

## Tackling uncertainties in infrastructure sectors through strategic planning: the contribution of discursive approaches in the urban water sector

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### Abstract

Several strategic planning approaches have been proposed for dealing with future uncertainties in the urban water infrastructure sector. We identify three well established perspectives that address uncertainties in strategic decisions: an adaptive perspective, focusing on an incremental adaptation of existing structures as a reaction to unforeseen developments, a modeling perspective, focusing on an improved characterization of future context conditions and a managerial perspective, focusing on increasing the flexibility of the infrastructure organization. Despite their virtues, these approaches have definite weaknesses in their approach to uncertainty: they often consider a restricted scope of alternatives, they face substantial difficulties in predicting context conditions over time periods of decades and often consider objectives and tradeoffs only implicitly. We elaborate and illustrate with a case study a fourth perspective that may compensate for these specific weaknesses and complement the established strategic planning approaches. This perspective is based on a discursive, qualitative assessment of key elements in the strategic planning process among a selected set of local stakeholders and decision makers. We maintain that this approach leads to a more explicit and reflexive treatment of future uncertainty, conflicting objectives and a broadening of the considered alternatives and therefore to a more robust decision-making process.

*Keywords:* Foresight; Public participation; Strategic planning; Water sector infrastructure

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## 1. Introduction

Urban water infrastructure has played a key role over the past decades in improving environmental, economical and social standards worldwide. Today's achievements in water protection would, for example, be unthinkable without the service provided by wastewater treatment plants. However, the capacity to deliver these services in a sustainable way (i.e. by considering long term social, ecological and economic effects) is being challenged by several developments.

The urban water management sector, like most infrastructure sectors in industrialized countries, was built based on a rather narrow socio-technical paradigm, mostly defined by engineers. This paradigm favored the construction of centralized and capital intensive physical infrastructure (e.g. widespread networks, large plants) with clearly defined tasks (e.g. drinking water provision, wastewater treatment) built to operate over a time period of decades (Markard & Truffer, 2006). The implementation of this paradigm relied on very specific assumptions about future developments and the objectives of an infrastructure organization. It was assumed that the socioeconomic development of the corresponding region could be predicted over decades with sufficient precision. Additionally, the provision of effective, homogenous and affordable services was regarded as the main objective of an organization operating an infrastructure system.

However, evidence suggests that although these assumptions were more or less defensible in the 1970s and 1980s (and mainly only for industrialized countries), they will not necessarily be equally valid in the future. Infrastructure organizations are confronted nowadays with an increasing amount of future uncertainty, the urban water sector being no exception. Herder & Verwater-Lukszo (2006) derived from Walker (2000) two types of future uncertainty: context and valuation uncertainty. Context conditions over the next 20–30 years are becoming more and more uncertain owing to emerging challenges such as massive investment needs, changing regulations, rapid urbanization and market liberalization (UNESCO/World Water Assessment Programme, 2003, 2006; OECD, 2006, 2007; UN-HABITAT, 2006; Urban Land Institute and Ernst & Young, 2007). On the other hand, the criteria by which infrastructure organizations will be evaluated in the future are also becoming increasingly uncertain. An ongoing intensive political debate has fundamentally questioned the goals of successful infrastructure management. For almost 100 years, infrastructure organizations were optimized to guarantee the provision of effective, homogeneous and affordable services. Since the early 1990s, economic efficiency has gained predominance in the public discourses (Gray, 1998; Hirsh, 1999) and privatization was considered the best means to achieve this goal.

This increasing future uncertainty has important consequences for the long term provision of water and sanitation services, as the responsible decision makers often lack the necessary know how for its handling. Worldwide, the provision of water-related services is usually a public sector function, organized at the municipal level (Aubin & Varone, 2007; Pinsent Masons, 2007). Municipalities are therefore not only responsible for the maintenance of the infrastructure system but also decide on its future development. However, recent studies have questioned the capacity of public organizations to handle both context and valuation uncertainty (OECD, 2006, 2007; Urban Land Institute and Ernst & Young, 2007). While the technical components of the infrastructure system have reached a high degree of refinement over the past decades, organizational, financial and especially strategic aspects have been largely neglected. The lack of these competencies is particularly daunting in strategic decision-making contexts, in other words when the long term uncertainties related to challenges, objectives and alternative system configurations have to be considered.

Strategic planning has been proposed as a tool to aid urban water organizations in the development of key competencies and the identification of alternatives for how to handle both context and valuation uncertainty (Domínguez *et al.*, 2009). Recent literature provides different strategic planning approaches and tools capable of supporting the strategic planning process like, for example, modeling tools, real option approaches and decision analysis (see e.g. Dyer, 2000; Dyer & Larsen, 2001; Zhao *et al.*, 2004; MacGillivray *et al.*, 2006; Gil, 2007; Heinrich *et al.*, 2007).

However, both the strategic planning approaches and the tools favored vary strongly depending on the disciplinary background of the authors. Most of these proposals may be attributed to one of three perspectives: an adaptive, a modeling and a managerial perspective. The adaptive perspective to strategic planning represents the currently dominant approach in engineering practice. It deals with future uncertainty by betting on the most probable development of context conditions (mostly in a business-as-usual type of forecast). Deviations from this prediction have to be compensated by incremental adaptation of the installed infrastructures. The modeling perspective focuses on an improved characterization of the future uncertainty faced. By contrast, the managerial perspective focuses on increasing the flexibility of the infrastructure system to improve its capacity to accommodate change.

In this paper, we discuss the applicability and limitations of these perspectives with regard to their approach to context and value uncertainties. We argue that these weaknesses can be compensated by a fourth, complementary perspective. This perspective builds on informed discourses between experts and stakeholders concerning available alternatives, pursued objectives and possible future context conditions, while explicitly addressing tradeoffs and the diversity of interest positions.

The paper proceeds as follows. In the next section, we will classify the strategic planning approaches in infrastructure sectors into the three perspectives. The literature review is by no means exhaustive, but rather aims at framing the problem. Drawing on recent experiences in environmental governance, we then propose a fourth perspective to strategic planning in the urban water infrastructure sector and introduce a corresponding strategic planning approach. We will then illustrate the different procedural steps of the strategic planning approach with the aid of a case study in the Swiss wastewater sector. In the discussion, we expand on the contribution of the proposed perspective, discuss how the different perspectives can complement each other and explore the transferability of the lessons gained to other infrastructure sectors.

## 2. Strategic planning in the urban water sector

### 2.1. Context

Strategic planning is understood here as a process aiding the infrastructure organization in the identification of both long term external developments affecting the organization and the possible alternatives for facing these developments. In accordance with the operational life of infrastructure, this process should address time frames of 20–30 years. The goal of the process is not to elaborate specific problem solutions but rather to reach a shared understanding between different parties about the longer term priorities of an organization (Schoemaker, 1992; Grant, 2003).

Strategic planning for such long time periods and for sectors with a strong role of public organizations has received little attention in the academic literature, so far (Domínguez *et al.*, 2009). Existing approaches usually aim to enhance the service performance over time periods of five to ten years (see e.g. Rothstein,

2003; Mugabi *et al.*, 2007). Tillman *et al.* (2005) analyze two major past conditions in the urban water infrastructure sector that may explain this lack of attention. First, over the past decades the sector had been operating under stable and predictable conditions. Second, in the past, adaptation costs played an unimportant role, as they could be integrated into the development and expansion of the infrastructure system. The 20th century was dominated by the construction and enlargement of the infrastructure system. In this building phase it was relatively uncomplicated to adapt to changes in the context conditions.

## 2.2. Perspectives for handling future uncertainty

As a consequence of the increasing future uncertainty in the infrastructure sector, the awareness for the need for an adequate strategic planning is increasing (Dyner & Larsen, 2001) and different approaches have been proposed over the years. We propose that the approaches found in the literature may be attributed to one of three perspectives: an adaptive, a modeling and a managerial perspective (see Figure 1).

The predominant approach to strategic planning in infrastructure sectors follows the adaptive perspective. Future socioeconomic context conditions are considered by incrementally adapting the existing infrastructure (see Tillman *et al.*, 2005; Domínguez & Gujer, 2006). This adaptation takes place within the system boundaries defined by the conventional socio-technical paradigm. That is, only minor variations of the centralized technical layout and the locally based organizational paradigm are considered (see e.g. Priemus, 2007). Additionally, external developments affecting the operational life of the infrastructure (population, requirements, etc.) are considered through models providing forecasts on the basis of past developments and current trends (Goodman & Hastak, 2006; Markard & Truffer, 2006). On the other hand, the objectives of the organization are regarded as externally given (e.g. compliance with a legal standard) which can best be assessed by technical experts.

The adaptive perspective may be regarded as adequate as long as the uncertainty regarding future developments remains low, an effective provision of service is the main objective and additional costs induced by adaptations can be covered by increasing tariffs (Dyner & Larsen, 2001). As these conditions applied in the past for many countries, most of today's infrastructure was successfully built according to this perspective. Owing to increased uncertainties in context conditions and objectives that should be

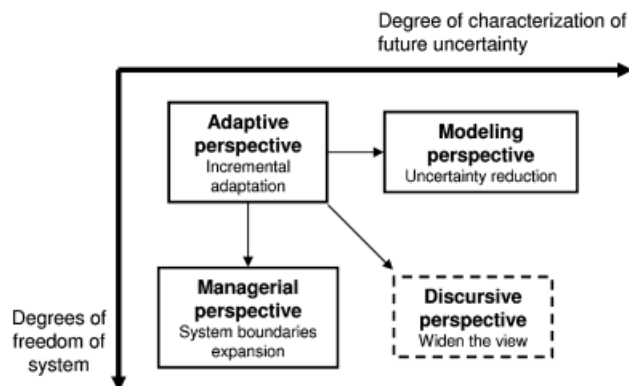


Fig. 1. Existing perspectives for handling future uncertainty and shifting objectives. We propose a fourth perspective focusing on a qualitative, structured discussion of the future uncertainty faced, the available alternatives and the pursued objectives (dotted box).

considered, the conventional perspective has mostly been enlarged in two different directions, one focusing on improving the characterizations of future developments (modeling perspective) and the other one on expanding the system boundaries for choosing appropriate technical solutions (managerial perspective) (see Figure 1).

The modeling perspective assumes the system boundaries of the conventional socio-technical paradigm (locally governed but technically centralized system structures, clear defined tasks) as given and aims to reduce or quantify the uncertainty present in predictions of the future. Objectives are regarded as externally given and subject to technocratic valuation. Reduction and quantification of the future uncertainty takes place by either enhancing the quality of the models that extrapolate past developments (see e.g. Gifford, 1993; Wilken et al., 1998) or by increasing the understanding of the interdependencies in the external environment and their consequences for the infrastructure organization (see e.g. Malmqvist, 2007).

Dyner & Larsen (2001) provide an overview of tools available for the latter action, ranging from agent-based modeling to scenario analysis. The information obtained can then be integrated into the planning and design of the physical infrastructure. For example, Rachmatullah et al. (2007) evaluated the upgrading plans for electricity infrastructure in Indonesia against the background of the uncertainty range depicted by future demand scenarios. In the same sense, Zhao et al. (2004) developed a stochastic model to account for long term uncertainties in highway development.

In the course of the ongoing debate on the privatization and liberalization of the infrastructure sector, a stronger managerial perspective has found its way into praxis. The argument is that only a market-oriented rationale can lead to an efficient resource allocation (Martin & Parker, 1997; Armstrong & Sappington, 2006). The managerial perspective assumes that future conditions cannot be known with any sufficient degree of certainty and therefore focuses on increasing the degrees of freedom available to an infrastructure organization by widening its system boundaries (see Figure 1).

This widening should provide the organization with an increased degree of flexibility to adapt to possible future challenges. Strategic planning is thus not limited to the optimization of locally governed but technically centralized, long living physical infrastructure providing a single service but rather addresses alternatives beyond these system boundaries. Examples of these alternatives are the decentralization of the infrastructure system (Larsen & Gujer, 2001; Wilderer, 2004) and the exploitation of synergies with neighboring communities (OECD, 2007; Hophmayer-Tokich & Khot, 2008) or other infrastructure sectors (OECD, 2007). The predominant objective within this perspective is efficient service provision, that is mostly aiming at minimizing costs.

Although both the modeling and the managerial perspective pursue a defensible strategy to compensate for the deficiencies of the adaptive perspective, they both possess three main limitations. First, by confining the scope of alternatives to the incremental development of existing structures, the modeling perspective risks perpetuating the existing path dependencies and thus hinders the emergence of innovative approaches, which would profit from wider system boundaries. Additionally, evidence suggests that the gradual enhancement of infrastructure as a response to a changing environment also bears its limits, especially in fast growing economies like China (Huang et al., 2007). On the other hand, increasing the degrees of freedom, as proposed by the managerial perspective, also comes at a price. A flexible system bears costs (e.g. idle capacity reserves) that have to be carefully weighted against the potential benefits. Additionally, the increasing complexity leads to a reduced knowledge of the variables relevant for the system and the consequences of one's own actions.

Second, both perspectives address and weight objectives in an implicit way. This hampers the evaluation of radically different options. Other than established solutions, these often involve a wide range of (mostly

uncertain) social and political relevant side effects. Cost-benefit analyses often have difficulty taking these complexities adequately into account (Flyvbjerg, 2007). Therefore an explicit assessment of the valuation criteria is called for (Gezelius & Refsgaard, 2007).

Third and finally, elaborate future predictions can convey a deceptive sense of security. When characterizing future uncertainty, the modeling perspective starts from the assumption that all relevant external developments and interactions can be identified, quantified and modeled over a time frame of decades. The applicability of this assumption is limited by the complexity and dynamic of the external environment of an organization, which over a period of decades can be quite considerable. Domínguez & Gujer (2006) show, in an empirical example from the wastewater sector, that the range of unforeseen changes in the context conditions can reach far beyond the range that could reasonably be expected in the context of the adaptive model.

One possibility to overcome these limitations would be to consider both the managerial and the modeling perspectives when conducting a strategic planning process. In other words, combine an improved characterization of future developments with an extension of the conventional system boundaries. This linking would require a better understanding of the processes and interactions within the new system boundaries in order to assess the impact of external developments. Several quantitative planning models have been introduced recently that aim to increase this understanding (Panebianco & Pahl-Wostl, 2006; Achleitner et al., 2007; Benedetti et al., 2008; Chung et al., 2008). Although promising, these models have problems addressing objectives that are not easily quantifiable (e.g. acceptance) and often require important simplifications in the modeled system structures. More importantly, this combination mostly does not lead to a more explicit and balanced consideration of objectives. In fact, concentrating on those objectives that can be quantified can lead to the disregard of important valuation criteria.

In view of the limitations of the three perspectives for handling future uncertainty, we propose to consider an additional perspective that accepts and incorporates uncertainty into strategic planning approaches. This perspective focuses on a discursive elaboration of the future uncertainty faced, the available alternatives and the pursued objectives and builds on exploratory foresight approaches like scenario planning (see Ringland, 2002). Through a series of structured discussions, the spectrum of possible options, objectives and future developments are to be opened for discussion and evaluated under different points of view. The resulting complexity calls for a purely qualitative assessment. Nevertheless, by adopting structured methods, this perspective should help clarify the suitability of different alternatives and their tradeoffs (Stirling, 2006; Störmer et al., 2009).

The general idea of opening up conventional approaches to strategic decision making by explicitly considering the uncertainty spectrum is not entirely new. It has been successfully applied to several policy and governance contexts (see e.g. Friend & Hickling, 2005; Brunner, 2005; Glasbergen & Driessen, 2005). There is however little experience of the applicability of this perspective in the infrastructure sector at the municipal level while considering time horizons of decades. Experiences from other fields cannot be simply transferred to this context owing to its special characteristics such as time ranges of decades, strong technological and organizational path dependencies and the high involvement of local public bodies (Domínguez et al., 2009). Nonetheless, these experiences lead us to expect that this perspective will help open up the option spectrum, encourage a balanced consideration of objectives and lead to solutions equipped to deal with future surprises. Additionally, we expect that the transparency of the decision-making process will increase the acceptance and satisfaction of the decisions reached and foster an understanding of the accepted tradeoffs. Finally, we expect that results from a strategic planning under this perspective can complement the other perspectives.

In the next sections, we will introduce a strategic planning approach for the urban water infrastructure sector based on the discursive perspective and illustrate its application and the expected results with the aid of a case study.

### 3. A strategic planning approach following a discursive perspective

#### 3.1. Requirements of the approach

Based on the above analysis, we derive two requirements for a strategic planning approach based on the discursive perspective.

First, the approach should systematically open up the spectrum of options, objectives and future developments addressed. To do so, we go back here to exploratory foresight approaches like scenario planning (Ringland, 2002). These are regarded in business literature as adequate for handling future uncertainty in contexts where the relevant time ranges are high and the knowledge of the relevant variables and their interaction is low. The use of scenario analysis for strategic planning purposes is well known in the management and policy literature. However, it has much less often been applied to infrastructure sectors in general and urban water infrastructure in particular (see Zegras et al., 2004; Means et al., 2005; Truffer et al., 2008; Störmer et al., 2009 for some exceptions).

Second, the strategic planning approach should encourage a systematic discussion under different points of view about the future challenges, the means available to deal with them and the tradeoffs involved. To be able to include different points of views, the strategic planning process has to be opened to stakeholders from outside the organization such as citizens and industry representatives. The involvement of different stakeholder groups allows access different forms of evidence and identification of potential conflicts which could eventually lead to a rejection of the strategies chosen (Grimble & Wellard, 1997).

#### 3.2. Procedure and structure

To fulfill the above stated requirements, we propose a strategic planning procedure in which the future uncertainty, the options available and the pursued objectives are systematically discussed in a series of workshops. The process is mainly carried out by a “core group” of four to six decision makers appointed by the infrastructure organization and representing a broad spectrum of points of view and system knowledge. The core group is typically constituted by one or two representatives from the organization, the carrying communes, regulators and a consultant engineering company. The core group carries out the analytical steps and is responsible for elaborating the final recommendations. Furthermore, it has to identify 10–20 additional regional stakeholders who could have an influence or may be affected by decisions taken in the strategic planning process (e.g. citizens and industry representatives). These stakeholders are involved in specific stages of the process, such as the assessment of the future uncertainty faced and the evaluation of the available alternatives.

The process is structured in four modules: scenario analysis, options analysis, objectives analysis and strategy specification (see Figure 2). The first three modules follow a bottom-up approach in order to achieve consensus among the involved stakeholders regarding the future uncertainties, the available alternatives and the pursued objectives. For example, in the scenario analysis module, prevailing visions or expectations of the future are discussed and decomposed into its core elements like economic development

or future legal requirements. In the next step, possible future realizations of the identified elements are addressed (e.g. economic growth or decline). Finally, the different possible realizations are clustered through a systematic approach to plausible future scenarios representing the relevant space of possibilities. These generic steps were repeated in both the options and objectives analysis modules.

- **Scenario analysis module:** The aim of the module is to identify systematically possible coherent images (so called scenarios) of how the socioeconomic context of an infrastructure organization could develop in the future (20–30 years) and the resulting challenges. Here we draw on existing scenario methods as applied for example in the business sector (Schoemaker, 1995; Gausemeier *et al.*, 1998; Ringland, 2002).
- **Options analysis module:** The aim of this module is the identification of a broad range of so-called strategic options. These are feasible organizational and technological constellations (e.g. optimization of existing structures, regionalization, etc.) that are potentially suitable for addressing the future challenges identified in the previous module. Strategic options are to be understood as a broad informative basis for facilitating a discussion about meaningful alternatives and not as ready to use development alternatives.
- **Objectives analysis module:** In this module, the objectives used to evaluate the strategic options are systematically identified, discussed and clarified. As a result, a shared set of objectives which have to be considered can be identified and the stakeholders become aware of the scope of different objectives. Furthermore, the specific weights attributed by different interest groups to the individual objectives can be made transparent. Objectives can be related to different sustainability criteria, such as environmental, social, economic or governance objectives. This approach is similar to the one taken by Muga & Mihelcic (2007) to evaluate the sustainability of technologies in the wastewater sector.
- **Strategy specification module:** In this module, the objectives, options and future scenarios assessed in the previous modules are related to each other. Specific recommendations for decision makers can be derived from a structured debate about how the strategic options perform under the different future

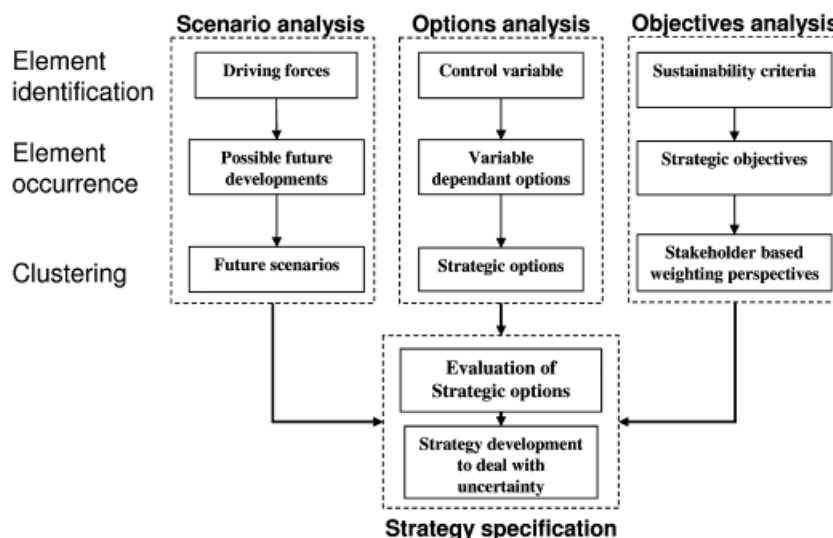


Fig. 2. Modules and generic steps of the proposed strategic planning approach. The methodology consists of four modules: Scenario, option and objective analysis and the identification of a strategy. The first three modules follow the same generic steps.



scenarios and how outcomes are evaluated from the points of view of specific interest groups. Strategic options (or elements thereof) can be identified which are accepted by all stakeholder groups and are expected to perform well under a wide range of future scenarios. Additionally, the process helps to specify knowledge gaps, critical future developments and potential conflicts. The first refers to those attributes of the strategic options, which have to be further clarified to allow a decision (e.g. cost effectiveness, political and technical feasibility, etc.). The second refers to those future developments which have to be monitored owing to their potential negative impact on the preferred strategic option. And the third allows timely identification of the potential opponents of a chosen option. The results of the process may finally be presented to the actual decision-making bodies, which are ultimately responsible for implementing the proposed strategy.

The proposed strategic planning approach should lead to more open minded decisions regarding a variety of objectives, possible future context developments and a wide range of alternatives. In particular, by considering a variety of assessments associated with a broad range of interest positions, decision makers are helped to think about potential future “social” preference rankings of the options. By this, we may assume that a more balanced and potentially more sustainable outcome may result (in particular, if we abstract from power relations within the decision-making body, see [Stirling, 2008](#)). The explicit consideration of potential social preference rankings strongly differs from the traditional assessment of strategic options in the water management sector, where preferences are defined by technical experts and/or elected local politicians. Additionally, the process should increase the awareness among the involved stakeholders of existing tradeoffs and different points of view ([Störmer et al., 2009](#)). We will next illustrate, with the aid of a case study in a Swiss wastewater organization, the detailed application of the proposed strategic planning approach and to what degree these expectations are met.

#### 4. Illustrative case study

The case study was part of a Swiss research project that aimed to develop a strategic planning approach suitable for publicly owned infrastructure organizations. The approach was applied in three typical examples of the Swiss wastewater sector, namely Dübendorf, Kloten-Opfikon and Bern. All three case studies are located in an urban environment and have a representative size for wastewater utilities in Switzerland. During the strategic planning process, the authors of this paper participated as facilitators and thus observed the process at firsthand. Our role as researchers was to instill methodological rigor in the different steps of the planning process and provide an outside view.

The case study Dübendorf is especially suitable for illustrating the application of the proposed strategic planning approach and how it can complement approaches following other perspectives. The organization analyzed was confronted with the highest degree of future uncertainty and the process required an extensive stakeholder involvement. A comparative evaluation and analysis of the results of the different case studies can be seen in [Domínguez et al. \(2009\)](#).

##### 4.1. System description: wastewater treatment organization Dübendorf

The wastewater treatment organization Dübendorf operates a 60,000 person equivalent wastewater treatment plant treating the wastewater of three communities in the urban agglomeration of the city of

Zurich, Switzerland. The influence sphere of the organization is currently limited to the treatment plant, as the sewer system is owned and operated by the individual communities. The treatment plant is running close to its capacity limits and will reach the end of its design life in the next 10 years, which makes planning efforts imminent. Additionally, the receiving water body is highly polluted by organic compounds and fails to meet the legal requirements, as it flows through a densely populated area and receives treated wastewater from six wastewater treatment plants.

Initial strategic planning efforts by the organization aimed to upgrade the existing treatment plant. However, it soon became clear that important uncertainties rendered this approach inadequate. For example, it was unclear if the existing trend in population and workplace growth in the region would continue for the next 20 years or if this trend could reverse. Similarly, the communes served possess important land reserves, which if urbanized would double the population of the region and require important investments in the wastewater infrastructure. On the other hand, there is a high uncertainty regarding future legal requirements in wastewater treatment. For example, it is unclear if the population in the region will continue to accept the high pollution of the received water or if new legal requirements demanding a revitalization of the river could come into force within the next 20 years. In addition, an upgrade of the treatment plant is expected to be extremely costly owing to space limitations in its current location.

The proposed strategic planning approach was applied within this context with the aim of identifying an adequate strategy to deal with this and other future uncertainties. In ten workshops, spanning a period of ten months and involving a total of 16 stakeholders, future scenarios were developed and the available strategic options were evaluated. The results of each module will be presented next.

#### 4.2. Development of future scenarios

In the case study Dübendorf, three scenarios for the year 2030 were developed based on five external factors. These factors represented forces with an impact on the service provided but whose future development can be regarded as uncertain. These driving forces were selected by the stakeholders involved from a wide spectrum of possible driving forces, ranging from job market development to climate change. This spectrum was identified by the core team based on an analysis of the current situation and literature research and enhanced by the stakeholders involved. Figure 3 shows the selected driving forces and their possible future development over the next 20–30 years.

The stakeholders combined the possible future outcomes of the selected driving forces into coherent scenarios. Scenario factors were selected from the list of driving forces by determining their relevance for the future of the region and its impact on the wastewater infrastructure. Drivers were chosen if additionally they were associated with a high degree of uncertainty about its future state. In a next step, workshop participants constructed coherent context scenarios from combinations of specific future states of these drivers. Care was taken to ensure that the combinations led to coherent and clearly differentiated pictures of possible future context conditions.

The scenarios developed focused on (i) economic downturn, (ii) increasing quality of life and (iii) a booming regional economy. They read as follows:

- *Scenario A: Downturn.* The core of scenario A is a negative economic development in the catchment area of the wastewater treatment organization. This development leads to a reduction of workplaces in the catchment area and to a slight population decrease and consequently to a reduction in the wastewater load to be treated. The personal and financial resources of the communities responsible for wastewater

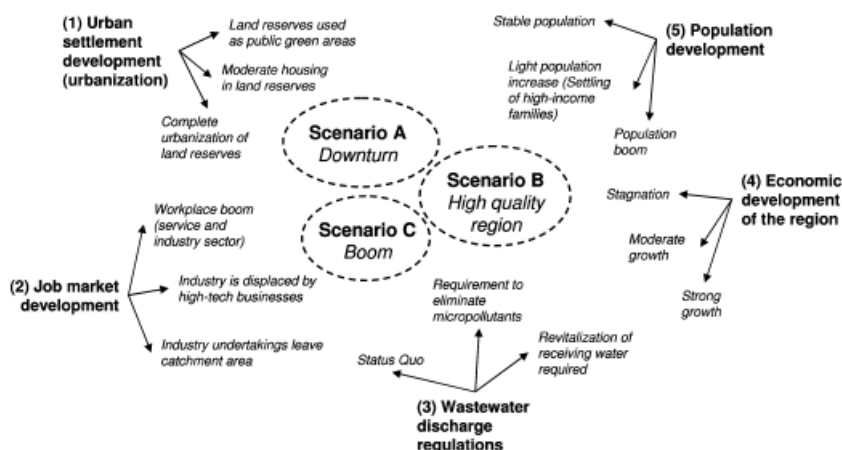


Fig. 3. Driving forces in the development of the future scenarios, *possible developments* for the year 2030 and the resulting future scenarios.

treatment are very limited. As a consequence, water protection activities are reduced to the minimal fulfillment of the legal requirements.

- **Scenario B: High quality region.** Scenario B is characterized by an increase in the quality of life in the region. The communities responsible for the wastewater treatment develop to an attractive recreation and housing region. This leads to a moderate increase of the population and thus to the wastewater load to be treated. The number of industry enterprises remains stable, as further growth would be inconsistent with the high quality of life. The expectations regarding the quality of wastewater treatment service are high. An increased ecological awareness leads to the introduction of rivershed management regulations and a revitalization of the receiving water is required.
- **Scenario C: Boom.** The basis of scenario C is the presumption of strong economic growth in the Zurich city region. Owing to rapid urbanization, the number of people working in the region practically doubles and there is also a strong population growth. Although this development leads to a strong increase in the wastewater load to be treated, the financial resources to manage this challenge are available.

#### 4.3. Assessment of strategic options

The strategic options were created based on four control variables where the organization possessed a configuration leeway: (1) the vertical integration of wastewater related tasks and infrastructure within the catchment area of the existing waste water treatment plant, (2) expanding the fields of activity to new tasks such as the operation of satellite plants, (3) optimization of existing structures (technical and organizational) and (4) the geographical scope of the organization (see Figure 4).

The four resulting strategic options represent the range of potentially feasible and coherent alternatives into which Dübendorf could evolve. They were identified by the involved stakeholders in a discursive way similar to the elaboration of the context scenarios. Their range went from incrementally developing the current organization to merging with neighboring organizations:

- **Strategic option I: Concentrating on core capabilities.** The organization remains in its current state. Future challenges are addressed by optimizing the technical structures as far as possible.

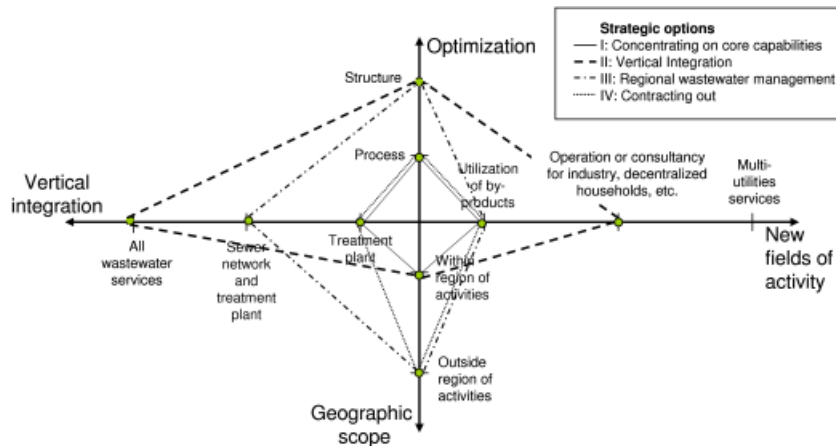


Fig. 4. Four strategic options evaluated in the strategic planning process in Dübendorf. They were created based on four control variables where the organization possesses a configuration leeway.

Additionally, different activities are undertaken to reduce the incoming load or prevent a further increase. For example, the wastewater of new urban developments within the region is to be directed, whenever possible, to the treatment plants of neighboring organizations. Conversely, measures are to be taken to ensure a more efficient pretreatment of wastewater in high-polluting industrial enterprises within the region.

- *Strategic option II: Vertical integration.* The Dübendorf organization is responsible for all wastewater-related tasks in the region. These include the ownership and operation of all wastewater-related infrastructure and duties such as fee collection and customer consultancy in wastewater-related questions. In new urban developments, the use of decentralized systems is to be evaluated and if possible implemented. These systems would be maintained and monitored by the organization. These new responsibilities would require an optimization of the organizational structures, leading to lean decision structures and a higher autonomy from the carrying communities.
- *Strategic option III: Regional wastewater management.* Dübendorf aims to build an organization that integrates all or most of the wastewater treatment plants and sewer networks along the receiving water body. By this, wastewater-related problems can be regionally solved, synergies exploited and an integral water protection can be provided.
- *Strategic option IV: Contracting out.* The organization merges with the local neighbor, which takes over the ownership and the operation of the treatment plant. As the neighboring plant possesses a certain degree of capacity reserves and discharges into a less sensitive water body, it is probable that the Dübendorf treatment plant will be taken out of operation and its wastewater redirected to the neighboring plant. Although this measure would prevent the discharge of treated wastewater into Dübendorf's sensitive water body, it would also reduce the influence that the carrying communities have on the organization. From the point of view of the communities, this measure is equal to an outsourcing of the wastewater treatment duty and can therefore be regarded as a structural optimization.

#### 4.4. Identification of strategic objectives and weighting perspectives

Figure 5 shows the different objectives that were to be fulfilled by the strategic options identified in option analysis module. They range from compliance with legal requirements to keeping public control

Sustainability criteria	Strategic objectives	Weighting perspectives
Environment	<ul style="list-style-type: none"> <li>• Compliance with legal requirements</li> <li>• Minimization of wastewater impact in watershed</li> <li>• Optimization of resource use (energy, nutrients recovery)</li> </ul>	
Social	<ul style="list-style-type: none"> <li>• Technology and restrictions are accepted by the customers</li> <li>• Provision of secure hygiene and health protection</li> <li>• Equal charging based on inducement requirements</li> </ul>	
Economic	<ul style="list-style-type: none"> <li>• Efficient and effective decision making process</li> <li>• Long-term maintenance of value</li> </ul>	
Governance	<ul style="list-style-type: none"> <li>• Controllability by the carrier communities</li> <li>• Democratic legitimation and representative participation of community members</li> </ul>	

Fig. 5. Sustainability criteria and strategic objectives addressed in the case study Dübendorf (aggregated from a more detailed objective tree). Their weighting was performed from the perspective of two stakeholder groups.

over the organization and address the whole sustainability criteria spectrum. The identification took place in a bottom-up process, that is, workshop participants stated what they regarded as potential objectives of the organization, which were then integrated to the sustainability criteria seen in Figure 5.

These strategic objectives were weighted from the perspective of industry and citizen representatives. The two stakeholder groups represented the most influential stakeholders in the region and for whom the highest potential conflict can be expected.

#### 4.5. Strategy specification

To specify a strategy for Dübendorf, workshop participants were asked to evaluate the suitability of each strategic option from different stakeholder perspectives and context conditions. To do so, the participants were asked to engage in a role play assuming themselves either to be a future industry representatives or a citizen living under a specific scenario. As such they had to prioritize and rank the different strategic objectives. This ranking was then used to discuss the strengths, weaknesses and desirability of each strategic option under each of the future scenarios. By this the tradeoffs of each option could be assessed, remaining uncertainties be specified and the timely identification of potential conflicts between stakeholder groups could be derived.

For example, as seen in Table 1, the alternative to incrementally adapt the existing structures (strategic option, SO I) was only regarded as desirable in an economically tense situation (scenario, Sc A) and only by the future citizens. In such a scenario both industry and citizens favor low cost solutions and regard environmental objectives as boundary requirements to be fulfilled but not exceeded. The strategic option would imply the lowest degree of investment for the citizens but require industry to upgrade their pretreatment. As a consequence, the alternative was rejected by the industry.

The evaluation led to favoring the option were all wastewater services were integrated (strategic option II), as it is assumed to possess the highest desirability and generate the least conflict between industry and citizens. Interestingly, it became clear that strategic options that required a reduction in the autonomy of the communities (e.g. strategic option III) were seen as problematic by the citizens despite potential financial savings and environmental benefits. Additionally, the evaluation pointed out important uncertainties that need to be considered in the future. For example, the option to outsource the wastewater streams could not be discussed in detail, as information was lacking regarding the extent and feasibility of the measure. Based

Table 1. Evaluation of the strategic options (SO) of the case study Dübendorf by the different stakeholder groups under the different future scenarios. Both the desirability of an option as its potential conflicts can be identified from the table.

		Sc A	Sc B	Sc C	Evaluation
SO I	Citizens	++	-	-	Undesired and with a high conflict potential.
	Industry	---	--	--	
SO II	Citizens	++	+++	++	High desirability, low conflict.
	Industry	++	++	++	
SO III	Citizens	-	+++	+	Little interest in regional solution as long as it is not externally required. Fear of reduction of co-determination by the carrying communities.
	Industry	-	++	+	
SO IV	Citizens	-	(+++)	(+)	Option only desirable if operation of the treatment plant Dübendorf stops. This is however at the moment highly uncertain.
	Industry	++	(+)	(+)	

on this assessment, strategic option II was complemented and defined in more detail by the members of the core team. This process resulted in a series of recommendations for the organization.

First, it is recommended that Dübendorf instigates a political and organizational process aimed at transferring the responsibility for several wastewater related tasks from the communes to the wastewater infrastructure organization. These include the coordination of duties related to sewer development, maintenance and domestic connections. Additionally, the organization will consult industry in wastewater-related matters, a need which was clearly identified by industry representatives in the workshops. Consultancy services, combined with an improved coordination of the wastewater duties and an optimization of the charge fees structures are expected to lead to a decreasing pollutant load. In parallel, a change in the organization structure from an association of convenience to a publicly owned stock corporation is to be induced.

Second, the discussion about how the existing land reserves in the communes are to be used is to be monitored. Third, the introduction of a series of complementary measures is recommended if signs indicate that an urbanization of these land reserves will take place in the next years. These include expanding the range of responsibilities to include the ownership of the sewer system and the supervision of the pretreatment plants in industry. Additionally, the redirection of wastewater streams to treatment plants in neighboring regions and the operation of decentralized plants in the newly urbanized regions are to be considered.

The value of the strategic planning process lay not in the novelty of the identified strategy, although the process also led to the identification of new options. In Dübendorf, for example, industry representatives stated a desire to be advised by the organization on wastewater-related issues. This option had not been previously considered by Dübendorf, despite the fact that it could have reduced the incoming load to the plant and thus created capacity reserves and delay upgrading measures. The value of the process lies rather in how it helps to reach better informed strategies which, if implemented, will most probably be supported by the stakeholders of the region. First, the reached solutions are based on a balanced consideration of objectives and address both possible future surprises and alternatives beyond the prevailing socio-technical paradigm. Second, a process based on a transparent discussion creates awareness for existing tradeoffs and different points of view.

As illustrated by Table 1, a strategy specified under a discursive perspective is the product of an intensive debate about different alternatives, evaluation contexts and points of view among relevant decision makers and/or stakeholders. The scope of the assessed alternatives is thereby not limited to adapting existing structures incrementally but includes alternatives which are usually not addressed under an adaptive or modeling perspective in strategic planning. The structured debate helped to evaluate these alternatives and led to the specification of a strategy that differed strongly from the previously favored simple adaptation of the existing structures.

Evidence suggests that the proposed strategic planning approach also increases the awareness of the involved stakeholders of existing tradeoffs and different points of view. For example, the regulators in the Dübendorf core group became aware that despite its environmental and financial advantages, a regionalized wastewater organization could only be enforced if legal requirements obliged the carrying communities to do so. Without a legal compulsion, the alternative will not find enough support among citizens and industry, because the political autonomy of the communities was weighted higher than potential environmental and financial benefits. This weighting also partly explains the poor score of the outsourcing option.

## 5. Discussion and conclusion

In this paper we introduced different perspectives to strategic planning in infrastructure sectors and identified their limitations regarding the handling of future uncertainty, the range of alternatives assessed and the consideration of objectives. We argued that a discursive approach to strategic planning could help to overcome these limitations and illustrated this with the aid of a case study.

We regard the discursive perspective introduced in this paper as a contribution to a more integrated way to do strategic planning in the urban water sector. The discursive perspective offers an additional approach focusing on a structured, qualitative discussion of the scope of available alternatives, pursued objectives and future uncertainties. That is, strategies developed under a discursive perspective will not be as rich in detail as those developed under other perspectives, but they will have systematically addressed a broader spectrum of possible future developments, available alternatives and valuation criteria. For example, the alternatives assessed under a discursive perspective in the case study envelop a broad range of general directions into which the utility organization could develop in the future. This range encompasses a broadening of the traditional system boundaries and is therefore not limited to adapting existing organizational and technical structures incrementally.

By contrast, from strategic planning approaches following an adaptive or modeling perspective we would expect feasible solutions with a clear cost–benefit ratio under defined boundary conditions. These solutions, although detailed, would be limited to end of pipe alternatives, focusing on an optimization of the existing structures, such as different technologies for the biological treatment of the wastewater in the central wastewater treatment plant or optimization of the decision-making process.

A discursive perspective to strategic planning is therefore especially suited to framing purposes and the identification of potential conflicts and knowledge gaps related to the strategic options. In this sense, it contributes to “opening up” the decision-making process (Stirling, 2006) It is therefore not a substitute for the adaptive, modeling and managerial perspectives of strategic planning, which follow a “closing down” mode, but rather a complement. The adaptive, modeling and managerial perspectives possess qualities and strengths that are needed at different stages of the strategic planning process.

The final sizing of a wastewater treatment plant requires quantitative information on the both expected costs and future load. This information cannot be provided by strategic planning approaches following a discursive perspective but rather by approaches following an adaptive or a modeling perspective. However, these stages can profit from a preliminary framing stage where the scope of the future uncertainty and the available alternatives are openly discussed. In this sense, a discursive perspective supports the modeling perspective by considering a wide range of potential future context conditions on which modeling efforts could be built. Similarly, the managerial perspective profits from the explicit consideration of future uncertainties and objectives. Finally, a discursive perspective complements the adaptive perspective by performing a preliminary assessment of the relevant alternatives, which can subsequently be quantitatively evaluated with regard to their feasibility and costs.

In our opinion, strategic planning in the urban water infrastructure sector has to be improved through a more balanced consideration of the different perspectives in order to confront the upcoming challenges. A discursive approach to strategic planning exploring a broad range of alternatives, objectives and possible future developments can be an important element in this endeavor. We argue that a joint consideration of discursive, adaptive, modeling and managerial perspectives will improve the quality of strategic planning in this sector. Through this, infrastructure organizations facing uncertainty should be in a better position to identify the capabilities required to secure a long term provision of services. This conclusion should be transferrable to other utility sectors with dominant public organizational forms and capital intensive structures with a clear defined task.

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