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Sanitation under challenge: contributions from the social sciences

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Abstract

This paper reviews the contribution the social sciences can make to the challenge of providing access to sustainable sanitation services and infrastructures for billions of people, in both the over- and underdeveloped parts of the world. The paper reviews and discusses three particular social scientific topics relevant for the sanitation challenge: the nature of socio-technical change, the issue of multilevel governance, and the role of the citizen-consumer. It is argued that sanitation is as much a social as it is a technical issue, and that the role of social scientific knowledge needs to be strengthened and given more attention in this context. The key contribution from the social sciences is to be found in its capacity to help widen the narrow, technical definitions of sanitation by including actors and their needs and belief systems, and by highlighting the alternative socio-technical tools and governance arrangements that are instrumental in moving beyond some of the dead-end roads of traditional water engineering and sanitation provision.

Keywords: End-users; Governance; Modernized mixtures; Sanitation; Social sciences; Socio-technical change

1. Introduction

Although sanitation has for long been the domain of health workers and water engineers, there are many social scientific questions to be resolved around sanitation. Such questions typically refer to the interfaces between consumers and providers of sanitation services, and between consumers and providers on the one hand and sanitation infrastructures and devices on the other. This paper aims to review recent social scientific literature in the fields of science and technology studies, environmental governance and sustainable consumption, to formulate the relevant social scientific questions and possible answers for the sanitation challenges in the world today. More specifically, we provide insights into how and to what extent social actors and their needs could impact on technological routes to choose, on how to govern sanitation systems and innovations therein and, lastly, how to bring back an end-user perspective into the analysis of the abstract expert system of sanitation provision.

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Before elaborating on the social sciences and sanitation, we first want to define what sanitation is about. For environmental health workers and water engineers, the following definition might have worked for a long time, with the first part satisfying health workers, the latter part the engineers: '*Sanitation is the process of keeping places clean and hygienic, especially by providing a sewage system and a clean water supply*' (Collins, 1995).

Indeed, providing a sewage system and clean water supply has been the dominant technological paradigm for over a century. A growing number of environmental engineers is, however, convinced that sanitation is more than just providing sewage and clean water, because sanitation concerns all water, energy and nutrient cycles and the technology to facilitate the transport, processing and reusing of flows (Zeeman, 2009). From a social perspective, such a definition is also unsatisfactory as it leaves us with questions of how innovations in sanitation systems evolve, how sanitation systems can be governed and how stakeholders along the sanitation chain, but especially at the extreme ends of the chain (e.g. farmers, householders) can be involved in sanitation innovations. Compared to the vast bodies of engineering and public health literature, sanitation has so far only scarcely been addressed from such a social scientific perspective. Historians have done their job in describing and explaining the emergence of toilet and sewage systems (Van Zon, 1986; Melosi, 2000) in Western societies. There are a few accounts of the social–cultural meaning of toilets (Gastelaars, 1996; Black & Fawcett, 2008) while, in the field of Science and Technology Studies, the study of water supply or water management technologies (Chappells & Medd, 2008; Medd & Marvin, 2008; de Graaf, 2009) by far outnumber the few on waste water and sanitation technology (Moss, 2000; Van Vliet, 2006; Hegger *et al*., 2007).

The failures of a narrowly defined engineering approach have come to the foreground everywhere around the globe, but especially in less developed countries. Once sewer systems have been rolled out in ways familiar to the developed world and sunk costs have been made, deviations from such centralized sanitation routes are hard to achieve. Such path dependencies also obstruct innovative routes to be taken. In many African cities, the heritage of a colonial sewer system is still limiting the innovation paths for wiser, more flexible sanitation options for the urban poor, even in cities where sewer connections exist for only a few percent of the city population (Nilsson, 2006). On the other hand, proponents of alternative sanitation solutions like 'eco-sanitation' or 'decentralized sanitation and reuse' show a tendency to develop belief systems that do not allow for large-scale technological routes, or possible combinations between on-site systems with the much disputed large technical sewage systems.

Apart from considering the newly developing engineering approaches to sanitation, we also observe significant shifts in the governance of sanitation service provision. Municipal or state organizations that for decades have had a monopoly in providing water and sewer services, have started to dissolve and give way to various forms of private participation in sanitation service provision. This is a worldwide phenomenon. Private participation means the involvement of the 'private sector' at all scales: from multinational utility companies to small local firms, as well as local associations of the ultimate users of sanitation services. Such differentiation in provisioning actors gives way to a range of new sanitation services to be tested and implemented. Decision making on sanitation is increasingly opened up, and the development paths are no longer being outlined beforehand. New arrangements are being developed that enable decision making on sanitation by a much wider range of actors than by state-actors only, and at multiple levels of governance.

Lastly, sanitation is a crucial but mostly hidden aspect of everyday life and consumption. While the largely unknown 'black box' of other infrastructure-related consumption (water, domestic waste, energy, transport) has been opened up slowly (Shove, 1997, 2003; Southerton *et al*., 2004) this has not been the

case for sanitation, until recently (Hegger, 2007). World wide, toilets and sanitary practices are sealed-off from society and culturally loaded with notions of dirt, shame and waste. Yet providing toilets is presented as the key to realizing the Millennium Development Goals and improving the living conditions of billions of people. In the developed world, flush toilets represent one of the biggest shares of domestic water usage and waste water production[1]. If this environmental burden is ever to be diverted in a more sustainable direction, we need to understand how standards of cleanliness, convenience and hygiene have been constructed over time and what strategies are needed to initiate a trend in other directions.

This paper is organised as follows. In the next section, we set the scene by elaborating on the challenges that both the developed as well as the developing world are facing in terms of sanitation, and thereby introduce the three social scientific issues addressed in the rest of the paper. The first issue, addressed in Section 3, is the interface between sanitation technology and society; then sanitation governance is discussed (Section 4) and, finally, the role of citizen-consumers in sanitation development (Section 5). We conclude our review of social scientific sanitation literature in Section 6 by summarizing the key social scientific approaches towards the sanitation challenge and the significance of an end-user perspective on sanitation innovations.

2. Sanitation under challenge

There is no doubt that meeting the UN Millennium Development Goal (MDG) of halving, by 2015, the proportion of people without sustainable access to safe drinking water and improved sanitation facilities (WHO & UNICEF, 2008) can be called a challenge. The challenge is even bigger when we also consider those parts of the world that have access to drinking water and sanitation, but where sanitation systems need to be modernized to make them more sustainable.

But where do we start? A great deal of research on innovation in sanitation is built around pilot projects in which new technologies are being tested (Hegger *et al*., 2007). In many cases, they do no more than just that: testing the technological feasibility of a new toilet or treatment unit. As we will argue later in this paper, a wider set of criteria, rather than technical criteria only, needs to be applied to assess the feasibility of new sanitation technologies. Increasingly, other kinds of testing are being introduced at pilot projects, with the evaluation of: consumer responses, various decision-making procedures, the willingness of chain actors (such as waste water managers, sewer authorities and farmers) to reuse waste waters, urine or other products derived from new sanitation technologies. Not surprisingly, strategic niche management (Schot & Geels, 2008) and transition management (Van Der Brugge, 2005; Van Vliet, 2006) approaches have been favored by social scientists to study technological pilots in water management and sanitation. Such approaches offer the tools to study processes of social and institutional learning, or the formation of new sanitation regimes in Western countries.

Following the MDG set for the developing world, the sanitation challenge is to provide improved sanitation services to the poor and the very poor, without compromising on sustainability. New configurations of employing the best practices of sanitation technology and management for rural and

[1] In the Netherlands in 2007, of a total tap water consumption of 127.5 L per person per day, 37.1 L was used for toilet flushing (VEWIN, 2008).

urban contexts need to be explored and evaluated. Also in this area, it has been suggested (Black & Fawcett, 2008; Kar & Chambers, 2008; Van Vliet *et al*., 2010) that a breakthrough is needed in decision making about sanitation, be it of a different kind and at a different level when compared to the developed world. In the absence or at least severe shortage of water and sanitation infrastructures that would create lock-in for certain technologies, the options for social and technological models of sanitation appear to be incredibly wide. But in fact, the choice is restricted by lack of funding, political commitment and, above all, by a lack of imagination. Often, models of conventional sanitation are being portrayed, with a sewage system and flush toilets, as an ultimate stage in a process of modernization. Or, alternatively, eco-sanitation options are envisaged that are hardly affordable or unacceptable for the large groups of users addressed (Mara, 2008).

In finding solutions for the challenges of sanitation provision for all, many engineers and development workers tend to focus on the diverse toilet and treatment systems of human waste (Tilley *et al*., 2008; GTZ, 2009). Toilets are a focal point as they are a node in the sanitation chain, and they embody the relation between users and sanitation service providers. But providing sanitation is more than just providing toilets or treatment systems. How toilet waste is to be transported and treated (and by whom), or how and by whom flows of treated waste water or the products of urine separating toilets should be reused, are in many cases rather vaguely presented and hardly being tested. In both the developing and the developed world, engineers are still dominating the issue of sanitation service provision, resulting in a technical and infrastructural bias to an issue that is as social as it is a technological one.

We argue that solving the sanitation challenges both in the developed and developing world would gain from widening the mere technical perspective with a social one. This would preferably lead to a widening of conventional technical experimentation with different technological and managerial scales and modes of provision, to new ways of decision making and sanitation governance, including the inclusion of end-users' perspectives in sanitation management.

3. Socio-technical dimensions of the sanitation challenge

There is a growing consensus among sanitation scholars and practitioners that focusing on small, appropriate technologies on the one hand or modern, advanced technologies on the other will not bring us much further towards sustainable sanitation. Even more so, focusing on technology or infrastructure (small or large) alone in meeting the sanitation challenges has proved to be a dead-end road. Many of the so called 'failed technologies' in sanitation were not failures because of technical deficiencies but because of their misfit in terms of scale, or the social, geographical, cultural or economic contexts in which they were implemented. Two examples of such 'failed technologies' from the developing and the developed world may illustrate this.

An Agenda 21 project in Jinja, Uganda[2] built community latrines with a digester producing biogas as an energy source for domestic cooking and lighting (UN-Habitat, 2002). Organic waste digestion and biogas production is proven and relatively simple technology and the need for alternative energy sources for the community was evident. Yet the project failed soon after its start in 2001: households complained about malodors and were said to be reluctant to use their own human waste for cooking, and

[2] Site visit, 22 February 2005, to Jinja by author for Environmental Management Capacity Building in Uganda (EMCABU) project, coordinated by NEMA (Uganda) and Wageningen University (The Netherlands).

eventually someone removed the pipes. The projects' failure can hardly be attributed to the hardware itself; rather the explanation for failure needs to be sought in the way it was implemented, and the social and cultural conditions under which that happened.

To show that such an example is not typical for developing countries, a similar story can be told for the attempts in 2002 to install a vacuum transport and anaerobic treatment system for toilet and kitchen waste in a new residential site in the city of Wageningen, the Netherlands. Parts of the proposed system had been successfully applied in other settings (vacuum toilets in trains and aircraft, anaerobic treatment in industry), yet this would have been the first application of such technology in a domestic urban setting. In discussions among the actors of the project group, it became apparent that both the municipality and the project developers acted as spokesmen for the still unknown residents. They were the first to object to experiments that might affect either the price or the attractiveness of the apartments to the potential buyers, or both. The municipality, although committed to the execution of the project, felt responsible for the well-being of its (future) citizens, as well as for the proper management of the whole system. At the start of the project, many aspects of the experiment with vacuum toilets and anaerobic treatment systems were still unresolved, from seemingly trivial issues like the shape and color of toilets to more crucial aspects of management and transfer of the technology after the experiment came to an end. Both the municipality and the project developers decided in 2003 to withdraw, causing the project to fail even before the technology could be installed (Van Vliet, 2006). Again, explanations for this failure should be sought in the social and cultural conditions under which the project was launched, and misfits with existing social–technical regimes of housing and wastewater management, rather than in the hardware itself.

It seems therefore wiser to assess sanitation solutions with a wider set of technical, social and economic criteria. A promising road that has been explored in recent sanitation research in both the developed (European) as well as the developing world (East Africa) is the 'modernized mixture' approach (Hegger, 2007; Van Vliet *et al.*, 2010). Modernized mixtures have been defined as 'those late modern socio-technical configurations of wastewater infrastructures in which various features of simple modern systems have been deliberately and reflexively reconstructed to deal with contemporary social, economic and environmental challenges' (Hegger, 2007, p. 48). Their variable set includes the scale of technology, the level of consumer involvement, a central or decentralized organization, and the separation or combination of incoming or outgoing water flows. These variables can represented in a diagram (see Figure 1).

Three main clusters of variables can be made to categorize sanitation systems:

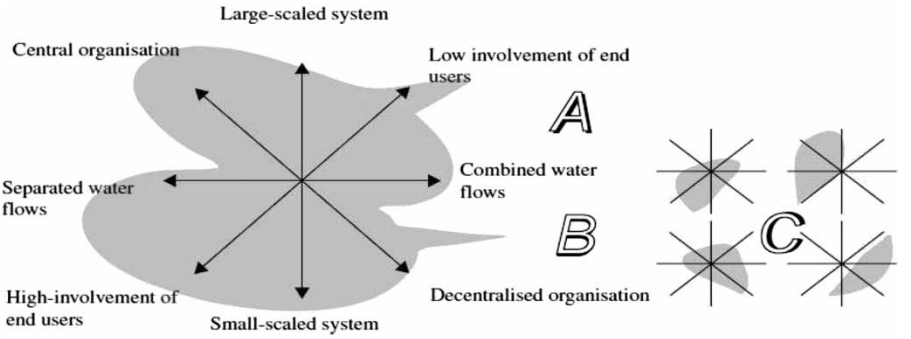

Fig. 1. Small- and large-scale sanitation provisions and modernized mixtures.

- (A) conventional systems are found in the clustering of values at the top of the diagram: central organization, large-scaled systems and low user involvement;
- (B) alternative systems are to be found at the opposite end of the diagram: small-scale systems, responsible users, de-centralized organization;
- (C) various combinations of social and technical variables make up 'modernized mixtures'.

Conventional sanitation systems (A) are centralized systems designed for the treatment of single water flows. Large-scale sewer systems that collect all water flows are the extreme example of this category. The end-user involvement in these systems is low. The category of alternative systems (B) has, since the early 1970s, been propagated and developed by supporters (consumers, technicians, philosophers and environmentalists) of Schumacher's 'small is beautiful' thesis (Schumacher, 1973). The idea is that not only the hardware of sanitation systems should be of a small, 'human' size, but rather that the social organization around the design, implementation, use and maintenance should also be kept as small or local as possible to secure democratic control by the users of such systems. Besides, it is believed that such small systems are the most environmentally sound. Examples within such an alternative category are 'stand-alone' systems that do not need a connection to larger infrastructures, such as composting toilets, rainwater recycling systems, and reed-bed filters for waste water.

The category of 'modernized mixtures' (C) encompasses various score sets on the four variables mentioned. Possible examples include centrally managed vacuum systems at the scale of a residential area with a high separation of flows and low consumer involvement; or small-scale but sewer-connected water systems that are based on dual water flows and high consumer involvement. As these examples illustrate, we are dealing here not only with a mixture of 'conventional' and 'alternative' technological aspects but also with a mixture of social and institutional elements. The modernized mixtures bring together social and technical elements that used to be strictly separated and organized into ideological debates between the opponents and defenders of conventional, centralized and complex large technical systems. In case studies of sanitation projects in which a modernized mixture approach was utilized (Hegger, 2007; Okot-Okumu & Oosterveer, 2010), the process of initiation, development and implementation of the new technology was closely monitored and the views of providers (technology developers, municipalities, utilities, water managers) about possible routes of diffusion and the role of end users was assessed. In addition, particular emphasis was placed on evaluation of the involvement of end users in design, diffusion, use and management, and the consequences of these changes for current practices and standards of convenience, cleanliness, comfort (Shove, 2003) and health that people tend to uphold. In this way Hegger (2007) explored innovative sanitation projects in Germany, Sweden and the Netherlands and showed that the two major routes for implementation (citizen–consumer driven and provider driven projects) can both be successful if due attention is given to end-users' needs for accessible information, transparency of costs, technological choices, monitoring and maintenance schemes. Letema *et al.* (2010) used the modernized mixture approach to assess the potential of satellite sewer systems in Kampala (Uganda) and Kisumu (Kenya) that could be promising alternatives to both unfeasible central sewer systems or individual pit latrines, given the local geographical and socio-economic circumstances.

The modernized mixture approach does not point at a particular definitive socio-technical configuration, but rather offers a tool box for the assessment of socio-technical innovation in sanitation. It incorporates local social, economic and geographical conditions to assess whether small- or large-scale technologies and management models would result in a best fit. As such, the approach helps in

decision making on various socio-technical sanitation options beyond the standard models of sewer or on-site sanitation techniques, which is the topic of the next section on sanitation governance.

4. Governance of sanitation

For decades, the prevailing mode of sanitation provision in developed regions has been to install water flush toilets connected to sewer pipes or septic tanks. Such icons of 'improved sanitation systems' have a penetration up to 99% in developed regions of the world. Everywhere else, such modes of sanitation provision have not been available, nor affordable or successful. The universal mode of provision in developing regions is local provision of mostly unimproved or shared latrines (24% in 2006), or no provision at all, leading to open defecation (23% in 2006) (WHO & UNICEF, 2008). Both the centralized and localized modes of provision are still dominant and have caused lock-in effects that have so far not been overcome. However, wider changes in the world of utility service provision have created windows of opportunity for new socio-technical configurations in both the developing and the developed world. Universal modes of provision of utility services, characterized by central and state-led investments in big infrastructure systems with the aim to provide all with the same services have made room market-based modes of provision by private parties, who differentiate products and services according to demand, rather than to supply (Van Vliet *et al*., 2005). This stronger strategic orientation of producers towards the demand side (consumers) has been called a 'consumerist turn' (Featherstone, 1991). This opens up possibilities for socio-technical solutions different from the centralized universal systems known from the past. The question here is how to enable innovation after the consumerist turn, and how to govern the new sanitation systems implemented?

A number of scholars (Seghezzo, 2004; Tilley *et al*., 2010; Van Buuren & Hendriksen, 2010) have dealt with the question of innovation in sanitation by designing tools for multi-actor and multi-criteria decision making. When designing new systems, making decisions on existing infrastructure and implementing them, a vast range of criteria and factors should be taken into consideration. These criteria have to be known and used by engineers, policy makers, housing corporations, water boards, farmers and end-users at specific moments in the process. Universal tool boxes do not exist, but some common building stones for decision-making processes have been proposed. First, recent efforts to describe, classify and assess the feasibility of diverse sanitation options (Tilley *et al*., 2008) provide the needed inputs to decide on the very diverse sanitation options along the waste water chain. Second, decision-making procedures based on multi-criteria decision making (Hammond *et al*., 1999; Lahdelma *et al*., 2000) have been proposed and tested for sanitation and drainage by, among others, Seghezzo (2004) and Van Buuren & Hendriksen (2010). Their method supports decisions about drainage and sanitation systems based on multi-criteria decision analysis in combination with stakeholder dialogues. Such participatory methodology brings about 'a learning process in which experts and non-experts are enabled to connect local experience with systemic knowledge, in order to generate, assess and select sustainable … sanitation solutions' (Van Buuren & Hendriksen, 2010, p. 87). Finally, principles of supply chain management (Mentzer *et al*., 2001; Peterson *et al*., 2001) have been proposed to acknowledge the many different interests among various actors, including consumers and farmers (Evers *et al*., 2010).

Another aspect of the governance of sanitation deserves further attention here: financing. This involves different activities, mechanisms and actors at various stages, for collection, transport, treatment and reuse. Each of these stages can be financed in different ways. Furthermore, the process of developing, implementing and maintaining sanitary facilities includes a host of other categories of expenses,

such as feasibility studies, training, promotion and coordination, which all have to be taken into account (Toubkiss, 2010). Wastewater and sanitation services have been considered universal, public utility services, and the need for cost recovery has rarely been prioritized. In the developed world, sewer services and wastewater treatment is paid for either through local taxes based on household size or size of houses (e.g. The Netherlands) or through the drinking water bill (e.g. Germany). In the developing world, a new approach has to be taken as cost recovery mechanisms are generally insufficient. Public provision of sewer services has been a failure, as operational costs and costs for maintenance are mostly not included in the initial donor funding that led to the rolling out of sewer systems in the first place. Sewer services are only partly paid for and generally borne by the relatively small middle and high income groups only. Sustainable planning of sewer extensions, satellite sewers for housing estates and community on-site sanitation systems in lower income areas should ideally include locally based cost recovery mechanisms for operation and maintenance, in which the end-users directly pay their share. This is certainly not the case in most of the cities in the developing world but signs of change can be noticed: in 2006, the National Water and Sewerage Corporation in Uganda charged 7.4% of the water bill (up to 1500 m^3 per year) to consumers who were connected to sewer lines, mostly middle and high income groups (Uganda Government, 2006). Even in the lowest income areas, evidence shows that people can be made aware and willing to pay a small charge for using safe, clean, supervised toilets in the area. Residents in the major slum of Kibera, Nairobi, pay a 2 Kenyan shilling (0.024 US$) fee for the use of latrines and washing facilities in a supervised shared latrine building (a 'sanitation tower') based on a bio-digestion dome (SIDA, 2010).

Of course, the governance of sanitation and waste water infrastructure entails much more than stakeholder participation in sanitation technology assessment and innovation, and the financing of sanitation infrastructures and services. In the case of sanitation governance, as in all scholarly debates about governance, the role of the state is a central point of discussion. This is particularly the case in developing countries where the idea of a minimal state with privatized public services is increasingly challenged, as this model seems unable to deliver effective sanitation systems, particularly for the poor. Oosterveer (2009) suggests that, at least for East Africa, two alternative views on the role of the state can be identified, the 'neo-developmental state' on the one hand, and the 'network state' on the other. The notion of a neo-developmental state underlines the continued need for an active role for governments in promoting development and in securing adequate service provision for the poor. The opposite view of a network state acknowledges the limitations of a state's role in the contemporary globalised world, and suggests the further involvement of other actors in society in the governance of urban environmental infrastructures. In this latter case, government takes up the role of facilitator rather than implementer in sanitation services, as would be the case in the first perspective. A neo-developmental state needs substantial planning, implementation and monitoring capacities to secure effective management of sanitation services but this requires considerable financial and human resources that are not always available. A network state focuses on the engagement of different government institutions in collaboration with NGOs, private companies and other civil structures to design, implement and manage sanitation services. In this respect, the main challenge is how to coordinate the different actors involved, as this form of governance is institutionally weak. Moreover, the legitimacy of the different actors (notably private companies and NGOs) involved in governance networks can be more easily challenged than is the case for state-based arrangements. Nevertheless, their flexibility provides better opportunities for network-based forms of governance to include stakeholder participation and to provide for solutions that better fit the local conditions.

5. End-user perspectives

The third and last theme in our discussion of social scientific perspectives on sanitation deals with the inclusion of the end-user as a knowledgeable agent in sanitation technology development and sanitation governance. Sanitation has long been the domain of mostly governmental health and environmental engineers and water service providers. In technical accounts of waste water systems, household consumers or end-users of sanitation services have been included as 'connections', the 'demand side' or other (from a sociological perspective) meaningless terms. Yet, reviewing contemporary sanitation projects in developing as well as developed countries, the end-user has certainly gained recognition. First, because it became apparent that certain new (and apparently well-designed) sanitation technologies failed in the implementation phase because they did not fit to the standards of comfort that users uphold, or were incompatible with cultural beliefs or religious codes. Eco-Toilet systems without a water supply have been denounced by many consumers because of religious codes demanding water for bodily cleansing, while the requirement for men to sit down while urinating, in the case of urine separation toilets, is likely to be ignored by a large segment of male users. So for pragmatic reasons only, end-users perspectives and expected behaviors should be taken on board early in the design phase of new sanitation systems. This would lead to adapted designs, better configured to the specific needs of the envisaged end-users.

The literature on the role of end-users in transitions towards sustainability argues that it is crucial to find adequate links between sustainable solutions and end-users' socio-cultural concerns and standards (Shove, 2003). This entails more than merely creating acceptance of sustainable solutions, or conquering the social and institutional barriers against sustainable transformations. End-users of sustainable solutions should be seen not as barriers but as potential driving forces for transitions towards sustainability (Spaargaren *et al.*, 2007). Domestic end-users in both developed as well as in developing countries can turn out to be important co-producers of change in sanitation if they are taken seriously as system users, and invited to rethink sanitation practices and to redefine their relationships to both 'neighbours' and 'nature' in experiments with new sanitation systems. The principle behind the successful community-led total sanitation approach, as a means to ending open defecation in developing countries, is to create awareness in the community and have end-users design, build and operate their own sanitation systems to end open defecation practices in the villages at stake (Kar & Chambers, 2008; Sah & Negussie, 2009). But also in the developed world, taking on board end-user perspectives in the planning, design and operation of pilot projects for new sanitation has proved to be a crucial success factor (Van Vliet & Stein, 2004; Marks, 2006; Van Vliet, 2006; Hegger *et al.*, 2007; Van Timmeren, 2008). Levels of consumer participation in experimenting with or implementing new sanitation systems may differ widely around the globe, but it is fair to conclude that context specific socio-cultural concerns and standards of comfort, hygiene and cleanliness that end-users uphold are major factors that must be dealt with for a successful implementation. The need to take on board end-user perspectives in sanitation development, and to take them seriously in the design and operation of new sanitation systems, is a lesson that should therefore be internalised by any environmental health or sanitation practitioner.

But it is not only for the enhancement of consumer acceptance that a plea can be made to include an end-user perspective in sanitation development. The call to emphasize consumers in sanitation is also emerging as part of a wider 'consumerist turn' that can be observed in modern systems of production and consumption, including infrastructures (Van Vliet *et al.*, 2005). Infrastructures have, from the date of their establishment to the end of the 20th Century, gradually turned into 'abstract' systems which have become invisible to their end-users. And since invisible also means out of sight and unknown, a divide

has grown between the experts in systems of provision and their domestic end-users. Such a divide has become problematic for various reasons: on the one hand unawareness may lead to inefficient, irresponsible behavior by end-users while, on the other hand, consumer preferences and lifestyles are misinterpreted or trivialized by providers, with inefficiencies in service provision as a result.

To overcome this divide, attempts have been made since the 1980s to make water and energy infrastructures visible or tangible again to their end-users. It has been assumed that increased visibility of water and energy resources and their infrastructures would lead to a better understanding of why and how these systems are designed, operated and maintained. From this increased understanding, a more rational resource use from the side of the end-user was expected to emerge. As well as systems becoming more visible to end-users, the end-users also became more visible to providers by means of smart metering systems, client desks, client panels and regular focus groups and surveys. What exactly becomes visible and to whom is, of course, a question that deserves a critical review (see Shove, 1997; Marvin *et al*., 1999) but the trend is undoubtedly that, for consumers and providers alike, the black boxes of abstract utility systems and household consumption, respectively, are being opened.

While in general the re-sensitizing of infrastructures of consumption is judged to be a positive phenomenon, sanitation infrastructures present a different case in this respect. This is because re-sensitization seems detrimental to the design principles of sanitation systems. Unlike any other urban infrastructural system, sanitation systems have been designed to avoid contact with humans and to diminish the sensory experiences of sight, touch and smell. Hence, starting to use the nose and the eyes again would clash with deeply rooted social–cultural norms, and with the practices of avoidance of smell and contamination with pathogens.

Thus, waste water infrastructures in some respects present the exception to the re-sensitization trend within urban infrastructures. This does not imply, however, that the ‘senses’ should be kept out of sanitation at all times and in all respects. From an analysis of sanitation innovations in Europe (Van Vliet & Spaargaren, 2010) we could conclude that, there also, the ‘senses’ are re-entering the scene, though in different ways and for different reasons compared to other infrastructures of consumption. For example, in sanitation projects, the emphasis is on the public display of infrastructures and flows, mainly to demonstrate that efforts have been made to make sanitation more sustainable, while in other infrastructures private practices of energy and water consumption are much more often displayed for reasons of rational resource use or social distinction.

6. Conclusions

This paper has addressed the questions of what is ‘social’ about sanitation and what answers can the social sciences provide to meet the challenges sanitation is facing? The easy answer to the first question would be ‘everything’. The main assumptions of Science and Technology Studies hold that sanitation systems and technologies (as with all technologies) are inherently socially constructed, mediated, utilized or dismissed. Nevertheless, and to present social scientific perspectives and answers to the sanitation challenge, we have discussed three categories of social studies that cover scholarly debates as well as the multiple scales and levels of sanitation. The first category is closest to technology and engineering of new sanitation systems and covers socio-technical debates of small versus large, and decentralized and centralized provision of sanitation services. A proposed modernized mixture approach

to such a debate includes social criteria next to technical criteria, such as the level of user involvement and scale of management in assessing existing or designing new sanitation systems. Adopting such an approach would help to define locally adapted, flexible and socially more embedded sanitation solutions, both in developing as well as developed countries.

The second category of social studies concerns the governance of sanitation and innovations therein. Decision-making tools based on a display of a wide variety of sanitation options, and multi-criteria analysis may help make informed, multi-stakeholder-based decisions rather than traditional engineering decisions based on existing infrastructural or institutional lay-outs and cost recovery mechanisms. It is argued that sanitation governance could benefit from insights from supply chain management to cover the diverse interests, stakeholders and technologies along the chain from waste production to the re-use of water and nutrients in industry and agriculture. In this respect the role of the state in sanitation provision also needs a further assessment, as it is no longer obvious that the state is the single provider of sanitation services. We defined two alternative views of the role of the state that better cover the current governance of sanitation in the developing world: the neo-developmental state and the network state. The emergence of both forms can be observed (in East Africa at least) but the latter provides better opportunities to include stakeholder participation and locally embedded sanitation solutions.

Finally, we discussed the category of social studies concerning consumption and end-user perspectives on sanitation services. Socio-culturally, sanitation is a much more delicate issue compared to energy or water use, as it connotes to, amongst other things, social and religious notions of dirt, shame, privacy and hygiene. This alone makes a plea for end-user participation in any attempt to build or revise local sanitation systems. But in the wider context of changing consumer–provider relations in utility systems, it would also be worthwhile to assess what a ‘consumerist turn’ would mean for sanitation. Some initial studies have revealed that co-provision by consumers and re-sensitization of services are indeed taking place, but in very specific ways due to the special social characteristics of sanitation systems.

In summary, the contribution of the social sciences towards sanitation lies in widening the narrow definitions of sanitation to include perspectives including actors and their needs and belief systems. In doing so, alternative socio-technical tools and governance arrangements outside of the dead-end roads of traditional water engineering and sanitation provision can be proposed and tested.

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