Table 3). Using our network, we recruited participants with several years of experience within their field, covering both water professionals and urban planners. In the first workshop we invited

277 consultants with different expertise who could cover a broad range of planning aspects.
278 During this first workshop, most of the stakeholders and objectives were identified.
279 In the other two workshops we asked for volunteers but sought to maintain
280 diversity among the groups (Table 3). All workshops lasted approximately three hours
281 and each was held at a different location; a consulting firm, a utility, and a research
282 institute. The sampling stopped after the third workshop, because we did not obtain new
283 information. Since participants in our workshops covered all the relevant professions,
284 we do not have reason to believe our results would have been different with different
285 participants. By the second and third workshop participants were struggling to identify
286 new objectives and indicators.
287 [Table 3 placed around here]
288 The workshops included the following elements:

289 • In the first session, participants were asked to brainstorm stakeholders and
290 objectives for two simplified and anonymous case studies. These were, a
291 specific plan for a local project and, a strategic plan for a larger urban
292 development area. Both case studies focused on the interaction between UWM
293 and urban planning. To test the diversity of objectives and stakeholders, we did
294 not present the objectives hierarchy nor the list of stakeholders to the
295 participants.
296 • In the second session, participants were asked to convert a selection of
297 objectives to indicators. Indicator selection was assisted by facilitators, who
298 merged the brainstormed objectives, so participants had time to cover them all.
299 Objectives overlapping in meaning, based on the definition of objectives as
300 described under terminology, were merged.

301 The purpose of considering these case studies, was to evaluate the impact of
302 spatial and temporal scales on objectives and stakeholders. Indicators were not
303 frequently used in UWM and urban planning literature. The workshops therefore placed
304 a particular focus on converting objectives into potential indicators.
305 Workshop sessions were based on group work. Groups were defined beforehand
306 based on the working area/background of the participants. In the first session, we aimed
307 at groups with a high mixture of working areas to create a dynamic atmosphere. In the
308 second session, we aimed at groups with similar working areas. Each group selected the
309 objectives they wanted to work with to promote meaningful discussions about
310 indicators. In each session we aimed at consensus between participants and between
311 groups. We therefore included a follow-up round after each session to ensure consensus
312 between groups and the same understanding of stakeholders, objectives and indicators.
313 Facilitation was kept at a minimum, and only used when a deeper insight was needed
314 (e.g. to clarify the definition of an objective). It was thus the participants eliciting
315 stakeholders, objectives and indicators with little facilitation. We used the coding
316 scheme to compare workshop and literature results, and revised the coding scheme
317 accordingly (Figure 2). The workshop material is available in Skrydstrup and Madsen
318 (2019).

319 ***Cross-comparison against secondary data***

320 The cross-comparison against secondary data (Table 2) aimed at validating both the
321 diversity of objectives and the connection of stakeholders and objectives (Table 1). The
322 first cross-comparison was with the first version of the objectives hierarchy (Figure 2).
323 We mainly tested the diversity of objectives, but were also inspired by their
324 categorization of objectives. We never removed objectives based on the cross-

325 comparison, but added objectives that appeared in several sources. Ultimately, the
326 comparison resulted in a condensed hierarchy.
327 The second comparison was performed after the workshops (Figure 2). Here, we
328 focused on validating stakeholder's connection to objectives. Also in this comparison,
329 no connections were removed. The comparison was purely qualitative and based on a
330 limited number of studies (Table 2).

331 ***Interpretation of alliances***

332 In a final step, we tried to identify stakeholders with a majority of objectives in
333 common. We defined similarity by means of the Hamming similarity measure (Garg
334 and Kumar, 2018; Hanneman and Riddle, 2005). The Hamming similarity measure
335 compares two vectors (i.e., two stakeholders) by counting the number of times they are
336 similar and divides the count with the length of the vectors. We define alliances as
337 group of stakeholders (minimum three) with at least 80% similar connections. Results
338 are described qualitatively and validated with our own expectations and already studied
339 alliances. Forming realistic alliances from our primary data is a way of validating the
340 literature and workshop results. The exact results are available in Skrydstrup and
341 Madsen (2019).

342 **Results and discussion**

343 The initial stakeholder analysis by literature screening resulted in 22 stakeholders and
344 43 objectives. After the workshops eight additional stakeholders were identified and
345 some objectives reformulated. The list was condensed to 14 stakeholders, 17 objectives
346 and 9 sub-objectives following internal group discussions, cross-comparison with
347 secondary data, and iterative condensing and sorting. The final coding scheme along
348 with descriptions of stakeholders and objectives are available in Skrydstrup and Madsen

(2019). The following sections will describe stakeholders, objectives and indicators. The final section will discuss how the results can be applied in planning of UWM.

Stakeholders and their objectives

Stakeholders

We identified 14 stakeholders (Figure 4). Health and social aspects were added in the workshops (*"Municipality – Health & Social")*, whereas "*Politicians"*, *"Legal"* stakeholders, and *"Foundations"*, were only identified in the literature screening. These stakeholders were also not mentioned in Madsen et al. (2018), which used snowball sampling to identify active stakeholders for climate change adaptation. Our workshop participants work with planning and implementation of water management, and are therefore rarely in contact with *"Politicians"* and *"Legal"* stakeholders. This is because the legal requirements are already nested in municipalities, while politicians are reflected in the stated objectives of civil society and/or municipality (Fratini et al., 2012b). However, *"Politicians"* and *"Legal"* stakeholders are important for changing objectives over time, i.e., by implementing new regulations.

Compared to our references (Fratini et al., 2012b; Madsen et al., 2018) we identified *"Foundation"*, *"Legal"* and *"Investors"* as additional stakeholders. It is essential to consider these stakeholders in a planning process, as they set the legal and financial boundary conditions for UWM. In addition, both studies included the municipality as a single organisation, but the municipality consists of several divisions with different objectives. Our analysis divided the municipality in four departments (Figure 4), as was suggested consistently during the workshops. Further differences between our references (Table 2) and our results are described in Supplemental Material (S4).

373 The stakeholders were grouped according to their role in planning (definitions of
374 groups are found in Supplemental Material, S3). Based on internal group discussions,
375 Figure 4 indicates the direction of influence. In the middle of the planning process is the
376 DM, often mentioned in literature with a "budget to spend" and as the entity responsible
377 for developing, planning and establishing strategies, often in collaboration with *"Utility*
378 *– Water"* and *"Consultants"*. The DMs are, for example, responsible for identifying
379 stakeholders, negotiating potential collaborations, and planning objectives. The
380 municipality is the typical DM in UWM and spatial planning (Figure 4) (Ministry of
381 Environment, 2012). DMs are influenced by all the other groups in the planning process
382 (Figure 4). On one side are knowledge providers (i.e., consultants). On the other side are
383 stakeholders that sets the boundaries of projects by legislation. Finally, there is the
384 group of opportunities and risks, here called "potential collaborators or opponents".
385 In some cases, stakeholders can switch groups. For example, if municipal
386 departments do not work together on a project, they may act as "potential collaborators
387 or opponents" or as "setting the boundaries" for each other.
388 [Figure 4 placed around here]

389 *Objectives*

390 The 17 objectives and nine sub-objectives were structured in a hierarchy (Figure 5).
391 There was an obvious grouping of objectives into *"Welfare for citizens"*,
392 *"Environmental protection"* and *"Economic growth",* in agreement with the three
393 pillars of sustainability (UN, 1992). *"Welfare for citizens"* covers objectives that
394 enhance livability, a word often mentioned as single objective, but in fact, composed by
395 many of the objectives in this group (Figure 5). Aesthetics, recreation, mobility, safety
396 & security and education are all components of livability. Health and well-being as well

as connectedness (the feeling of belonging to an area) and occupation are also part of welfare. *"Environmental protection"* contains objectives of good water quality, protecting resources and protection of nature (e.g., increasing biodiversity, protecting coast lines). *"Economic growth"* contains objectives of business development and low cost (investments, operation and maintenance, tangible damages from floods, etc.) that ensure economic growth.

Finally, we decided to add an additional group with *"Technical objectives",* directly addressing water infrastructure. These are central for utility companies, who are key stakeholders in UWM. For example, supply safety, i.e., ensuring safe and reliable drinking water and removal of wastewater, is the core objective of any water utility (Belmeziti et al., 2015). This is a key service to society (Ferriman, 2007), even though it is often taken for granted. Technical objectives ensure that new water infrastructure is; integrated with existing infrastructure, flexible for future changes, ensures supply safety, and is designed for simple and transparent management (Figure 5). These technical objectives can be viewed as means to achieve higher level objectives, such as health and well-being or good water quality. We decided to keep them as separate objectives, because they are practical preconditions for the design of water infrastructure and they appear in some of our secondary data (Ferguson et al., 2013; Harris-Lovett et al., 2019, 2018; Lienert et al., 2015). These are often also based on technical and legal constraints and hence have a different form than the other three groups. The technical objectives were derived from a decision support tool developed by one of the biggest utilities in Denmark (VCS Denmark, 2017) (Table 2).

[Figure 5 placed around here]

BeST covers roughly the same groups of objectives as found in our study, but considers a mix of very specific objectives (e.g., rainwater harvesting and pumping

wastewater) and more abstract objectives that match our objectives (e.g., education, health and water quality). Unlike BeST (Horton et al., 2019), we also include objectives of connectedness, occupation, transport time and technical objectives. In addition, mobility objectives are not seen in PLASK 3.0, Lienert et al. (2015), Harris-Lovett et al. (2019, 2018), Ferguson et al. (2013), Kuller et al. (2017), Fratini et al. (2012b), Madsen et al. (2018) and only very limited in VCS Denmark (2017) and BeST (Horton et al., 2019). However, mobility appeared most frequently in the literature screening and was mentioned at all three workshops, both as a benefit and threat. Mobility is a public service and an essential aspect of spatial planning (Meurs and Haaijer, 2001). Further differences between secondary data (Table 2) and our results are described in Supplemental Material (S4).

Stakeholders and their connection to objectives

Table 4 summarizes how often different objectives were linked to stakeholders in the screened literature and workshops (i.e., our primary data). Our sampling strategy aimed at capturing the diversity of planning objectives and stakeholders. The counts can therefore not be interpreted as the strength of a connection, but merely as an indication of the most frequent connection between stakeholders and objectives found in the primary data.

In addition to validating the objective-stakeholder connections, new connections were found in the workshops. For example, there were intuitive connections missing for *"Municipality – Traffic & Roads"*, such as reducing traffic disturbances, which were captured in the workshops. Similarly, the workshops also added new objectives of transport safety and reducing traffic noise that affect the *"Civil society"*.

[Table 4 placed around here]

Some of the connections between objectives and stakeholders are intuitive and can be recalled in other literature. For example, the *"Utility – Water"* is interested in increasing flood safety (service levels), keeping their costs low and ensure good water quality for recipients. These are considered "traditional" objectives for water utilities (Fratini et al., 2012b). In our study, the utility was also connected to objectives of recreation, reduction of traffic disturbances (mobility), health, and education. While the utility's objectives are not part of the repertoire of stakeholders outside UWM, the opposite is quite true. This was evident in both the literature screening, the utility decision support tool and Madsen et al. (2018). Dominguez et al. (2009) found the Swizz utilities to have social and environmental objectives as requirements to be fulfilled, but not as the primary focus, which bears similarity to our results.

The *"Consultants"* covered both engineering consultants and other types of consultants (e.g., architects), resulting in connections to most welfare objectives (except occupation) and the entire environmental protection group (Table 4). Madsen et al. (2018) found similar diversity.

"Commercial" stakeholders are mentioned in nine articles, with different objectives in almost every article and most new objectives after the workshops. This most likely illustrates local business interests.

The urban planning department of the municipality (*"Municipality – City planning"*), covers all of the welfare and economic objectives. These stakeholders are responsible for the physical development of the urban space (Fratini et al., 2012b), which means accommodating many different needs from society. Connections between *"Municipality - Health & Social"* and *"Municipality - Traffic & Roads"* were rarely visible in the articles (contrary to the workshops), so their interests might be covered by *"Municipality – City planning"*. It was difficult to distinguish between *"Municipality –*

City planning" and *"Municipality – Water & Environment"* in the selected literature (Table 1). We assumed that *"Municipality – Water & Environment"* was implied, if the municipality (with no further specification) was mentioned in EVA-B or DVC, while mentions in BPN were assumed to refer to *"Municipality – City planning"*.

As stated previously, the identification of objectives and stakeholders are dependent on context, spatial scale and time. We embedded this in our research design, by including these factors in the literature screening and in the workshops. However, we did not find any patterns in our data relating to the defined spatial scales and temporal scales. One reason may be that most articles in the literature screening were operating on city scale with long time horizons, which could indicate that these projects are more interesting from a planning perspective. The final coding scheme is available in Skrydstrup and Madsen (2019).

Stakeholder alliances

We identified stakeholders with most objectives in common, as an indication of their potential for forming alliances. This was a way of validating the results by reconstructing meaningful alliances. We acknowledge that alliances are complex and thus also based on other conditions such as, money/procurement, governmental structures, personal relationships and social networks (Lee and Cavusgil, 2006; Love et al., 2010). We identified eight potential alliances, in which all stakeholders shared a majority of their connections to objectives (Supplemental Material, S5). This section focuses on the description of the two key alliances. More alliances can be identified based on the raw data (Skrydstrup and Madsen, 2018).

Many stakeholders are interested in a diverse range of planning objectives (Table 4). Therefore, identifying alliances is simplified by referring to objectives that distinguish the alliance. *"Civil Society"* enters two alliances. The first alliance is with

the *"Municipality – City Planning"*, *"Commercial"*, *"Politician"* and *"Government Agency"*. These stakeholders have recreation, mobility and health & well-being in common. It is the common link to connectedness, business development and low costs that makes the alliance unique. The alliance is typically seen when political strategies and municipal objectives are merged into local developments plans in spatial planning in Denmark (Ministry of Environment, 2012).

The second alliance is between *"Municipality – Water & Environment"*, *"Utility – Water"* and *"Consultant"*. They share objectives that include mobility, safety & security, nature and low costs (Table 4). However, it is the common interest in aesthetics, safety & security and water quality that distinguishes the alliance. Also of note is the missing interest in occupation. The *"Consultant"* group has a lower similarity with the *"Utility – Water"* objectives (Table 4). However, the *"Consultant"*, *"Utility – Water"* and *"Municipality – Water & Environment"* usually work closely together on climate change adaptation projects, where citizen involvement is increasingly becoming a part (Madsen et al. 2018; EVA, 2016-2017; DANVA, 2016).

Alliances are expected to be sensitive to the local context and how a project addresses planning objectives. Having similar objectives, does not mean stakeholders agree on how they should be addressed. Nevertheless, the results give a preliminary idea of potential project partners and how other stakeholders might be encouraged to participate in strategic planning.

Indicators

We screened for indicators to quantify planning objectives, both in the literature and during the workshops. However, many stakeholders do not commonly apply indicators to measure the success of planning. Indicators could be identified in three out of 24 BPN articles and four out of 18 articles in EVA-B and DVC. Similarly, the workshop

participants were struggling to identify meaningful indicators outside their area of expertise, but did manage to identify indicators for well-known planning objectives within their own field. However, participants did not agree on either their importance, or their specification. Some workshop participants were concerned that indicators would divert planning efforts towards optimizing numbers (e.g., economic).

Based on the sparse representation of indicators in our data, we could not conclude on the representativeness of our results and excluded it from further analysis. This result underlines the need for a better understanding of the connection between indicators and planning objectives for both practitioners and research, as well as a continued dialogue between stakeholders. The identified indicators and coverage of the objective's hierarchy (Figure 5) are included in Supplemental Material, S7.

Application in decision-making

Every planning process is initiated by drivers, e.g., a need to reduce floods, reduce crime or improve water quality in a river. Returning to our study's contributions to the SDM approach(Gregory et al., 2012) (Figure 1), it is the second step where stakeholders, objectives and indicators are defined. Our study provides a list of stakeholders relevant for UWM and urban planning (Figure 4), from which DMs can identify stakeholders relevant for their project. Furthermore, we developed an objectives hierarchy (Figure 5). Similar to Fratini et al. (2012b) and Madsen et al. (2018), and confirmed that stakeholders speak about objectives differently (Supplemental Material, S2). The objectives hierarchy can provide a starting point for discussion by giving an initial list of objectives to consider (Figure 5). This can help to ensure a common language and understanding of objectives that can support the identification of a common direction. This requires that stakeholders actively discuss what the objectives

in the hierarchy actually mean within the decision context (e.g. Is “good water quality” related to the recipient stream and/or groundwater resources?).

Step 2a and 2b (Figure 1) are coupled by Table 4, connecting stakeholders with objectives. The list is generic, and the project context will thus exclude irrelevant stakeholders and objectives. This simplifies the process of moving iteratively within the second step of SDM. Finally, our results feed directly into the third step of SDM, where strategies (i.e., “alternatives” as used by Gregory et al. (2012)) are developed. All steps should be approached iteratively.

In summary, our study simplifies the work of future planning studies while explicitly recognizing the different objectives of the stakeholders. We provide a practical starting-point for use within time-limited planning processes that can streamline communication between stakeholders and initiate exploration of innovative UWM strategies. Our results provide a foundation for which DMs can identify, discuss and prioritize objectives, which can later be coupled to monetary valuation, as decisions are often based on budgetary constraints. On a scholarly note, we have illustrated a reproducible and transparent method for elucidating generic connections between stakeholders and objectives. We focused on UWM and urban planning, but the developed method (Figure 2) could also be applied in other fields, (e.g. energy supply) to produce similar results (i.e. an objectives hierarchy applicable within SDM).

Limitations

We could not find any patterns in objectives and stakeholders for different spatial-temporal scales in our primary data. City wide projects with long time horizons dominated the primary data sources, making them unfit for assessments of scale dependencies. Furthermore, interpretation in the literature screening was unavoidable as objectives and link to stakeholders often were ambiguous. Similar issues were found in

570 the workshops, as participants were struggling to set-up objectives according to the
571 definitions in the section describing the scope of this study. Expanding the number of
572 workshops with the same participants, or extending the educational session before
573 group work, might help participants separate objectives (ends) from the means to
574 achieve them. We chose literature within a confined geographical area (Denmark) and
575 time period (2016-2017). We compared with secondary literature from other countries
576 in Europe and Australia to ensure diversity and no blind spots. We believe the diversity
577 of stakeholders and objectives are useful for both local- and larger planning scales
578 within a European context, but we cannot speculate about relevance outside Europe,
579 where the dynamics of stakeholders and objectives are different.

580 **Conclusion**

581 In this study, we focused on exploring the diversity of stakeholders and objectives in
582 planning of UWM in the context of urban planning. We developed a hierarchy of
583 planning objectives, as well as an overview of stakeholder's link to the objectives. The
584 results were derived and documented in a transparent manner.

585 We identified 14 stakeholders that are relevant to consider, as well as 17
586 planning objectives and 9 sub-objectives. These could be divided into welfare for
587 citizens, environmental protection, economic growth and technical objectives. Unlike
588 previous studies, we also identified stakeholders that define legislative and financial
589 boundaries as important for strategic planning of urban water management. In addition,
590 the identified planning objectives are more generic and cover a broader scope of urban
591 planning.

592 We identified few indicators in the literature screening, and in the workshops, as
593 participants were struggling to connect indicators to objectives. We thus concluded that
594 most stakeholders do not tend to use indicators in planning, and they do not agree on

595 their definition, or their importance. The process of developing indicators is on-going,
596 and future research should continue to bridge the gap between indicators and objectives.
597 Similar to other studies, our literature screening suggests communication
598 difficulties, where stakeholders speak about planning objectives differently. Our results
599 can help avoid miscommunication when speaking about planning objectives by
600 ensuring standardized terms for the different objectives. Thus, our work also provides
601 input for the second step of structured decision making (SDM) in urban water
602 management and assists in identifying potential collaborators. For example, we
603 identified the utility to most likely form alliances between the water and environmental
604 division of the municipality, and civil society; an alliance typically seen in climate
605 change adaptation projects. In general, our methodology allowed us to construct
606 meaningful objectives, as the stakeholders that participated in workshops often went
607 beyond those identified in the secondary data.
608 Our results are subject to gradual changes over time and cultural context, which
609 could, for example, involve different prioritizations of the objectives. However, they
610 provide a starting point for discussion in other locations, as well as support for holistic
611 management where multiple stakeholders and objectives are considered jointly.

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