Constructing sustainable water supply and sanitation services – what do future water engineers need to learn?

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Abstract

Sustainability of water supply and sanitation services is crucial for the sustainability of society. The aim of this paper is to explore how water sector experts construct and understand sustainable development, and what kind of learning needs are associated with it. The research is based on semi-structured interviews with eight Finnish experts of water and sanitation services.

Based on this research, it seems that the water sector experts construct sustainable development focusing mainly on the environmental aspects and technological fixes, and thus, the need and ability to enhance sustainability are perceived limited. However, when discussing more broadly about the future of water supply and sanitation services, it is obvious that the sector has a significant role and potential in a transition to a more sustainable society. To fulfil this potential it would be necessary to construct a more encompassing understanding of sustainable development. This would require learning for a more active role of the professionals and open dialogue and self-reflection about the role in society; i.e. what is the essence of sustainable water and sanitation services. The future water engineers need to have a better understanding of the 'bigger picture' including especially the social aspects of water supply and sanitation services.

1 Introduction

Water supply and sanitation services are one of the cornerstones of functioning societies. The provision of safe drinking water is essential to human health and well-being. Sanitation services play a central role not only in securing human health but also in enabling conglomerations of human settlement thrive without compromising the state of environment. In addition, water resources are directly or indirectly connected to economic activities, and food and energy production (see e.g. UNDP, 2006; Olsson, 2012). As water encompasses the three spheres of sustainable development, environment, economy and society, it can be considered a central issue in the quest for sustainable development.

In Finland, as in many other countries with high coverage of publicly provided water supply and sanitation services, these services are taken for granted and they are perceived to already have achieved sustainability. However, Blewitt (2008) and Newman (2005) remind that sustainable development is dynamic and complex in nature and thus, it is should be understood as an on-going process rather than a goal. In addition, the water sector is facing a multitude of challenges and new demands potentially compromising its sustainability (Mann & Runge, 2007). Perhaps even more importantly, sustainable development requires a constant re-evaluation of current practices and approaches (Juwana *et al.*, 2010).

The aim of this paper is to find out how water sector professionals construct and construe sustainability of water supply and sanitation services. As Hajer & Versteeg (2005) argue, sustainable development is a socially constructed and reconstructed concept. To better understand how sustainability is and could be managed one needs to first understand how the concept is construed and constructed. Based on this understanding, further aim of this paper is to discuss how engineering education in the water sector should be developed. As Gelb (2010) maintains, water sector professionals are essential in ensuring the sustainability of water supply and sanitation systems. Moreover, as Sterling (2001) reminds, what distinguishes a sustainable future from a chaotic future is learning. Thus, the focus is on learning and re-learning for sustainable water supply and sanitation services.

2 Research approach

The empirical part of this paper is based on semi-structured face-to-face interviews with eight Finnish water sector professionals. As the aim is to provide rich and contextual descriptions (Borrego *et al.*, 2009) of how sustainable development is constructed in water supply and sanitation services, the research approach chosen is a qualitative case study. The goal is not to generalise results quantitatively in global context. However, the empirical results are evaluated and discussed against literature in sustainable education and sustainable water services to assess their general relevance and allow the readers to reflect the transferability of the results into another context (Borrego *et al.*, 2009).

The face-to-face interviews were conducted in 2011 and analysed according to qualitative content analysis. The semi-structured interview technique was preferred as it provided structure, yet allowed flexibility in exploring themes also outside the original list of questions. This was perceived important to ensure that the research material would include a rich variety of

perspectives to sustainability in the water supply and sanitation services instead of a strong focus on the preconceived ideas of the author. The relatively small number of interviewees is explained by the aim to have a detailed analysis of the research material. The research design was dictated by trying to find balance between the versatility in the research material and the depth of the analysis of the material.

To ensure that the research material would represent a diversity of perspectives to sustainable development in water supply and sanitation, careful attention was paid to the backgrounds of the interviewees. Thus, the eight interviewees were selected according to purposeful sampling. They represent different organizations in the Finnish water sector: municipal water and wastewater utilities (three interviewees), co-operatively run water utility (one interviewee), state administration (one interviewee), regional administration (one interviewee), and civil society (two interviewees from associations working in the water sector). All interviewees work as water supply and sanitation experts. Some are in their early careers whereas others have more experience.

The interviews consisted of two major themes; sustainable development in the water sector (that is the focus of this paper) and careers and education in the water sector (see Takala, *in press*). However, the two themes overlapped in many cases and this paper will draw on both of these themes.

3 Sustainable development in water supply and sanitation services

This section will discuss how the interviewed water sector experts construct the sustainability of water supply and sanitation services. These constructions are analysed against the traditional division of sustainable development into environmental, social and economic aspects, although the problems of this division are acknowledged (e.g. Gough & Scott, 2007). At the end of the chapter, implications to engineering education are discussed.

These results and interpretations will be discussed utilising the direct quotations from the research material that have been translated by the author (interviews were in Finnish). This is to enable the reader to assess the reliability and credibility of the interpretations.

3.1 Environmental aspects

The majority of the experts interviewed initially perceive sustainable development mainly from the point of view of environmental issues; more specifically the consumption of energy and materials such as chemicals. As *Interviewee 1* puts it *"Of course, all things related to energy consumption"* and *interviewee 5* continues: *"First thing that comes to my mind is of course all questions related to materials. Chemicals, what kind of chemicals are used?"* So, the initial and self evident response is that sustainable development is about trying to limit the consumption of energy and chemicals.

Energy and material issues are associated with centralization of water supply and sanitation services. For example, *Interviewee 4* argues *"So, questioning this centralization. There is a lot of talk on these material flows that this centralization is causing. That we are transporting precipitation chemicals from far away… Transfer lines are also linked to centralization, they use energy and require maintenance."*. However, *Interviewee 6* points out that current situation with centralization in Finland is sustainable, as not much energy is needed for pumping due to geographical situation: *"But I think that water acquisition is on a rather sustainable basis, even*

though water is transferred somewhat long distances as it is usually from the interior to the coasts, so it is quite cheap as you don't need that much pumping."

Another aspect related to material use is durability. Sustainable development is seen to be linked to the long lifespan of water systems. *"When choosing materials, sustainable development is of course about using the best possible ones, so that you don't have to renew it next year. If you build a water treatment plant, and you need to renovate it in two years time and then again in four years, it is not sustainable development. You should do it properly and with high quality."* (*Intrerviewee 3*). *Interviewee 1* agrees and reminds that *"when building water supply and sanitation pipes, we are building them for long time periods, decades or even hundreds of years. So, we should try to remember at that point to try to make them as good as possible and not just stare at the price… You should use materials and methods that will last.*" And *Interviewee 7* continues *"Well, first thing that comes to my mind is the choice of materials, that you do not bury underground anything that you are not totally happy with or convinced about…we need to change thinking from fifty years to hundreds of years*".

In the Finnish language words sustainable and durable are both translated as the same term *kestävä*. So, in some cases sustainable development in Finland can be understood more concretely (as durability) than perhaps in other languages and cultures. This might explain why the material use is emphasized in the interviews. Then again, the mentality with high quality was not linked only to materials but basically all activities: *"All that we do, we do well."* (*Interviewee 1*).

However, continuous improvement of quality, i.e. quality of water, is also criticized. There is a tendency that the requirements for both quality of tap water and treated wastewater are tightening. "*It is not anymore according to sustainable development if we treat it to 100%, it consumes so much energy and chemicals*" (*Interviewee 6*). Also, *Interviewee 5 questions* the sensibility of "*improving water quality just by 0,01…you should think about what the actual value is*".

Even though the relevance of energy consumption is generally highlighted, one interviewee was of the opinion that the ultimate purpose of water supply and sanitation services should first be taken into account: *"When we talk about energy, we have to remember that we need to serve our customers. If we start to buy green energy, well, I don't know if we are serving our customers in the best possible way."* (*Interviewee 3*).

Also protecting water resources from pollution is considered an essential aspect of sustainable development in water supply and sanitation services. For example, according to Interviewee 3, "*in practice, from the point of view of a water utility, sustainable development is that you don't exhaust your fresh water resources, and that in any case you don't ruin them. You should not discharge treated wastewater so that it causes damage to the receiving waters. This is self-evident, but these are the starting points [of sustainable development].*" Furthermore, *Interviewee 6* links water protection with the consumptions of energy and chemicals: "*in water acquisition, we should do more to keep the water resources pure. If we can maintain the purity of water resources also in future, then it's sustainable development, as we don't need so much chemicals or energy in the water treatment process*".

Due to the emphasis on environmental aspects, most of the interviewees seem to feel that sustainable development is already taken into consideration in the water supply and sanitation services. After all, water supply and sanitation services originated in environmental health concerns, so taking care of the environment is self-evident. However, after some discussion, and

when the interviewees discuss more freely about the important questions in water supply and sanitation services, a more versatile idea of sustainable development is constructed. Furthermore, even the energy and material questions are discussed in a wider context, for example, linking them to the long lifespan of water or what the purpose of water supply and sanitation services actually is.

3.2 Social and economical aspects

In the interviews, economical aspects were discussed at many points. One key challenge of the water sector is considered to be balancing economy of water and wastewater utilities and the lacking economic competencies of water sector experts. However, for many interviewees, economy is not, as such, a perspective of sustainable development. Quite the contrary, sustainable development is in many cases, e.g. in the use of high quality materials, considered to contradict economical aspects. For example, from general sustainability perspectives it might be considered desirable to limit water consumption, however, as *Interviewee 1* describes partly joking, "*we in Finland don't have problems [with the quantity of water], we cannot help if in Ethiopia or elsewhere they don't have water… besides, it is better for us water utilities the more water we sell, haha*".

If one is to understand sustainable development as sustaining the water supply and sanitation services in the long run, then it would be justifiable to include also economic aspects. This is also supported by the fact that the interviewees talk about economy in relation to the *reliability of services*, their *vulnerability* and their *tolerability to risk*. As mentioned earlier, centralization is discussed in somewhat negative terms in association with energy and material consumption. However, in relation to economics centralization is mainly discussed more positively. It is maintained that development into bigger unit sizes would mean more resources and better capability to respond to challenges. Especially consolidation of water utilities is seen to minimize overlaps and this way make activities more efficient. More resources would provide better possibilities to develop services systematically. Then again, some of the interviewees feel that one should take into account the fact that bigger is not automatically better, but that we should aspire for a suitable size taking into consideration the context (see also van Vliet *et al*., 2005; Werbeloff & Brown, 2011). According to *Interviewee 1*, a water utility should be "*suitably small, so that when you are making decisions... it is flexible*." In addition, the same interviewee maintains that a suitably small utility is more efficient, as it is easier to manage the entity.

When asking about sustainable development in water supply and sanitation services, one interviewee mentions the staff in addition to the self-evident energy and material questions. According to *Interviewee 7*, one central question about sustainability is how to motivate the staff and get them to comprehend the significance of their work. Furthermore, it would be vital to have "*some kind of urge to learn and think if things could be done in a better way, of course taking also into account the environmental values*." Similar issues were discussed also in other interviews but they were not explicitly linked to sustainable development but to building of professional pride and sense of professional responsibility.

Discussing professional pride and responsibility raised the wider social aspects of water supply and sanitation services. As *Interviewee 3* points, in relation to energy issues "*we have to remember that we need to serve our customers"*. One needs to take into consideration the ultimate purpose of water supply and sanitation services. Social considerations are not merely limited to the staff or customers but include wider society and citizens: "*I feel perhaps kind of*

social responsibility. Am I taking society into right direction?" (*Interviewee4*). *Interviewee 3* continues describing that in the water supply and sanitation sector, "*you can have a concrete impact on things, you can guide and develop things, help citizens in your municipality*."

3.3 Learning for sustainable water supply and sanitation services

The interviewees mainly construct sustainability of water supply and sanitation services through environmental issues. These aspects were also considered to be already in order. Thus, not many learning needs are related to e.g. material and energy flows and these are can be perceived to be already incorporated into the engineering education of water sector experts. However, when taking into consideration all the aspects related to material and energy flows (durability, lifetime, quality, the actual purpose of water services) it can be argued that a key learning need is holistic understanding or systemic view of the whole water supply and sanitation system, and systems interconnected to it (see Grigg, 2008). Also, a more encompassing understanding of sustainable development showing how the economical, social and environmental aspects are multi-faceted and inter-related, would be important (Grigg, 2011). This would help to reach sustainable overall solutions instead of partial solutions, e.g. of improving water quality with no significant impacts to environmental or human health but increasing energy and chemical consumption significantly.

Interviewee 3 discusses the current education of water sector engineers: *"It is so easy to teach and learn through numbers. In engineering world they work well, and you can argue for things by showing that these are more expensive or that purification results are in percents this much higher or lower. But when you have to think about the general acceptability and reliability of services, and when you have to interact with the staff, citizens, customers and the political world, well, then this is quite a complex entity, where everything needs to be taken into consideration*." This does not imply that one person should be expert in everything but emphasis is on sharing expertise across domains and also with the wider population (Hurley *et al*., 2008; Takala, in press). This is about communication and interaction skills and the attitude to be willing to share expertise. Furthermore, it is about recognizing your own role in society and appreciating others (Takala & Korhonen-Yrjänheikki, 2011).

Engineering education in the water supply and sanitation services sector should take into account social aspects instead of focusing merely on technical solutions. This could help change the technocratic culture of water sector (Werbeloff & Brown, 2011), and also respond to the necessity raised by interviewees to build a stronger sense of professional pride and responsibility. For example, the ultimate purpose of water supply and sanitation services should be discussed in engineering education; to analyze the nature of these services and what is to be achieved through these services and how are they linked to other services and social structures in general (van Vliet *et al.*, 2005).

Despite the impressive track record of water utilities in improving environmental health, it is debatable if environmental issues are adequately acknowledged in the water sector (see Conrad *et al.*, 2010 and Olsson, 2012 for an assessment of energy issues). Environmental issues are, in addition, considered from a rather narrow and engineering-centred point of view. As van Vliet *et al*. (2005) argue, the focus tends to be on resources rather than services, and thus, contemporary conventions and standards are not questioned. Palme (2010), moreover, calls for critically examining the existing water supply and sanitation systems, from the point of view of recycling nutrients or responding to the challenges of climate change. Even if environmental aspects would be acknowledged sufficiently at the moment, one of the basic principles of

sustainable development is to constantly review and re-examine one's own approaches (Juwana *et al.* 2010). This would require the skills and mentality of lifelong learning.

The interviewees mention the quality aspect of water supply and sanitation services: *"All that we do, we do well."* (*Interviewee 1*). This is similar to one of the Royal Academy of Engineering's guiding principles for sustainable development: "Do things right, having decided on the right thing to do." (Dodds & Venables, 2005). Again, it is vital to understand the purpose of the service to be able to do it well or right. Furthermore, providing high quality service can help to build professional pride and responsibility, but also vice versa, without the right attitude there will be lack of motivation to do things as well as possible.

Long-term thinking or long view is inherent to both sustainable development and water supply and sanitation services. It shows also in the way the interviewees talk about sustainable development. Thus, one could assume it is already present in engineering education. However, as Beck (2011) argues, long view must be central in our thinking, and thus, it cannot be exaggerated.

4 Conclusions and recommendations

The interviewed Finnish water experts construct sustainable water supply and sanitation services in a somewhat narrow way focusing mainly on environmental issues and technical fixes. Furthermore, they hold their view of sustainability as something self-evident as manifested by the frequent use of term "of course". This can be problematic as it can block the learning process and re-evaluation of current practices that are essential to sustainable development (Blewitt, 2008). Furthermore, this kind of a narrow construction of sustainable development can induce a sense of limited leverage in society and in a transition to more sustainable practices.

When the interviewees discuss more freely about important aspects of water supply and sanitation services, the social and economical aspects are highlighted. To take these better into account, a more active role of the water professionals, open dialogue with society, and self-reflection about their role in society is required; i.e. one needs to think about the essence of sustainable water and sanitation services. These seem to be the main areas in need of development in engineering education. Constructing a more encompassing understanding of sustainable development through education could also help to build professional pride which seems to be a key question in the quality of water supply and sanitation services (see also Wals, 2006).

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