

Investigating consumer attitudes towards the new technology of urine separation

C. Pahl-Wostl*, A. Schönborn***, N. Willi**, J. Muncke** and T.A. Larsen**

* Institute of Environmental Systems Research, University of Osnabrück, Albrechtstrasse 28, D-49069 Osnabrück

** Swiss Federal Institute of Environmental Science and Technology (EAWAG), Überlandstrasse 133, CH-8600 Dübendorf

*** Armadillo Webworks, Lucerne, Switzerland

Corresponding author (E-mail: pahl@usf.uni-osnabrueck.de)

Abstract The technology of urine separation and the recycling of anthropogenic nutrients as fertilizer in agriculture are considered as major innovations to improve the sustainability of today's urban wastewater management. The acceptance of consumers will be key for the introduction of the new technology. Citizens will have to make important decisions in their role as tenants and owners of houses and as consumers buying products fertilized with urine. Consumer attitudes towards the new technology were explored in a number of citizen focus groups in Switzerland. Focus groups are deliberate, moderated group discussions with informed citizens on a certain topic. The information was provided by a computer based information system specifically designed for this purpose. The acceptance of individual citizens for the new technology proved to be quite high. The majority of the citizens expressed their willingness to move into an apartment with NoMix toilets and to buy food fertilized with urine. However, they were not willing to accept additional financial costs or efforts. Arguments related to long-term sustainability (closing nutrient cycles) were of less importance than arguments that relate directly to the effects of micropollutants on human and ecosystem health. For the introduction of the new technology on a wide scale it will thus be crucial to explore the fate and effects of micropollutants.

Keywords Citizen focus groups; consumer attitudes; micropollutants; sustainable nutrient recycling; urine separation technology

Introduction

Historically, wastewater treatment technology has been developed exclusively by engineers. The public was not involved in the whole process of planning and implementation. Today's situation is characterized by a quite complex centrally controlled system about which most people have only little knowledge. However, with the introduction of decentralized technologies at the household scale (see e.g. Larsen and Gujer, 2001) citizens are increasingly taking an important role. Citizens will have to make decisions as voters, as house-owners, as tenants, and as consumers. It is therefore essential to involve citizens at an early stage in the process of technology development and application, when there is still ample room for taking into account their wishes and concerns. This corresponds to an overall increasing awareness of the importance of public participation in environmental decision making and the assessment of environmental risks (Renn *et al.*, 1995; Connor, 1999; Glicken, 2000).

An example of a technological innovation at the household scale is given by urine separation and the recycling of anthropogenic nutrients (nitrogen, phosphorus, and potassium) as fertilizer in agriculture (Larsen *et al.*, 2001). The two main arguments for introducing urine separation are the improvement *and* at the same time simplification of water pollution control (because most nutrients and an important fraction of the micropollutants are contained in urine) and the possibility of closing the nutrient cycle – especially for phosphorus,

a limited, essential resource. In the context of the interdisciplinary project NOVAQUATIS (at EAWAG, Switzerland, www.novaquatis.eawag.ch), consumer attitudes towards NoMix (urine separating) toilets and the idea of anthropogenic nutrient recycling were investigated using the IA-focus group methodology. This paper introduces the methodology, which is a novelty for technology assessment, especially for urban water management, and reports the results.

Materials and methods

The method employed was citizen focus groups. Focus groups are deliberate, moderated group discussions with informed citizens on a certain topic. The focus group method for integrated assessment (IA-focus groups) is a participatory method that draws on elements of both public opinion research and marketing studies (Dürrenberger *et al.*, 1999; Jaeger *et al.*, 1999; Schlumpf *et al.*, 2001). They differ from both fields in their explicit goal of providing ordinary citizens as well as various other stakeholders with an opportunity to articulate their voice in a debate. Citizens are provided with information that draws on the state-of-the-art in scientific research and the assessments aim at receiving from citizens information that is suitable for shaping actual decision making.

With IA-focus groups, the following questions may be clarified (Schlumpf *et al.*, 2001):

- How do citizens perceive and translate scientific input into shaping their opinion and assessments?
- How do they cope with uncertainties?
- How do informed citizens judge the risk of an environmental issue?
- What policy options do they prefer?
- What are their policy recommendations?

Typically, IA focus groups are used for a comprehensive assessment of an environmental problem such as climate change or sustainable development of a region. This implies giving recommendations for a range of possible options. This study, however, focused on a technology assessment. The intention was to involve relevant stakeholders in an early phase into a research process, where they could still have some influence on the other, more technical-scientific research projects of NOVAQUATIS (see also Lienert *et al.*, 2002 on a survey amongst Swiss farmers).

The main issues that were addressed in the study are:

- Assessment of citizens' perception of nutrient recycling, production of urine-based fertilizer, and its use in organic farming as well as its contribution to sustainable development.
- Assessment of citizens' perception of risks arising from pharmaceuticals in urine for the environment today. Furthermore, we also assessed perception of potential risks in the new system, for instance of micropollutants contained in urine-based fertilizer products.
- Elicitation of consumer preferences regarding product attributes such as use, maintenance or design of NoMix toilets in comparison to current technology.

In general IA focus groups consist of eight to ten participants. The input is provided by specifically designed computer tools, fact sheets that summarize in one or two pages the most important facts on one issue, or expert statements.

Meetings with ten gender specific groups of citizens with eight to ten participants were conducted during 2000/2001. The focus group participants were recruited both by phone and by a newspaper advertisement in the local press. They were chosen to be a representative sample of the population regarding age, profession, political attitude, and environmental awareness. The groups met twice for two hours in two successive weeks. Information about the NoMix technology was provided by a specifically designed interactive computer-based information system, the NoMix Tool (www.novaquatis.eawag.ch; see below). The

focus group participants had the opportunity to visit a NoMix toilet (Dubbletten, from BB Innovation, Sweden). The state of knowledge and citizen attitudes was assessed using questionnaires. The state of knowledge was assessed at the beginning of the meetings, and attitudes at the end. During each meeting the most important statements were recorded on a protocol. In addition, each session was recorded on a tape recorder and partly transcribed to check individual statements.

The focus group methodology allows exploration of the range of arguments and perceptions that could arise about an environmental issue in a well-defined setting. Ideally, it consists of a representative sample of the informed public. However, since the number of people that can be addressed in such detailed studies is limited, sample-groups are often not representative for the entire population, and the data generated are qualitative, rather than quantitative.

An interactive computer-based citizen information tool (ICIT) was developed for the focus group discussions. The purpose of ICITs is to make decision oriented expert knowledge on complex problems accessible and utilizable for citizens (Schlumpf *et al.*, 2001). To fulfill their task of informing citizens about scientific results and making the process of research visible, ICITs need to match the following criteria:

- scientific results must be described comprehensibly and clearly
- the presentation ought to be trustworthy and balanced
- the information needs to be up-to-date
- ICITs have to enable and support independent study
- and they should be fun to work with.

The scientific information in the NoMix Tool is based on literature surveys and on subjective expert judgements, which were gained by an iterative exchange with scientists. This scientific information represents the state of the art of knowledge in the field of urine separation, and is relevant for a lay public. Figure 1 shows the interface of the NoMix Tool, where the main idea of closing nutrient cycles and of preventing remnants from hormones and drugs to enter the aquatic environment is visualized. The users can choose any one of the different issues simply by scrolling over it with the computer mouse to receive more in

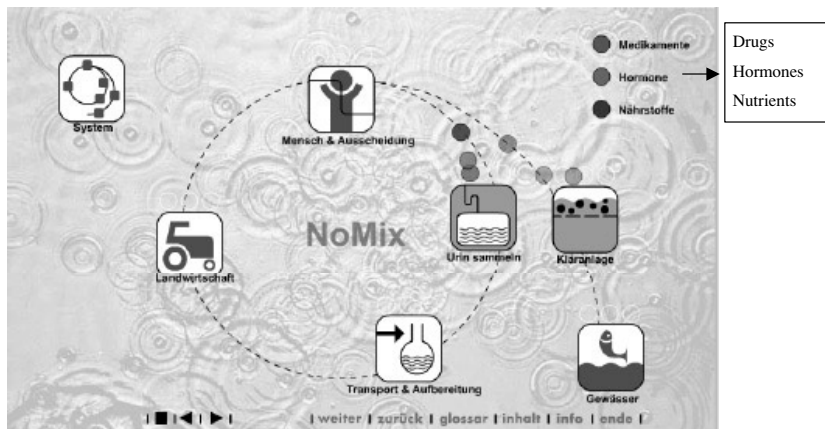


Figure 1 Graphical user interface of the interactive citizen information tool (ICIT). The flows of drugs (red) hormones (blue), and nutrients (green) are symbolized by animation. The user can get access to additional information from this information tool ([www.novaquatis.eawag.ch/NoMix Tool](http://www.novaquatis.eawag.ch/NoMixTool/)). The symbols within the circle denoting the new system refer to urine collection (Urin sammeln), transport and processing (Transport und Aufbereitung), agriculture (Landwirtschaft), human beings and excretions (Mensch und Ausscheidung). The symbols in the path leaving the cycle refer to waste water treatment plant (Kläranlage) and aquatic environment (Gewässer). Additionally, higher-level information is given under the symbol system (System)

depth information. In the tool, information on the following topics is given: the content of nutrients and micropollutants (pharmaceuticals and hormones) in urine, the problems of collecting and storing urine in households, the possible technologies for transport and treatment of urine, and the concerns of agriculture. Moreover, the important role of phosphorus as a limiting and essential nutrient was discussed as well as the advantages for treatment plants and receiving waters which can be expected from the introduction of NoMix technology.

Tables 1 and 2 summarize the questions of the questionnaires. The results are given in the next section.

Table 1 Questionnaire 1 – general information (prior to group discussions)

1. How do you judge the quality of the drinking water in Switzerland today?
2. Has the quality of drinking water increased or decreased over the past years?
3. Which type of substances are removed in wastewater treatment? Please indicate for each substance in the list to which extent they are removed (a list of substances followed).
4. Please indicate if the following statements are appropriate (a list with statements about the fate and effects of hormones and drugs, their removal in waste water treatment).
5. A number of questions to judge environmentally friendly behavior.
6. To which extent do you consider yourself to be environmentally friendly?
7. How often do you buy food produced in organic farming?
8. Gender, Age, Education
9. Size of the household and number of children.
10. Are you tenant or owner?

Table 2 Questionnaire 2 – about the NoMix toilet (after group discussions)

1. What do you think in general about the NoMix toilet?
2. What do you find particularly good and what do you find particularly bad regarding the NoMix toilets?
3. How would you explain your neighbor the idea of the NoMix toilet?
4. Please judge the following properties of the NoMix toilet (handling, aesthetics, ecological aspects, smell, waste management, cleaning, and suitability for children).
5. Do you have suggestions for improvement?
6. Could you imagine purchasing a NoMix toilet?
7. Could you imagine moving into an apartment with a NoMix toilet?
8. Could you imagine collecting the used toilet paper in a separate bag?
9. NoMix toilets imply that both men and women always sit when they use the toilet. Could you imagine to always sitting down when using the toilet to urinate?
10. What do you prefer – vegetable fertilized with urine or vegetable grown with artificial fertilizer?
11. Could you imagine to purchase regularly vegetable fertilized with urine?
12. Should all farmers use urine fertilizer?
13. Who is cleaning the toilet in your household?
14. Could you imagine that all of Switzerland would have NoMix toilets?
15. What could be the societal benefits of a Switzerland with NoMix toilets only?

Results

State of knowledge and representativity of the groups

When asked to classify their own environmental awareness on a scale between 1 (no environmental awareness) and 10 (very high environmental awareness) the focus group

participants classified themselves on average at 7.45. The answers to the more specific questions about their behavior in daily life showed as well that the participants had a high environmental awareness and were prepared to translate this into environmentally friendly behaviour.

Most citizens are not aware of the complexity of the urban water system, but in general the confidence in the technical system is high. To assess the overall knowledge about the current system a number of questions were asked before the focus groups started. Most participants were convinced that the quality of the drinking water in Switzerland today was good and had improved over the past years. If more specific questions were asked – e.g. regarding the efficiency of wastewater treatment plants – it was evident that citizens were quite uncertain. We conclude that there is a high public confidence in the quality of drinking water supply and waste water treatment, which is however based on little detailed knowledge. The average citizen is not interested in a technology that is invisible and outside of the realm of decisions made in daily life. The confidence in the reliability of the technical system is high given the fact that failures are rarely realized by the public.

General evaluation of acceptance

The overall acceptance for the new technology was high. Eighty per cent of the focus group participants made a positive judgement of the idea of the NoMix toilet (Figure 2), and more than 60% expressed a willingness to introduce the new technology in their households and to purchase “urine-fertilized” products from organic farming.

The focus group participants were also asked what they regarded as particularly positive or negative about the NoMix technology. For women, the main arguments in favor of the new technology were environmental friendliness and the idea of water saving. For men, the main arguments in favor of the new technology were the removal of hormones and drugs. The main arguments against the new technology for women were the considerable additional effort required for maintenance, urine collection and transport, and for men the unsolved technical problems.

Participants expressed a high willingness to decide in favor of the new technology as far as their own decisions were concerned (Figures 3A, B). The results showed a clear gender difference. Whereas 47% of the women were clearly willing to purchase a NoMix toilet, only 17% of the male participants were ready to do so. The willingness to move into an apartment with a NoMix toilet was higher for both men and women. 71% of the male participants expressed their clear willingness to move into an apartment with a NoMix toilet, whereas 58% of the women were clearly willing to do so. The higher overall acceptance for question 3B can partly be explained by the fact that most people in Switzerland are tenants

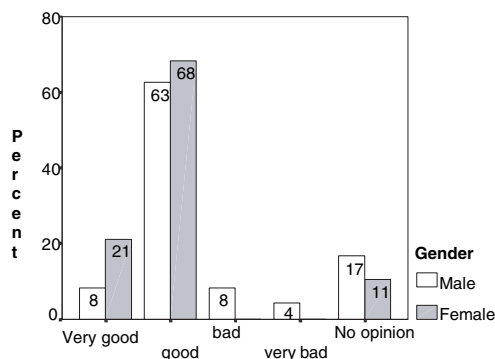


Figure 2 Distribution of answers to the question “What do you think in general about the NoMix toilet?” The percentages are given on the top of each bar

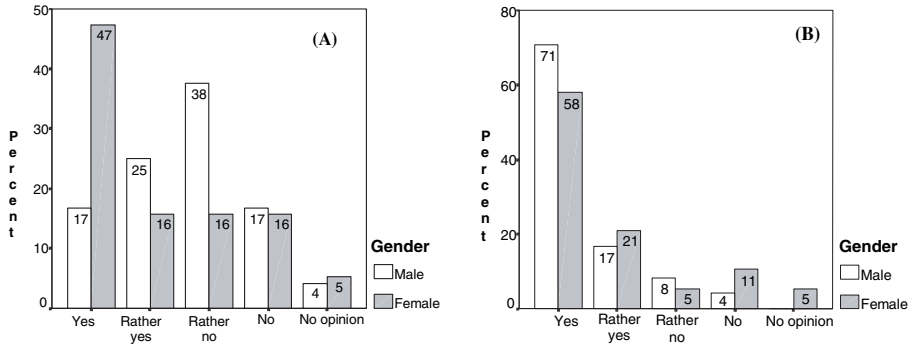


Figure 3 Answers to the question (A) Could you imagine purchasing a NoMix toilet? (B) Could you imagine moving into an apartment with a NoMix toilet? The percentages are given on the top of each bar

and not owners of their house or apartment. Hence, they are not able to make the decision to purchase a NoMix toilet. Further, citizens hold the subjective perception that the purchase and installation of the NoMix technology is associated with considerable additional efforts. In particular the male participants justified their negative attitude to buying a NoMix toilet with the premature state of the whole technology. If additional costs and efforts are carried by the landlord the willingness to move into an apartment with NoMix toilet is high.

Focus group participants were less optimistic regarding the large-scale introduction of the NoMix technology in a country such as Switzerland. More than 50% of the participants could not imagine Switzerland having only NoMix toilets. This may be attributed to the fact that the whole idea is still quite remote for most people. A typical statement made during discussions in the plenary supports this:

“Overall I think that the separation technology is a good thing. But I have difficulties to imagine how to put the new philosophy into practice. I am interested to find out how to communicate the idea and how to translate it into action. How many generations will be required – the whole thing is very remote. To be honest, I do not give the whole new philosophy a real chance. Human beings are comfortable and complacent. Often a message is not communicated in the right fashion and to the right audience at the right moment (designer, age 56).”

Ideas for improvement of the NoMix technology and general recommendations

Participants made quite a few practical recommendations for improvements. Most suggestions from women were related to an improved and more esthetic design. The suggestions from men were mainly related to technical improvements. Overall, the suggestion was repeatedly made to introduce the NoMix technology into public buildings, hospitals and home for the retired where the input of drugs via urine is particularly high. This shows the importance attributed to the removal of pharmaceuticals.

Urine as fertilizer in agriculture

Participants were asked if they could imagine eating vegetables fertilized with urine. Figure 4 shows that a majority (72%) answered positively. Also 80% stated that they would prefer vegetable fertilized with urine to artificial fertilizer. Arguments in favor were related to the fact that urine fertilizer is more natural. Schmidtbauer (1996) reported similar results from a survey in a Swedish municipality.

People pointed out the need to find an attractive name and develop good marketing to overcome the possible bias towards urine as a basis for fertilizer production. Despite

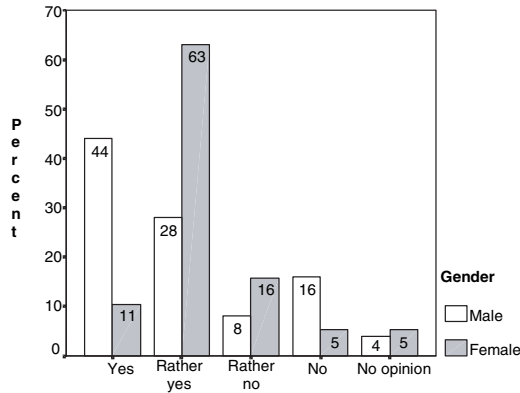


Figure 4 Answers to the question “Could you imagine buying regularly urine-fertilized vegetables”. The percentages are given on top of each bar

this overall positive attitude participants emphasized that any health risks should be excluded:

“As long as potential sources for disease and threats to human health cannot be excluded, I would not welcome the application of human urine even when artificial fertilizer is not a very attractive alternative (Environmental consultant, age 35).”

Discussion

Finding focus group participants proved to be rather difficult. This resulted in a biased composition of the focus groups, with a large level of environmentally friendly attitudes. A larger number of citizens could be addressed with a survey. This would allow putting the quantitative results on a stronger statistical basis. However, it can be expected that the bias towards environmentally friendly citizens would be at least as high or even higher unless the focus of the questionnaire were shifted towards human health. The issue of urban water management and wastewater treatment does not rank high on the agenda of the average Swiss citizen. The system seems to function perfectly and there is not much awareness for a need for change. This was also the message that was conveyed to the public for years. The complexity of the overall system is not anticipated by the broad public, who has only a little responsibility for the well-functioning of the system.

It proved to be quite difficult to convey the complex idea of nutrient recycling despite the efforts devoted to producing a comprehensive and easy to understand citizen information tool. Citizens were mainly interested in the practical aspects of household/bathroom technology and in the whole issue of drug removal. This supports the experience with citizen focus groups on climate change (Schlumpf *et al.*, 2001; Pahl-Wostl *et al.*, 2000; Kasemir *et al.*, 2000). In particular the whole aspect of uncertainties is difficult to convey to a lay public. This was especially prevalent for climate change, but became also evident in the discussion of the focus groups on NoMix technology. Citizens need further a clear link to topics of relevance in their daily lives (see e.g. Schlumpf *et al.*, 1999). In particular direct threats to environmental and human health proved to be the main focus of interest. Here citizens requested absolute certainty that potential threats to human health could be excluded for using urine-based fertilizer in organic farming. Considerable efforts have thus to be devoted to research into developing the technological basis of removing drugs and antibiotics in the process of fertilizer production and to explore methodologies to assess the ecotoxicological effects of drugs. These are important topics of the NOVAQUATIS project. Given the fact that absolute certainty cannot be obtained, much emphasis will

have to be devoted to the communication of risks and possible uncertainties. One has further to keep in mind that the focus groups were run just after the BSE crisis, which was particularly strong in Switzerland. People were quite sensitive to potential health threats. The whole idea of closing cycles in the human chain was partly linked to negative associations given the experience with BSE. Given this fact the high general positive attitude is very encouraging.

However, one has also to take into account that citizens are hardly prepared to carry additional costs and efforts. If this attitude prevails already in groups where the environmental awareness is high, one has to expect that the average citizen will be even less prepared to invest time and money. This implies that in particular in the initial state the new technology will have to be financially supported and that technological development has to focus as well on comfort and the ease of handling.

The high individual willingness of citizens to accept a NoMix toilet in their own households and to buy urine-fertilized vegetable corresponds to the results from a survey amongst Swiss farmers presented by Lienert *et al.* (2002). 57% of the farmers thought the idea of using urine-based fertilizer was good or very good, and 42% were willing to purchase such a product. Farmers, however, raised similar concerns regarding micropollutants as found in this study: 30% indicated concerns regarding micropollutants, without being specifically asked to answer any question on this subject.

Despite the individual willingness to accept the NoMix technology, there was a general skepticism regarding the willingness of the majority in society or another stakeholder group to do the same. In informal discussions with different stakeholders, we often encounter the same phenomenon. Many people find the idea of urine separation convincing, but think that farmers will not accept or apply the fertilizer. Experts on sanitary devices accept readily that NoMix technology would be beneficial for the environment, but they are equally convinced that people will not want to buy them. It would be an interesting issue to explore further the reasons for the discrepancy between individual willingness and the skepticism regarding the willingness for the majority in society or another stakeholder group to accept the new technology. It would make also much sense to foster an exchange among the different stakeholder groups. A future project could involve an actors' platform with representatives from the major stakeholder groups (e.g. farmer association, consumer association, manufacturers of sanitary technology, etc.).

The study reported here is focused on a technology assessment. It provides a good base for a more comprehensive investigation of new scenarios for urban water management and socio-technical transformations, of a new role for citizens and households in a system with changed decision-making structures and institutional settings.

Conclusions

In summary, the technology of urine separation is well accepted as long as it offers the same level of comfort and is not more expensive for individuals than conventional technologies. For the participants in the focus groups, the topic of micropollutants proved to be the most important argument for introducing NoMix technology.

There was a high acceptance of urine as fertilizer, under the condition that risks connected to hygiene and micropollutants could be excluded. However, this seemed to be based on more intuitive arguments such as urine being more natural than artificial fertilizers. Arguments related to long-term sustainability (closing nutrient cycles) are still of less importance than arguments that relate directly to the effects of micropollutants on human and ecosystem health.

For a successful introduction of NoMix technology in Switzerland, removal of micropollutants and a high hygienic standard are essential elements. However, development will

also have to focus on esthetic aspects and practical everyday handling as well as providing sound technical solutions for storage, transport, and process engineering.

The attitude towards the new technology is in general positive. However, more efforts need to be devoted to inform the public and to get the different stakeholder groups involved in a more in depth discussion.

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