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Planning for Sustainable Sanitation Infrastructures

Ensuring eco-efficient resource use through participatory foresight

Eckhard Störmer, Annette Ruef, Bernhard Truffer

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Introduction

The role of sanitation infrastructure within resource management

The sanitation sector uses and offers resources in two quite different meanings: 1) It ensures water resources by treatment of used water. This process itself requires further resources e.g. in the form of treatment plants and infrastructure networks (sewer systems). 2) The availability of sanitation capacities is a resource which affects the scope for regional development of settlements and industries.

The sanitation system offers services to reach important tasks of water policies: cleaning of used water from households and industries to guarantee tolerable living conditions for aquatic ecosystems in the receiving waters, and to make the water bodies usable for further aims like reuse and leisure reasons of swimming and water sports. With this function the water resource cycle can be closed with minimized impacts on the ecosystem. The water can also be used as a source for drinking water.

In a historical perspective the original aim of sanitation was the transport of unhygienic waste water from the places where it occurs to ensure healthy living. Nowadays in industrialized countries the existence of a working sanitation system is a basic resource for using places for living and working. Sanitation system is a derivative of settlements. The infrastructure has to have the cleaning capacity of the water consumption patterns of households and industries. By fixing the dimensions of the sanitation infrastructure, the expansion of settlements can be limited. Or, in other words: sanitation infrastructure itself is a resource for regional development.

The installation and operation of sanitation infrastructure needs resources themselves. These are material resources and economic resources. The efficiency of the system – either measured in material units per service unit (MIPS) or in monetary units – depends from the right technological solution and mainly from the right size of the technical infrastructure. But changes within the quantity and quality of the waste water are a great challenge for the long lasting infrastructure.

"[W]astewater treatment is one of the most spectacular examples of technologies that must change in order to be sustainable. Facing continuing population increase and increasing environmental degradation (…), we realise that new, economically efficient and environmentally sound methods of water management and novel technology of wastewater recycling and treatment must be developed and implemented." (Niemczynowicz, 2995, p. 30)

Problems of the sanitation sector and the need for a new planning approach

The 'Regional Infrastructure Foresight' (RIF) method introduces foresight as a new approach into strategic planning processes of regional sanitation infrastructure in Switzerland in order to reach two goals:

- to facilitate sustainable long-term planning by combining perspectives of experts and stakeholders;
- to enhance the strategic skills of key decision makers for sustainable long-term investments,
- to reach eco-efficient resource use in sanitation infrastructure,
- to offer appropriate infrastructure services as a resource for living and working.

The sanitation sector suffers from a need for new planning approaches as it relies on slack, long lasting technologies (25-80 years) with limited flexibility. Furthermore, uncertainties about the long-term prospects of water infrastructure systems are growing considerably. Major drivers that increase complexity are new regulatory frameworks (e.g., privatized ownership of utilities), reduced financial stability, risks from new pollutants or hygienic parameters, new technologies (e.g., household centred water treatment), regional population dynamics, and scepticism regarding the sustainability of the conventional centralized system.

Despite this need for transformation, the sanitation sector as other infrastructure sectors is characterized by strong inertia. In such "large technical systems", changes require much time because of the material longevity and the strongly established institutional and professional expertise structures. Material and social infrastructure networks constitute a fine-tuned socio-technical system, which is extremely successful if its conditions remain stable. Uncertainties impede the system's development, and rapid adjustments to new demands are difficult. Thus, incremental innovations are preferred, and socio-technical systems rather undergo continuous improvement than radical restructuring.

What is more, sanitation is a public task which is usually organized at the local level – at least in Switzerland. This means that local politicians can exert a high influence on infrastructure planning. They are usually driven by multiple rather short-term objectives which can conflict with the task of the development of the sanitation infrastructure. A consideration of a long-term, regional perspective on sanitation management might reveal considerable synergy potentials.

RIF method as a long term assessment of the regional sanitation system

The 'Regional Infrastructure Foresight' (RIF) method is based on the assumption that we need fundamentally new concepts for strategic infrastructure planning. Strategic infrastructure planning is a transformative and integrative (usually) public-sector-led sociospatial process through which a vision, coherent actions and means for implementation are produced (see Albrechts 2006, p. 1152) that shape and frame what a regional infrastructure is and what it might become.

In its role in an early step of decision making, RIF method can be added to *ex ante* evaluation instruments. The high uncertainties about future challenges for the sanitation sector and the inertia of its infrastructures imply the adoption of a long-term perspective. Besides an exploration of possible future developments (scenarios), the consideration of unconventional technological and organizational solutions

(alternative options) seems essential to open the strategic space towards more sustainable infrastructures.

Strategic infrastructure planning involves designing plan-making structures and developing content, images and decision frameworks for influencing and managing infrastructure's change (see Albrechts 2006, p. 1152). "It is about building new ideas and processes that can carry the ideas forward, thus generating way of understanding, ways of building agreements, and way of organizing and mobilizing for the purpose of exerting influence in different arenas." (Albrechts 2006, p. 1152).

The RIF method adopts a participatory foresight approach to facilitate sustainable long-term planning by combining perspectives of experts and stakeholders and to enhance the strategic skills of key decision makers. This is an additional learning aspect of the RIF method to establish awareness for future challenges in daily work and especially in planning procedures.

Foresight and the RIF method

Foresight exercises are concerned with "the generation of reasoned statements about the future, the interpretation of such statements in terms of informed action, and the collective learning processes that are involved in responding to challenges of the future" ((Salo and Cuhls 2003)). Foresight activities can also be characterised as "collective learning processes to support strategic decision-making" ((Barré 2001), 120). They are usually carried out in interaction with different actors, e.g. from industry, science and public governance, with the aim of developing or co-ordinating strategies. Foresight is thus a participative "multi-actor activity that supports network developments across established institutional and sectoral borders" ((Borup 2003)).

In recent years, foresight has established itself as a key instrument of strategic policy intelligence ((Salo and Cuhls 2003)). Traditionally, it was applied above all to design national S&T policies or to set funding priorities. However, foresight can be applied at different scales and with different objectives ((Cuhls 2003)). Foresight exercises carried out at the regional level have gained importance especially in Europe, as an instrument for the strengthening of regional knowledge economies (REF, HLEG Report "Thinking the Future"). According to its aims, the benefits of foresight exercises can stem as well from the foresight process itself as from its products (e.g. published reports).

A whole range of tools and methods can be employed in foresight processes, drawing on approaches at the intersections of future studies, planning and networking. Given the prospective orientation of foresight, methods for the development of longer-term *futures* (typically more than 10 years away) and the examination of alternative paths of development (e.g. scenario methods, Delphi studies, simulation modelling) are at the heart of the process. Different types of *planning* tools (e.g. action plans, evaluation methods, panel activities) can then be applied to inform decision-making. Furthermore, participatory approaches and methods aimed at *network* building and mobilising stakeholders around the visions of the longer-term future (e.g. workshops, group work, steering groups) usually form an important part of the process ((Miles 2002)).

In the case of RIF, the foresight process is conceived as an instrument of strategic infrastructure planning. In contrast to European regional foresight exercises, the development of the regional economy – delimited by political or administrative

borders – does not take the centre stage. The method aims at facilitating sustainable long-term planning of sanitation infrastructures at a small-scale "regional" level of several communities or sanitation associations. The foresight exercise is designed first of all to enhance the strategic skills of key planners and decision makers. They get the opportunity to critically reflect traditional views, and the integration of the different perspectives of the participating stakeholders opens the mind for weak signals of possible future changes. A further aim of the workshops is to develop joint visions of the future as a base for mobilizing co-operation among different interest groups.

The participatory character of foresight exercises is well suited for the involvement of a broad range of relevant actors of the sanitation sector in a region. A planning committee is formed by key decision-makers and planners of the regional sanitation sector. The committee members are the core participants of the whole process and are responsible e.g. for the definition of the objectives of the foresight exercise, the funding and organisation of the process, as well as for the communication and implementation of its results in the regional decision making context (similar to a foresight "steering committee", cf. (Miles 2002), (Barré 2001)). This committee (i.e. about three persons) should encompass more than the members of the conventional planning teams in order to integrate different perspectives. It mobilizes the technical and organizational expertise of the local sanitation practitioners and plays an important communication and outreach role. In special workshop phases, a wider circle of stakeholders is involved into the foresight exercise. However, the number of participants to the workshops is limited to a small selection of stakeholders (5 to 10 persons) in order to allow for open discussions.

Core activities of RIF exercises

Regional Infrastructure Foresight (RIF) exercises encompass two major steps or core activities: 1) a *scenario* process and an 2) assessment of *strategic alternatives* for the development of the regional sanitation system. They combine intuitive approaches such as brainstorming, group discussions and narrative picturing of the future with elements based on uncertainty-impact and cross-impact analyses, and formalised methods for the assessment of possible options for action. This approach benefits from both, the creative collection and assessment of ideas in the scenario construction, as well as from more rational assessments of drivers of change and options for action.

1) *Scenario* methods are widely used in foresight for the generation of internally consistent pictures of future possibilities and the examination of the implications of uncertain developments and courses of action ((Miles 2002)). RIF aims at the development of *explorative* scenarios in contrast to *predictive* or *normative* scenarios (according to a recent typology of scenarios, cf. (Borjeson, Hojer et al. 2006)). They focus on possible developments of external factors that the intended target group may have to take into consideration in one way or another, and they provide a framework for the development of robust strategies.

This type of scenarios typically implies the use of qualitative techniques for the different steps of scenario building, i.e. the generation of ideas, the integration into scenarios and their check for consistency (ibid.). RIF employs the workshop technique for all steps, combining work in small groups and plenary sessions. It draws on a set of conventional methods based on scenario planning approaches originally developed in corporate planning (cf. e.g. (Schwartz 1996), (Ringland 1998), (Fink, Schlake et al. 2002)).

The scenario process starts with a presentation of the local/regional problem definition, the time horizon (25 years) and the goal of the foresight process to the workshop participants. These discuss a list of external factors influencing the regional sanitation system submitted by the research team and complement them by their expert knowledge in a brainstorming exercise. In a next step, a discursive uncertainty-impact analysis is carried out, identifying the most relevant factors (key drivers) and assessing their uncertainty. Small working groups then elaborate possible future states for each of the selected key factors (about 10-12).

The interrelations of different future states of the key factors are examined in an implicit cross-impact (CI) analysis ((Weimer-Jehle 2006)). Combinations of future states considered most consistent and interesting are then selected to generate rough scenarios. The consistency of the combinations selected in the workshop can later be checked in a formal CI-analysis by quantifying the descriptions of the interrelations. In the workshop, small working groups elaborate rough scenarios by reflecting cause-effect-relationships between the key factors. The resulting scenarios are discussed with all participants and fleshed out further after the end of the workshop.

2) The assessment of *strategic alternatives* starts with an outline of potential innovative technological and organisational alternatives for the development of the sanitation system (e.g. decentralized anaerobic sewer systems, recycling of phosphate out of urine, minimization of micro pollutants, or a central management of small sewer units). These general system alternatives are characterised in terms of their features regarding the external developments sketched by the scenarios. In order to develop strategic options for the future, the robustness and flexibility of the alternatives for different scenarios are assessed in a multi-criteria analysis. Criteria of evaluation are e.g. the ability of the system alternative to respond to the challenges the regional sanitation system might face and the sustainability of the solution they offer to the problems in each of the scenarios. Finally, a consistent set of alternatives is selected as strategic options which are considered worth while to be further examined.

Steps towards an actual strategy development for the regional sanitation system are then carried out by the planning committee. Decision makers and planners discuss how to deal with the strategic options identified and decide about measures to be implemented in the short term, e.g. monitoring activities of external factors or further studies of the technological or organisational alternatives. The main goal is the identification of further steps to undertake in order to achieve a sustainable investment and innovation strategy for the regional sanitation system, to prepare for future risks and to benefit from possible opportunities.

Finally, the results of the workshops and strategy development have to be communicated to the workshop participants, and possibly also to a wider local and regional audience. Depending on the regional governance structure, different communication strategies may be relevant, e.g. workshops with representatives of local and cantonal (federal) administration and other relevant stakeholders, public hearings, flyers and other documentation.

Conclusions

The presented design of a participative foresight process is conceived as a means to open up the strategic space of infrastructure planning to a long-term regional perspective and to the potential of sustainable innovations. Participatory scenario development is useful to manage normative uncertainty as well as to reduce

informational uncertainty and to make it more transparent ((Newig, Pahl-Wostl et al. 2005)). The involvement of stakeholders allows for the mediation of different interests and structures the process of goal determination by developing joint visions of possible future developments (reduction of normative uncertainty). The elaborated scenarios work as an easily understandable, illustrative communication tool ((Miles 2002)) with policy makers and stakeholders (transparency of informative uncertainty). The experts of the regional sanitation system in the planning committee provide access to local knowledge and insights into the social system as well as information about the possible acceptance of alternatives (reduction of informational uncertainty).

With these benefits the RIF method tries to establish a framework for effective and efficient infrastructure solutions. The *ex ante* assessment approach includes the elaboration of the challenges for the future infrastructure system. Theses challenges are the assessment criteria for the solutions. Are they robust against diverse future challenges? Solutions facing these criteria are effective. By widening the scope of possible options, the more efficient solutions can be detected and chosen. Within the inert infrastructure system, efficiency is often close to flexibility of the solution: flexibility for varying waste water quantities and qualities. This means adaptive management of the resource 'infrastructure' for the settlements to guarantee the resource water for aquatic ecosystems and population.

The benefit of the foresight exercise does not only stem from the products developed (e.g. scenarios, strategic options), but as much from the participative process itself (i.e. mediation, networking, social learning). Recalling the aim of RIF, i.e. the facilitation of sustainable long-term planning in regional sanitation systems, the use of intuitive and discursive methods seems appropriate. They are intended to serve the purpose of the foresight exercises being first of all a learning process for the key decision makers and planners in sustainable infrastructure planning.

Project context

The 'Regional Infrastructure Foresight' (RIF) method is developed and tested in an interdisciplinary research project funded by the Swiss National Science Foundation (2005-2008). RIF exercises will be carried out in three cases of Swiss communities or sanitation organisations with typical problem profiles of the sanitation sector. The process is conducted by a small, interdisciplinary team of researchers: engineers and social scientists from Eawag, the Swiss Federal Institute of Aquatic Science and Technology and the Sustainability and Infrastructures Department at the Fraunhofer Institute for Systems and Innovation Research (FHG ISI, D). They prepare scientific inputs for the different steps (e.g. assessment of the given sanitation infrastructure, identification of drivers of change, actor analyses, evaluation of innovations) and moderate the interaction with the participants. After a an evaluation of the pilot projects, the procedure for RIF exercises will be put down in a handbook in order to allow a wide application of the method by engineering consultants, decision makers and planners.

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