Supplemental Material

For article:

Incorporating objectives of stakeholders in strategic planning of urban water management

Contents

S1 Sorting and categorization of objectives

The objectives hierarchy was created through an iterative process of several rounds with sorting, condensing and categorising the coded data. The rounds involved:

- Categorization and grouping after similar themes, e.g., objectives concerned with social aspects of water.

Figure S1-1: Our process of categorizing and grouping objectives from the literature screening. All the green post-its are preliminary categories.

- Sorting means, strategic and process objectives from end objectives (i.e., distinguishing fundamental objectives ("ends") from objectives that are ways of obtaining ("means") the fundamental objectives. See Gregory et al. (2012)

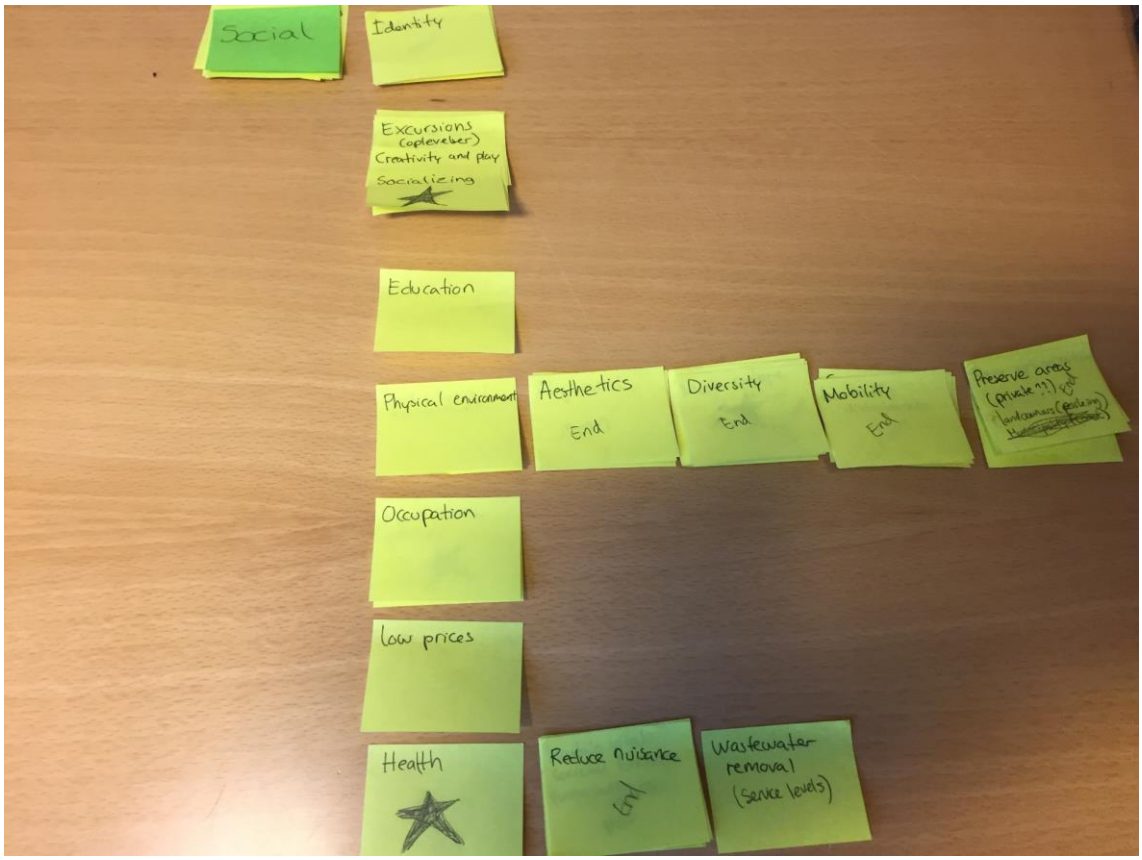

Figure S1-2: Our process of sorting means from ends. Pictures showing the process for some of the social objectives (Group later called welfare for citizens)

- Cross-comparison against secondary data (See S4)
- Discussions with internal and external collaborators

S2 Comparison of primary literature sources

While going through the screened literature, we aimed at capturing diversity. EVA-B and DVC had *"Consultants"*, *"Municipality – Water & Environment"* and *"Utility – Water"* as most prominent stakeholders, i.e. these stakeholders appeared in the majority of articles (Table 4). This was expected because EVA-B and DVC are aiming at an audience with a water management background. Similarly, BPN had *"Civil society"*, *"Politicians"* and *"Municipality – City planning"* as most prominent stakeholders, as BPN are aiming at *"Politicians"* and *"Municipality – City planning"*. Both often mention *"Civil society"* in connection with their own objectives (Table S2-1).

EVA-B and DVC also share most of the identified prominent objectives, covering recreation, safety and security from flooding, water quality and low costs (Table S2-1). Many of the projects described in these two sources, work with above-ground solutions (e.g., Blue-green infrastructure) to reduce flooding and improve water quality. Stakeholders on these projects mention the multifunctional character of these solutions with their recreational benefits. BPN also mentions recreation and low costs, but also objectives of aesthetics and education. Education is a wide objective, covering school education, story-telling (e.g., sharing narratives) and learning (e.g., reminders of flooding). DVC and BPN also share mobility, but focus on two different sub-objectives. In DVC mobility is in the form of traffic disturbances, while BPN is more focused on the softer pedestrians and their walk- and bikeability, i.e., moving easily while feeling safe in traffic.

Table S2-1: Data sources and the most prominent stakeholders and objectives

Source	Prominent stakeholders	Prominent objectives
EVA-B	*"Consultant", "Municipality – Water & Environment", "Utility – Water"*	Recreation, Safety and security, Water quality, Nature, Low costs
DVC	*"Consultant", "Municipality – Water & Environment", "Utility – Water"*	Recreation, Mobility, Safety and security, Water quality, Low costs
BPN	*"Civil society", "Politician", "Municipality – City planning"*	Aesthetics, Recreation, Mobility, Education, Nature, Low costs

The language use in EVA-B and DVC is different from BPN. It is very rare that the words “goal/objective/aim” are directly used in DVC and EVA-B. Instead words such as “The results are..”, ” The strategy was..”, requiring more interpretation to convey to objectives. BPN uses a more direct way of communicating objectives such as “The goal is…”, “We hope to…”, “There is need for…”. In addition, the majority of articles from EVA-B and DVC are based on previous or current projects, while BPN articles are a mix of projects, reviews on regulation and interviews with politicians. The BPN articles tend to be more future oriented than EVA and DVC.

In summary, the three data sources overlap in objectives, but talk about them differently. These results confirm previous findings that conclude that stakeholders from UWM and urban planning experience communication difficulties (Fratini et al., 2012b; Geldof and Stahre, 2004; Madsen et al., 2018).

S3 Stakeholder planning groups

Table S3-1: Description of the groups we defined for stakeholder's roles in planning

Groups	Description
Decision-makers	Stakeholders responsible of developing the strategies and making the final decision. Typically, the Municipality is the decision-maker when it comes to urban planning, whereas the *"Utility – Water"* has the responsibility for drinking water and wastewater management.
Knowledge providers	Typically hired by decision-makers to provide knowledge on projects, e.g. reducing floods, designing parks, etc.
Potential collaborators or opponents	This is a diverse group of stakeholders that can be potential collaborators on projects by providing funding (e.g. *"Investor", "Foundation", "Government Agency", "Legal")* and/or knowledge (e.g. *"Civil society", "NGO", "Commercial"*). This group can also pose a risk for the implementation of a strategy if their objectives have not been considered (Fratini et al., 2012b). For example, they can punish decision-makers by e.g. withdrawing their funding/investment.
Setting the boundaries	This group sets and enforces laws, and thus set the boundaries for projects. The *"Legal"* stakeholders and *"Politician"* sets the law, while the *"Government Agency"* and the Municipality enforces it.

S4 Differences between primary and secondary data

We compared our results from the literature screening and workshops with secondary data, i.e., selected as key literature in considering planning objectives for urban water management. Table S4-1 represent the main differences between our results and secondary data.

Table S4-1: Main differences between our results and identified secondary data sources

Data source	Description	Difference to our results
PLASK 3.0 (Miljøstyrelsen, 2018)	PLASK 3.0 (Miljøstyrelsen, 2018) is a Danish tool used to qualitatively assess the co-benefits of climate change adaptation projects. PLASK 3.0 considers 16 co-benefits that are divided into four categories; City and Landscape, Outdoor activities, Nature and Biodiversity and CO_2. PLASK 3.0 is a successor of PLASK 1.0 that quantified and valuated four co-benefits (Noise, Nature, Carbon sequestration, Water savings). It is not clear how co-benefits were derived, and no explicit link to stakeholders is provided.	**Stakeholders;** study contains no link to stakeholders. **Objectives;** we include technical and economic objectives, where they focus more on environmental and health objectives. Furthermore, we include safety & security and mobility. Some objectives are specific enough to be sub-objectives to our objectives (e.g., access and stay to e.g., connectedness).
BeST (Horton et al., 2015)	BeST (Benefits of SuDS (Sustainable Urban Drainage Systems) is a British Tool (Horton et al., 2015)) which quantifies the benefits of local drainage systems above ground in monetary terms. BeST consists of 20 benefits, where 17 are connected to a monetary value. These benefits are also linked to stakeholders from national, regional and local authorities covering both UWM and urban planning, as well as several funds, corporate stakeholders and utilities. However, BeST focuses on SUDS and considers a very specific set of stakeholders (in particular, various funding agencies). This assessment has a different scope than our work, where we try to broadly identify the various stakeholders linked to UWM in the urban planning context.	**Stakeholders;** very specific stakeholders and connection to objectives based on their own assumptions. **Objectives;** some objectives are very specific and can be considered sub-objectives to ours (e.g., groundwater recharge, pumping wastewater), whereas others are more abstract and aligned with our formulation (e.g., education, health, water quality). In addition, we cover more objectives; occupation, connectedness, resources, simple and transparent, supply safety, fit

	Therefore, we did not use BeST for validating the stakeholders we identified, but we did compare the identified planning objectives.	with existing infrastructure, transport time and walk-and bikeability.
VCS Decision Model (VandCenter Syd, 2017)	The Danish water utility, VandCenter Syd (VCS, "Water Center South"), has developed a decision support tool to help prioritize their many water, wastewater and climate change adaptation projects around Odense, Denmark. The tool is divided into different focus areas; 1. Economy, 2. Supply safety, 3. Service, 3. Organisation and Working environment, 4. City and Climate, 5. Environment and Climate. The planning objectives were derived based on internal group discussions.	**Stakeholders;** limited to one stakeholder, i.e., the utility. **Objectives;** We cover more objectives, i.e., connectedness, education, occupation, nature and business development.
Kuller et al. (2017)	The study developed a framework for suitability analysis of Water Sensitive Urban Design (WSUD) as part of the urban environment. Two aspects of suitability were considered; "WSUD needs a place" and "A place needs WSUD". The latter, assesses the multiple benefits of WSUD and thus relates to the objectives defined in this paper. It is not clear how planning objectives were derived, and no link between objectives and stakeholders is provided.	**Stakeholders;** objectives not connected to stakeholders. **Objectives;** the study formulated very specific objectives, which can be a sub-set of our objectives. Furthermore, they do not cover objectives related to health and mobility.
Ferguson et al. (2013)	Through participatory workshops with stakeholders involved with water planning. These groups included representatives from government, utilities, water retail companies, municipalities and consultants. Participants formulated principles that guide how planning, investment, design, governance and evaluation would occur in Melbourne as a water sensitive city. Formulation based on previous visioning exercise in Melbourne. These formulations resulted in strategic objectives.	**Stakeholders;** objectives not connected to stakeholders. However, their list of stakeholders overlaps with ours. We also include NGOs, Citizens, Investors, Foundation and Commercial stakeholders with no direct relation to water planning. **Objectives;** Most of their strategic objectives matches our list of planning objectives, but they have no direct link to Mobility, Occupation and Business development.
Lienert et al. (2015)	Objectives and indicators for drinking water and wastewater infrastructure in a Swiss context were derived through 27 face-to-face	**Stakeholders;** objectives are not connected to stakeholders and urban planning.

	interviews and a workshop. Local planning engineers, municipalities and regional and national authorities took part in the study.	**Objectives;** study does not consider urban planning, so they do not include welfare objectives.
Harris-Lovett et al. (2018;2019)	Stakeholders, objectives and indicators for nutrient management in San Francisco Bay were derived through 32 face-to-face interviews. The study only includes stakeholders with professional interest. The following stakeholders took part in the study; water managers, baylands stewards, researchers, engineers, regulators, urban planners, flood control managers, and advocates for the coastal industry or the environment at local, regional, and federal scales.	**Stakeholders;** they did not include citizens, as only stakeholders with professional interest was included. Otherwise**,** the stakeholder categories are broad enough to overlap with our list of stakeholders. **Objectives;** study does not consider urban planning, so do not include many of the welfare objectives. However, they did include Aesthetics and Recreation.
Fratini et al. (2012b)	Objectives for urban flood risk management in a Danish and Dutch context were derived through 35 face-to-face interviews. The interviews covered three different case studies and involved water professionals (e.g. consultants, municipality, regional water management) from both local and regional institutions, as well as urban planners, insurance companies, natural scientists and lay persons (e.g. NGOs, local representatives, etc.).	**Stakeholders;** they did not include Foundation, Legal, Investors and wider commercial companies. In addition, they included municipality as single organisation, whereas we divided into four departments with different objectives. **Objectives;** limited to 11 values that are abstract (e.g., Logical, Historical, Social, etc.)
Madsen et al. (2018)	Objectives were derived for climate change adaptation projects in Denmark through 32 interviews covering three different cases. Stakeholders included consultants, utility, municipality, research, product companies, NGO, governmental institutions (other than municipality) and construction companies.	**Stakeholders;** study did not include Civil Society, Legal, Investor, Foundation, Politicians. . In addition, they included municipality as single organisation, whereas we divided into four departments with different objectives. **Objectives;** some objectives were very specific (e.g., prevent basement flooding, secure hydraulic capacity) and/or very

	broad (e.g., added values, quality of life). We covered more welfare objectives.

S5 Stakeholder alliances

We identified eight potential alliances, in which all stakeholders shared a majority of their connections to objectives (Figure S5-1). We used hamming similarity measure to calculate. We define alliances as group of stakeholders (minimum three) with at least 80% of their connections to objectives in common.

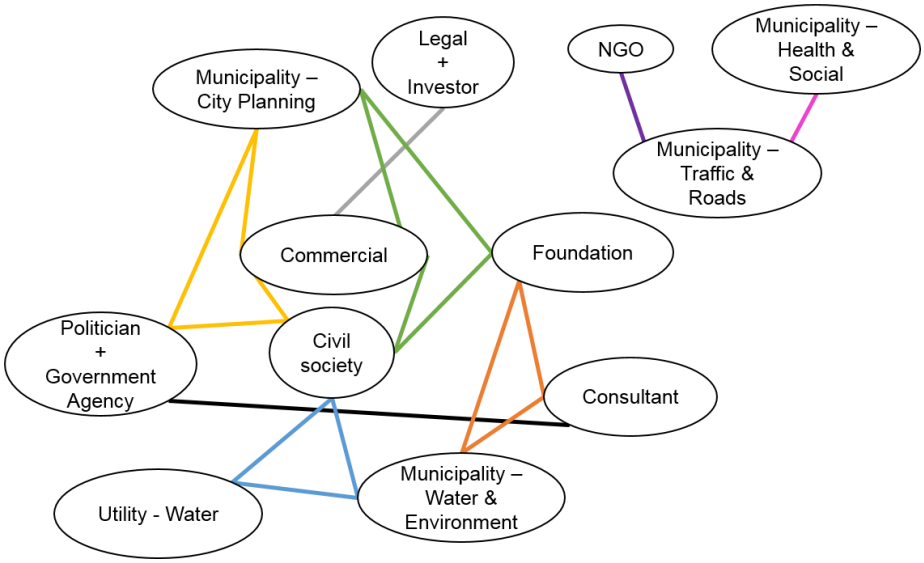

Figure S5-1: Estimated alliances between stakeholders and their objectives. Each colour represents an alliance where all stakeholders share a majority of objectives.

"Commercial" stakeholders are often mentioned together with the *"Civil society"* in the literature, usually as one "customer" of urban planning. Based on the methodological approach, i.e. minimizing interpretation, they end up sharing many of the same objectives, e.g. recreation, mobility, education and low costs. *"Civil society"* can potentially form three alliances, where *"Commercial"* takes part in two of them. The first alliance is formed with *"Municipality – City Planning"*, *"Politicians"* and *"Government Agency"*. The second alliance exchanges *"Politicians"* and *"Government Agency"* with "Foundation". Common for these two alliances are that they work with citizens in mind and thus creating cities with high welfare, and commercial stakeholders in many cases adhere to citizen's needs. The *"Civil Society's"* third alliance is with *"Utility – Water"* and *"Municipality – Water & Environment"*. This separate alliance is formed from the common interest in water quality and no connection to occupation. The *"Consultant"*, *"Utility – Water"* and *"Municipality – Water & Environment"* usually work closely together on climate adaptation projects (Madsen et al. 2018; EVA, 2016-2017; DANVA, 2016). The *"Consultants"* are, however, not appearing in this alliance

due to a lower similarity with the utilities objectives. The lower similarity is based on the *"Consultants"* missing interest in connectedness and fit with existing infrastructure, and the utility's connection to business development. It is hard imagining the *"Consultant"* not being interested in business development or the utility not being interested in fitting strategies into existing infrastructure (being a technical objective deriving from a utility decision support tool). The *"Consultant"* and *"Municipality – Water & Environment"* forms an alliance with *"Foundation"*. They have many similar objectives, but it is the absent connection to objectives of occupation and business development that form this specific alliance.

The *"Commercial"* stakeholders and *"Municipality – City Planning"* share all objectives, except for one but it is the missing interest in objectives of water quality and minimizing resources that creates their alliance with the *"Foundation"*. The *"Commercial"* stakeholders settle in a similar formed alliance with *"Legal*" stakeholders and *"Investors"* as they are not connected to objectives of minimizing resources. Both alliances makes sense in a traditional planning perspective.

"Municipality – Health & Social", *"NGO"s* and *"Municipality – Traffic & Roads"* cover very few objectives. This means that the similarity is high. *"Municipality – Health & Social"* and *"NGO"s* each have one objective in common with *"Municipality – Traffic & Roads"*, forming the two alliances shown in Figure S5-1. The limitation of the method and the low appearance of these stakeholders should be kept in mind when interpreting these results.

Based on our results, it was possible to form intuitive alliances. However, our results do not imply that the suggested alliances are always true. Some objectives will be more important to a stakeholder compared to others, and this is likely to change from project to project and over time. Furthermore, having similar/dissimilar objectives, does not mean they agree on how objectives should be reached, and hence might hinder an alliance.

S6 Indicators found in primary data

Included only meaningful indicators, i.e., indicators that can quantify objectives and indicate the direction the project/strategy is progressing. Furthermore, they should be easily (relative) accessible.

Objective	Indicator	Primary data source
Welfare for citizens		
Aesthetics	Higher house prices	Workshop
Recreation	Bathing water quality, Contamination risk of bathing water Quality and extent of nature (0-100) points Higher house prices Increased life expectancy	EVA-bladet Byplan Nyt Workshop Workshop
Mobility	Time savings (cars, vans and trucks)	DVC
Health & well-being	Expense for hospital service, absence due to sick days, House prices	Workshop
Safety & security	Reduction in risk of storm surges Reduction in floods	EVA-bladet Workshop
Connectedness		
Education		
Occupation		
Environmental protection		
Water quality	Reduction in COD, P and N Reduction in risk of large run-offs to recipients Reduction in combined sewer overflows (CSO)	DVC EVA-bladet Workshop
Resources		
Nature & Biodiversity	Willingness-to-pay, Changes in “key” species	Workshop
Economic growth		

Business development	Average income per. Citizen, GDP	Bypan Nyt
Low costs		
Technical objectives		
Integration w. ex. infrastructure		
Flexibility		
Simple and transparent solution		
Supply safety		