Integrated Water Resources Management in the Lower Jordan Rift Valley

Sustainable Management of Available Water Resources with Innovative Technologies

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Demand for and interest in Decentralised Wastewater Treatment and Re-use: An empirical analysis of stakeholder views

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1 INTRODUCTION AND RESEARCH AIMS

Decentralised wastewater treatment technology and local re-use of treated wastewater is one of the most promising ways to tackle water scarcity problems in water scarce countries, such as Jordan, in the future. However, in the past, it has proved very difficult to implement appropriate technologies for wastewater re-use due to institutional barriers and public opposition (Dolničar and Saunder, 2006, Hurlimann and McKay, 2005).

In this paper, the focus is directed away from technical aspects of wastewater treatment and re-use (WWT&R) towards investigating the possibilities and impediments of implementing decentralised solutions from a social perspective. The aim is to assess the perceived demand for and views towards WWT&R among different stakeholders. While a range of technologies for the wastewater treatment and re-use are readily available to suit different climatic, geological and topographical conditions, investigating the non-technical social side of their implementation is considered to be important in order to 1) engage relevant stakeholders in the decision-making process, 2) take concerns into account and 3) tailor respective solutions in a way that suits end-users' needs.

In the past decade, the notion to use treated wastewater to supplement conventional water sources in the water-scarce regions of the world has experienced a sudden increase in recognition, as the finite nature of natural water resources has become increasingly apparent. Experts from the US and Australia suggest a range of options for which treated wastewater can be used. These re-use options are considered to generate a range of potential benefits for the communities, the environment and freshwater resources (see Table 1)

Table 1: Re-use options and advantages according to experts

Re-use options
▪ **Landscaping:** parks, greenbelts, golf courses, highway medians ▪ **Commercial/public uses:** car washing, fire protection ▪ **Indoor uses:** toilet flushing, air conditioning and potable use ▪ **Household uses:** garden watering, outdoor cleaning, car washing, pets, fish pond ▪ **Industry:** cooling and construction ▪ **Agriculture:** food crops, fodder, fruit trees, plantations, pastures, nursery stock ▪ **Recreation:** lakes and ponds ▪ **Environment:** creation, restoration and enhancement of wetland
Advantages General wastewater re-use: ▪ Conservation of freshwater resources ▪ Savings that come from avoiding using drinking water. ▪ Cost savings in comparison to using freshwater ▪ Replacing artificial fertilizer Decentralised solutions: ▪ Water cycle is closed at the local level ▪ Increase re-use of treated wastewater ▪ Fewer treatment processes are needed to treat settled sludge ▪ More cost-effective ▪ Permits incremental development and investment

Source: Bino (2006), Dolničar and Saunder (2006), Russell, et al. (2006), Kennedy and Tsuchihashi (2005), EPA (2004) and Marks et al. (2002).

Despite these advantages, the general public has a number of concerns with respect to treated wastewater. These are mainly related to the perceived low quality of treated wastewater and potential health problems (Marks, et al., 2002, Bino, M.J., 2006 and Dolničar and Saunder, 2006). Even though the elicitation of the public's perceptions is essential for the successful implementation of WWTP, the limited literature on public participation has merely focussed on lacking acceptance, one of the main impediments for implementing wastewater re-use technology (e.g. Haruvy,1996, AQUAREC, 2006). However, this does not yet answer the question whether *decentralised* treatment and reuse would be implementable.

In order to get a deep insight into the perceived demand for and concerns with decentralised WWT&R a case study was carried out in the Jordanian part of the Lower Jordan River Basin

taking different stakeholder groups into account (for study area see Figure 1). It was felt that, apart from end-users, all other stakeholders that would be involved in the decision-making process, such as government officials responsible for wastewater at different levels of administration and representatives of municipalities should be included in the study. Approaching all relevant stakeholder groups allows an investigation of views and perceptions regarding decentralised treatment plants and re-use from different perspectives. As such it helps to find out in what respects there is convergence and in what aspects there is divergence of views. Such an analysis can also be considered as an important prerequisite for a successful implementation of such solutions. Specific aims of this research task are to:

- identify different uses for treated wastewater.
- assess the interest in setting up decentralised wastewater treatment plants (WWTP).
- assess the perceived demand for and interest in re-using treated wastewater. from such plants and potential applications.
- understand the concerns related to decentralised WWT&R.
- test for end-users' willingness-to-pay for treatment and re-use services.
- compare interests/concerns between stakeholder groups.

Figure 1: Study Area

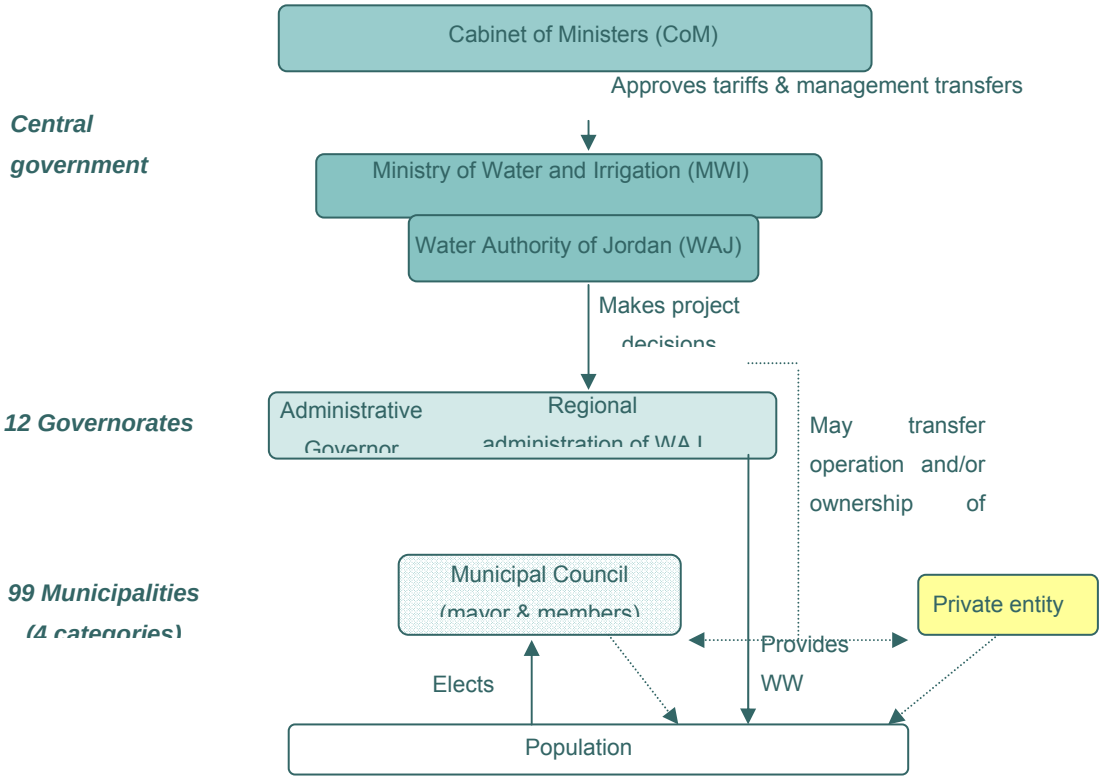
Source: Wolf, et al. (2007)

The paper is organised in the following way: Section 2 describes the data collection methods and sampling procedures applied in this study. The analysis of the data is presented in Section 3. The paper ends with conclusions and policy recommendations in Section 4.

2 SAMPLING AND DATA COLLECTION METHODS

Considerable effort was spent to identify stakeholders in relevant institutions and citizens to gather information on demand for and acceptability of WWT&R. The aim was to include administrators concerned with wastewater at the central government and governorate level, representatives of municipalities or village councils in rural areas that are not yet connected to wastewater systems as well as households and potential end-users of treated wastewater in these communities. Initially, a range of experts at the Ministry of Water and Irrigation (MWI) and the Water Authority of Jordan (WAJ) who are concerned with wastewater treatment were selected in collaboration with project partners from the Jordanian consulting company EcoConsult. Further relevant government experts at the governorate level were recommended by MWI and WAJ representatives. Since available resources constrained representative sampling of village councils and users, data collection was focused on three villages that had previously been selected within the SMART project as potential test sites for decentralised WWT&R, the villages Ira, Yarqa and Al-Ramah in the Lower Jordan River Basin. These villages were considered to require decentralised WWT&R as it would be expensive to connect these villages to central wastewater systems due to due to their remoteness and mountainous topography (van Afferden and Daoud, 2008). End-users were selected together with the respective village councils and included an equal distribution of gender and age groups. End-users were residents who would get connected to the sewerage system and/or would re-use treated wastewater. Figure 2 illustrates the relevant stakeholder levels concerned with wastewater treatment and re-use in Jordan. The identification of the various stakeholder groups ensured stakeholder representativeness rather than socio-economic representativeness (e.g. representativeness in terms of age, income, etc.) throughout the Jordanian part of the Lower Jordan River Basin, as this was considered to better illuminate the range of views and perceptions regarding WWT&R.

Figure 1 : Responsibilities and stakeholders in the context of wastewater treatment



Source: own compilation

Qualitative interviews were considered to be the most appropriate method to obtain information from experts at the governmental and governorate level as well as of village councils, as they are particularly suited to describe individual perceptions. Contrary to standardised quantitative surveys, qualitative interviews can be used to elicit subjective perspectives, are flexible with respect to questions and answers, and allow respondents to talk as in everyday life. One of the disadvantages of qualitative research is that it is typically based on small sample sizes, and it is therefore not suited to achieve representativeness of large populations. Instead data can be analysed more intensively and the researcher can investigate an issue in greater depth (Atteslander, 2006 and Diekman, 1996). For the purpose of this study, it was decided to move away from socio-economic representativeness towards stakeholder representativeness, as in-depth analysis of the views of different stakeholder groups was our pivotal interest.

Actual data collection took place in form of semi-structured face-to-face interviews. This involved a questionnaire (Appendix 1 and 2) with a certain degree of freedom with

respect to the order in which questions were asked and the possibility to take up a new relevant topic that might come up during the interview.

In order to investigate end-users' views and perceptions regarding decentralised WWT&R it was decided to use focus groups. This data collection mode was considered useful because it enabled us to provide participants with relevant information on decentralised treatment plants and re-use, and encouraged participants to discuss issues introduced by the moderator and to raise issues that are of relevance to them. The major advantage of such discussions is that participants are collectively able to raise more issues than an individual alone and hence, interaction and feedback within the group provides insights into the issues that are relevant to people (Brouwer, *et al.*, 1999, Krieger, 1999 and Morgan, 1998). Focus group research seemed essential in order to generate an understanding of people's experiences of, knowledge about and attitudes towards WWT&R.

Although an attempt was made to recruit participants that represent the village, representative sampling is difficult considering the limited number of participants in focus groups (Atteslander, 2006). Opinions and views expressed in the discussions can therefore not be taken to represent those of the entire village population. In each group several questions were discussed among 8-15 participants (see Appendix 3). The focus groups were moderated by a Jordanian moderator in Arabic.

The number of interviews and focus groups, involved institutions and dates of implementation are summarised in Table 2.

Table 2: Number and dates of interviews and focus groups

Stakeholder group	Institution	Number of interviews	Language	Date
Central Government	MWI & WAJ	3 face-to-face interviews	English	January 2008
Governorate	Irbid & Balqa	4 face-to-face interviews	English	January 2008
Village councils	Ira, Yarqa & Al-Ramah	3 face-to-face interviews	Arabic	April 2008
End-users (residents)	Ira, Yarqa & Al-Ramah	3 focus groups	Arabic	April 2008

All face-to-face interviews and focus groups were tape-recorded and then transcribed. Arabic transcripts were translated into English. The analysis of transcripts involved the detection of trends and patterns that appeared within the stakeholder groups and the identification of issues that repeat and are common to several participants. Attention was also paid to the range and diversity of respondents' views and experience.

3 RESULTS AND DISCUSSION

This section presents the findings from the interviews and focus groups with respect to (1) the perceived demand for treated wastewater, (2) perceived advantages of decentralised WWT&R, (3) concerns regarding decentralised WWT&R, (4) end-users' views on the location of the potential treatment plants and (5). end-users' willingness to contribute to the costs of the services associated to decentralised WWT&R.

3.1 Perceived demand for treated wastewater in Jordan

All stakeholder groups perceived that there is great demand for treated wastewater in Jordan and mentioned a range of potential uses. Irrigation and fertilizer in agriculture were considered to be the main uses for treated wastewater, and, contrary to expectations, no

concerns were raised with regard to the quality of treated wastewater in any of the interviews and focus groups. Apart from uses in agriculture, interviews and focus groups revealed a range of further potential uses. Stakeholders at the Government and Governorate level identified large-scale uses that address water scarcity problems in the entire country (e.g. forestry and landscaping), whereas village councils and residents (end-users) suggested uses from the perspective of village and individual household needs (outdoor cleaning and drinking water for animals) (Table 3). Apart from use options, the table also shows the number of interviews in which certain uses were mentioned (on the Government and municipality level) and the frequency of stating uses in the focus groups.

Table 3: Potential uses for treated wastewater according to stakeholder groups

Government/Governorate (stated in x out of 7 interviews)		**Municipality** (stated in x out of 3 interviews)		**End-users** (total no. of statements)	
- Irrigation	5	- Irrigation	3	- Irrigation	17
- Fertilizer	4	- Fertilizer	2	- Fertilizer	5
- Industry/construction	4			- Construction	3
- Landscaping/public gardens	4			- Outdoor cleaning	1
- Forestry				- Drinking water for animals	1
- Golf courses	1			- Landscaping	1
	1				

The frequencies confirm that agricultural irrigation had highest and fertilizer second highest priority within all stakeholder groups. Construction was the only other use that both end-users and Government/Governorate administrators found useful. Landscaping received most interest by the Government administrators. Uses for forestry, golf courses, outdoor cleaning and drinking water for animals were only sporadically mentioned.

Government perspective:

In all interviews conducted at the MWI, WAJ and with administrators at the Governorate level there was consensus that there is great demand for treated wastewater in Jordan. One of

the interview partners stated that the Government plans to increase the country's level of wastewater treatment from 85 million m³ in 2007 to 200 million m³ per year by 2020. The following points stated by the interview partners underlinethe need for treated wastewater:

- Protection of fresh- and groundwater resources.
- Replacement of conventional fertilizer in agriculture.
- Possibility to increase area used for agriculture.
- Increase farmers' income and thus reduce Governmental subsidies paid to them.

The interviews revealed that treated wastewater should be mainly applied for irrigation purposes. While irrigation with treated wastewater currently concentrates on fodder production (alpha-alpha), Government representatives also favourised an increase in wastewater re-use for vegetable and fruit cultivation. In none of the interviews it was mentioned that raw vegetables might contain germs. Apart from using treated wastewater for agriculture, Government representatives of Irbid Governorate felt that there is demand for re-using water in forestry: "*In forestry it is very important to have sufficient water for new plantations*". Industry, landscaping and golf courses were considered to be minor users of treated wastewater in the future.

Municipality perspective

There was agreement among all village councils that Ira, Yarqa and Al-Ramah would benefit from treated wastewater. If treated wastewater was made available it would mainly be used for irrigation and as fertilizer. While water availability for irrigation is currently not a major problem in the villages of Ira and Yarqa, Al-Ramah faces serious shortages in the supply of drinking and irrigation water: "*We have witnessed dry weather for the last 10 years (in the Jordan Valley) and people are now starting to depend on water from wells*". Hence, the Al-Ramah village council voiced an urgent need to treat wastewater in order to prevent groundwater depletion: "*In Al-Ramah, farmers are forced to pump groundwater from their private artesian wells that have about 150m depth…*". In Ira and Yarqa, village councils did not seem to depend on treated wastewater.

End-user perspective

Table 4 lists the uses that treated wastewater could be used according to focus group participants.

Table 4: Re-use options suggested in the focus groups

Ira	Yarqa	Al-Ramah
Irrigation Fertilizer Construction (building stone hedges) Outdoor cleaning	Irrigation Construction Drinking water for animals Landscaping	Irrigation Fertilizer

In Ira, views on the demand for treated wastewater in the village were polarised among focus group participants. On the one hand, some participants liked the idea to use treated wastewater as a substitute for fertilizer in olive plantations. On the other hand, given the absence of irrigated crops in the village, some participants did not see the need for treated wastewater. Despite this initial reluctance, the discussion ended with a vision into the future: "*but there is an opportunity that if we were provided with sufficient amounts of water, then we would plant some crops that could be irrigated*." (participant in Ira).

While participants in the Yarqa focus group felt that treated wastewater would be needed for a number of uses, it was repeatedly voiced that it should by no means enter the household: "…*definitely not for household uses taking into consideration the religious view as we have to use drinkable water to wash our clothes*." (participant in Yarqa).

The Al-Ramah focus group revealed that the village is connected to a range of water sources (provision through JVA, Kafren dam, Husban's stream) and will benefit from a new irrigation project starting in November 2009 (the Mujeb dam project). Nevertheless the new project will not provide sufficient water to meet water demand in agriculture. According to one participant, the Mujeb dam project will only satisfy 25% of water demand for irrigation in Al-Ramah. Overall, there was great interest in using treated wastewater for irrigation: "*This area will definitely benefit from having a treatment plant because it will provide an additional source of water […]. The amount of water used for irrigation will be increased […] so we don't need to divide our land into units anymore, we can plant it all. Instead of planting 10 dunums out of 70 I can plant the whole land*." (participant in Al-Ramah).

3.2 Advantages of decentralised WWT&R in rural Jordan

Views towards WWT&R in rural areas were positive in all stakeholder groups, and there was agreement that decentralised wastewater treatment would protect freshwater sources. Again, stakeholders at the Government/Governorate level looked at the big picture, e.g. cost-effectiveness, whereas stakeholders from municipalities voiced local benefits, such as preventing odour and social problems between neighbours (see Table 5). There was a strong interest among village councils and end-users to change the unsatisfactory situation related to overflowing cesspits. Note, that the interview and focus group discussions sometimes shifted from the focus on *decentralised* wastewater treatment plants to advantages of wastewater treatment in general. This section includes arguments for both *decentralised* and general wastewater treatment.

Table 5: Perceived advantages of decentralised WWT&R

Government/Governorate	Municipality	End-users
- Protection of groundwater - Replacement of conventional fertilizer - Increase area of cultivated land - Increase yield/ farmers' income - Reduce subsidies paid to farmers - Cost-effectiveness - Suited to mountain areas - Job opportunities	- Reduce groundwater depletion - Stop leakage and overflow from cesspits - Prevent social problems - Reduce flies and health problems	- Prevent contamination of rainwater wells - Reduce social problems - More convenient - Reduce health problems - Cheaper - Reduce odour

Government and Governorate representatives seemed to be well informed about the advantages of decentralised WWT&R when comparing their statements to advantages stated by the literature. However, a range of advantages revolved around expected improvements to the rural economy (e.g. employment for residents, increasing treatment in rural Jordan. It also shows that it is important to take the views of local stakeholders and end-users into account.

Government perspective:

Government representatives voiced a range of advantages with respect to the introduction of decentralised wastewater treatment plants to the Lower Jordan River Basin.

Arguments for decentralised WWT&R were driven by four aspects:

- Cost-effectiveness

The interview partners argued that a decision whether to go for centralized or decentralized wastewater treatment has to be made for each particular case based on cost considerations. However, it was argued that in remote villages building small treatment plants within the village would reduce the costs of collecting wastewater from the villages and taking it to a central treatment plant: "*For small villages decentralised plants would work better as we do not have to pump their water, they can get their own water and re-use it on their land and the cost will be less*". In particular interview partners from Balqa and Irbid Governorate voiced that decentralised treatment plants would be particularly suited to mountainous areas, as this would save costs of pumping wastewater to the central treatment plant, and minimise problems occurring during power cuts. According to the interview partners the capital costs for decentralised treatment plants would be relatively low, whereas the operation costs might be relatively high. The interview partners were positive that the operation costs could be compensated by the re-use opportunities on site, but there was strong agreement that the operation costs must be calculated before a decision can be made.

- Environmental protection

A number of interview partners were concerned about the current wastewater situation in rural Jordan, as leakage from cesspits is a common problem and groundwater sources are jeopardised. A decentralised treatment plant was therefore considered to be particularly suited to prevent leakage and overflow and thus groundwater contamination.

- Benefits to rural communities

The interview partners perceived that most residents in rural areas would be interested in re-using treated wastewater locally, as this would help them to increase their yield. Hence, government subsidies to the local population could be reduced. A further advantage of

decentralised treatment plants were considered to be job opportunities, that is, according to the interview partners, locals could be employed for operating and maintaining the plant.

Municipality perspective:

Village councils stressed that the current wastewater situation in the villages is inacceptable. According to the interview partners, wastewater is currently collected in cesspits, and there is no sewarage system in place. One of the major concerns with cesspits was the environmental impact of leakage and overflow: "*The increasing amount of cesspits cause a major hazard to the environment due to leakage, especially ground water and drinking water wells are at risk to be contaminated*". The high costs of pumping cesspits (between 50-60 JD per tanker) seem to be unaffordable for the majority of residents in the three villages. Hence, overflows and leakage are a common problem. Apart from environmental pollution, the failure to regularly empty cesspits causes two other problems: Firstly, social problems arise among neighbours as a result of leakage from one lot to the other, and secondly, the increasing number of flies are perceived as unhygenic and believed to cause health problems. Although the village councils were initially suspicious when asked whether decentralised WWT&R is a good idea for their village due to concerns with respect to odour and flies, they became more positive in the course of the interview and believed that a decentralised treatment plant in their village could indeed solve many of the environmental and social problems.

End-user perspective

One of the key points discussed in the focus groups was the question over whether residents of the villages would in principle agree to the installment of a WWTP in their village.

Overall, focus group participants were very positive and felt that a WWTP would have a range of advantages. There was general agreement in all focus groups that a decentralised WWTP would be preferred to the status quo as it was considered to be more environmentally friendly, reduce health problems and be cheaper (no expenditure for tankers and construction of new cesspits). In the mountainous villages of Ira and Yarqa focus group participants believed that a decentralised WWTP would prevent contamination of rainwater wells. Al-Ramah participants were particularly interested in eliminating odour arising from cesspits.

Since the wastewater treatment plant would also involve the connection of each household to a sewerage system, focus group participants were asked about their views towards getting connected to the sewer network. Overall, reactions were positive in all three villages:

- "*It will reduce negative environmental impacts such as odour*." (participant in Al Ramah)
- "*It is more convenient*." (participant in Al Ramah)
- "*It is cost-effective*." (participant in Yarqa)
- "*This has been our request for years. We have been asking for getting this service for years*." (participant in Ira)
- "*The village will benefit from getting this service economically and socially*". (participant in Ira)

None of the focus group participants had objections regarding the fact that minor constructions needed to be undertaken in their house in the course of the treatment project.

3.3 Concerns regarding decentralised WWT&R

Overall, perceived advantages seemed to outweigh the perceived concerns. While a number of minor concerns were raised, specifically on the municipal and end-user level (e.g. odour and flies), bigger issues, such as risk of leakage and environmental pollution were mainly raised by the interviews held on the Government level and to a far lesser extent by end-users. Interviews and focus groups revealed that lacking affordability was perceived to be a key problem in all stakeholder groups. Both village councils and end-users were concerned that they might have to take responsibility for operating and monitoring the plant (see Table 6 for an overview of concerns).

Table 6: Perceived concerns regarding WWT&R

Government/Governorate	Municipality	End-users
- Monitoring	- Odour	- Odour
- More staff	- Flies	- Risk of penetration
- Leakage	- Responsibility	- Responsibility
- Affordability	- Affordability	- Affordability

While the stakeholders voiced some concerns, there was no strict opposition in any of the interview and focus groups, and the range of advantages related to treated wastewater indentified in Section 3.4 shows that stakeholders are generally in favour of decentralised treatment plants. This is an interesting finding, as one would have expected stronger disagreement among end-users. One explanation for this positive result can be found in Hartley (2006) who identified a range of conditions that enhance public acceptance. Table 7 lists these conditions and indicates for each condition whether it is met according to end-users' perceptions. The table reveals that the majority of conditions were met. Furthermore it shows that stakeholders are very interested in obtaining all the benefits associated to decentralised WWT&R, but at a low cost.

Table 7: Conditions that increase public acceptance

Type of condition	Condition met as perceived by end-users
▪ Degree of human contact is minimal	*
▪ Protection of public health is clear	✔
▪ Protection of environment is a clear benefit of re-use	✔
▪ Water conservation is a clear benefit of re-use	✔
▪ Cost of treatment and sewerage systems is reasonable	No
▪ Perception of wastewater as a source for recycled water is minimal	*
▪ Awareness of water supply problems in the community is high	✔
▪ Role of reclaimed water in the overall water supply scheme is clear	✔
▪ Perception of the quality of reclaimed water is high	✔
▪ Confidence in local management of treatment plant is high	No

* issue not raised in the focus groups

(Source: based on Hartley, 2006, p. 116)

Government perspective:

Despite the overall positive attitude towards decentralised solutions among Government representatives, a number of concerns were raised. These centered around monitoring, financing and environmental risks.

- Environmental risk

While most interview partners considered decentralised WWT&R to be better than cesspits with respect to groundwater protection, two interview partners perceived that they would not be as safe as centralised treatment plants: "…*you will never have a treatment plant without leakage, or pipes without leakage…*". Clearly, if at all, this problem would apply to both centralised and decentralised WWTPs, but Government representatives perceived that the

risk of leakage from many smaller treatment plants might be higher than from few centralised treatment plants. The interview partners therefore emphasised that the construction site for a treatment plant should be carefully selected and stay away from vulnerable aquifers.

- Monitoring

In two interviews concerns were raised that decentralised treatment plants would require more staff for management and monitoring and that much more effort needs to be spent on controlling the water quality in comparison to centralised treatment plants.

- Finances

According to the majority of interview partners on the Government level the budget for the water sector is very limited. Hence the interest in decentralised treatment plants depends on their operation, maintenance and capital cost. The interview partners said that case by case decisions would be taken on the basis of cost-benefit comparisons.

Municipality perspective:

When prompted that a decentralised treatment plant in their village could ameliorate social and health problems, village councils were initially not convinced. Main concerns revolved around odour and flies stemming from the plant, and thus it was emphasised that the treatment plant would need to be located as far away from the villages as possible. In Ira and Yarqa, the village councils were very concerned about the distribution of responsibilities for a decentralised treatment plant. In their view, the municipality would neither be able nor be interested in taking any responsibility, and hence the Government should provide technicians to supervise, monitor and operate the treatment plant. A further concern was raised with respect to financing, as the municipalities have no budget for a treatment plant. Hence, it was hoped that the Government would support such a project: "*It requires to be financed, and we alone can't afford the training of our employees*".

End-user perspective:

While the reaction towards a WWTP was affirmative, some concerns were raised in the Al-Ramah focus group. Contrary to Ira and Yarqa, a number of participants in Al-Ramah were concerned that wastewater might penetrate from the treatment plant and thus contaminate

drinking water. Participants also believed that the treatment plant would be a source of odour.

3.4 Location of the treatment plant in the villages

During the interviews and focus groups, village councils and end-users were presented with two options for decentralised wastewater treatment in their villages: 1) one treatment plant for the entire village, and 2) several smaller treatment plants shared by two or more houses. They were then asked which of these options they would prefer.

In the mountainous villages Ira and Yarqa both village councils and end-users favoured the 'one plant' alternative. Reasons included insufficient space between houses for several treatment plants and the desire to locate the treatment plant outside the village to avoid problems with odour and flies. Furthermore, both village councils and end-users were keen to avoid responsibility of individual households for small treatment plants: "*The situation […] would be more chaotic […]. They* (the cluster solution) *might lead to some managing problems that can consume our time and effort*" (Village council). "*I prefer the first option because the Government will be responsible for it and the inhabitants will have nothing to do with operating it.*" (participant in Ira).

Due to the geographical distribution of Al-Ramah in form of three clusters (Al Shaghoor, Al Mayar and Al Nahdah), the cluster solution would be more suited according to the village council, as this was considered to minimise the number of required pipes and thus be less expensive. In the focus groups, a lengthy discussion on the potential location of the treatment plant took place among end-users. Finally, it was agreed, in line with the village council, that each cluster within the village should have one treatment plant. While some participants stated that Al Shaghoor and Al Mazar have sufficient space between houses and could thus accommodate two plants, others were strictly opposed to having treatment plants anywhere near the settlement due to odour and the risk of groundwater pollution: "…*but it must be constructed in a far away region, maybe 7 to 8 km*…" (participant in Al-Ramah).

3.5 Financial support for WWT&R from end-users

The focus groups were also used to test whether end-users have a sense of responsibility when it comes to financing the services provided by the wastewater treatment plant. Hence, participants were prompted at the end of the discussions to state whether they would be

willing to pay for 1) using treated wastewater, e.g. for irrigation, and 2) for the connection to the sewerage system.

Reactions to the question whether participants would pay a small amount for treated wastewater varied among focus groups: In Ira, none of the participants would pay anything, not even the price they currently pay for treated wastewater in irrigation (10 fils/m³), because they felt that the service should be paid for by the Government. In Yarqa, some participants stated that they would be willing to pay up to 0.5 JD/m³ in order to enhance irrigation of olive trees. In Al Ramah, the majority of participants were positive towards paying for treated wastewater: Some participants stated that they would pay 10 fils/m³ and one participant was willing to pay 100 JD/month in order irrigate his crops. However, there was also opposition towards paying for treated wastewater: "*No, I will not even pay 10 fils to get polluted water while I pay 400 JDs to get water from Husban's stream*". The payment question did not relate the payment to the amount of treated wastewater that would be used.

Willingness to pay for sewerage connection was strongly anchored to the amount of money people currently pay for tanker disposal. Since some households do rarely pump their cesspits, willingness to pay was very low or non-existent: "*I do not pump my cesspit, or maybe I do every 4 or 5 year, I am not willing to pay per month*". In total six out of X participants stated that they would be willing to pay up to 10 JD per year.

This is an interesting finding, as it shows that the actual beneficiaries of the wastewater treatment plant show very few signs of personal responsibility with respect to financing the sewerage and treatment service, despite the fact that end-users were aware of the range of benefits associated to WWT&R. Hence, considerable effort needs to be spent on enhancing the sense of responsibility and stressing that payments by users are a prerequisite for the implementation of a decentralised treatment plant. A sophisticated Willingness-to-Pay study with end-users would help to educate people and better assess ability and willingness to pay. On this basis it would then be possible to design a realistic and informed tariff structure.

4 CONCLUSIONS AND RECOMMENDATIONS

This study confirms that there is urgent demand for treated wastewater in Jordan. Among all stakeholder levels, main uses for treated wastewater were seen in the agricultural sector, in particular for irrigating fodder, fruit and vegetables, and as a substitute for conventional fertilizer. Stakeholders also appreciated the idea to introduce decentralised WWT&R to rural

areas. It was perceived that decentralised WWT&R would solve many of the problems Jordan currently faces, such as pollution of freshwater resources, social and health problems resulting from overflowing cesspits and low income among farmers. However, financing issues, risk of leakage, monitoring, odour and responsibility issues were major concerns.

Contrary to similar research that found strong initial resistance towards re-use of treated wastewater in the general public due to concerns regarding water quality health risks (e.g. Russel and Lux, 2006), in this study, Government representatives, villages councils and end-users were clearly more positive than negative towards decentralised WWT&R. This demonstrates the utmost urgency for additional water sources as perceived by all stakeholders, and might explain why "low quality" of treated wastewater for the irrigation of crops was not raised as an issue of concern. This finding is in line with Po, et al.'s (2003) notion that awareness of water shortage problems and the need to conserve water leads to higher acceptance to re-use wastewater.

Interestingly, concerns related to re-use of wastewater in the US and Australian literature do not seem to apply to the Middle East. None of the stakeholders was concerned about low quality of treated wastewater nor childrens' health as long as it is used outdoor. Only one participant was generally worried about potential health problems, but others believed that a treatment plant would reduce current health risks associated to cesspits. However, in this study we found that that the main obstacles towards the introduction of decentralized WWT&R are financing problems and a lacking sense of responsibility among municipality councils and residents.

The location of the treatment plant was a sensitive issue in all interviews with the village councils and in the focus groups. According to the discussions, neither village councils nor residents wanted to have the treatment plant close to their house due to fears of odour and health problems. Hence, all three villages were interested to reduce the number of plants as much as possible: Participants in Ira and Yarqa were interested in one plant, and those in Al-Ramah were in favour of having one plant for each of the three village clusters. The cluster solution (one or more houses sharing one plant) was not favoured due to lack of space between houses, the "not in my backyard" view, and because people felt they would have more responsibility for the plant.

Even though all stakeholder levels appeared to be interested in WWT&R, attention needs to be paid to the concerns raised by end-users. Some of the concerns, such as odour and flies associated with WWTPs, may be based on misconceptions. However concerns related to financing and the responsibility for operation are serious matters that complicate the decision-making and implementation process. In order to ensure successful implementation of decentralised WWT&R it is important to address all issues of concern and to identify solutions. The interviews and focus groups conducted in this study should be regarded as an initial step in a public participation process. Further engagement with the public is necessary alongside the entire decision-making process (AQUAREC, 2006 and US EPA, 2004). With the research findings in mind, we would therefore suggest that water authorities and industry engage with end-users in consecutive workshops to

- address potential conceptions (odour, flies)
- discuss remaining concerns and put them into perspective in the light of the status quo
- inform end-users on alternative technologies and their advantages and disadvantages
- present and discuss financing options for the construction and operation of the plant
- select a technology tailored to peoples' needs and concerns
- choose an appropriate location for the plant
- present alternative operational models, and
- discuss the role municipalities and end-users could play in the operation of the plant.

Parallel to this the decision-making process requires a thorough Willingness-to-pay study in the villages. There are two motivations for this: 1) raise awareness among end-users that the services associated to WWT&R are not for free, and 2) establish whether sufficient funds can be raised to finance the installation and operation of a decentralised treatment plants.

The study also revealed that stakeholder representativeness was important. While the existing literature on acceptance literature mainly focuses on the general public's (end-users') views vis-à-vis reuse only, the study shows that it is useful to take the views and perceptions of different stakeholders into account as there is not necessarily full convergence. According to our findings, all stakeholders were interested in WWT&R and all of them also had concerns. While there were a lot of common advantages and concerns

among all stakeholder groups, there were also some significant divergences (compare Table 8). Information on these divergences is important for a successful decision-making process.

Table 8: Comparing perceptions on decentralised WWT&R

	Administrators	**Village councils**	**End-users**
Perceived demand for TWW	Irrigation Fertilizer Industry Landscaping	Irrigation Fertilizer	Irrigation Fertilizer Construction Outdoor cleaning Watering animals
Perceived advantages of decentralized WWT&R	GW protection Save fertilizer Increase income of/ reduce subsi-dies to farmers	GW protection Prevent social & health problems associated with cesspits	GW protection Reduce social & health problems More convenient Reduce odour
Perceived concerns related to decentralized WWT&R	Affordability Monitoring More staff	Affordability Responsibility Odour, flies	Affordability Responsibility Location of plants

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APPENDIX I

Questionnaire Guide for MWI/WAJ Representatives and Governors

0) What is your involvement with wastewater treatment and reuse?

1) Demand for treated WW

   a. In your view, is there a demand for treated wastewater in Jordan?
   b. If so, for which uses (irrigation (food/non-food), urban uses/landscaping, groundwater recharge, industrial reuse, environmental enhancement)?
   c. What is the relative importance of the respective uses, now and in future?
   d. What benefits does water reuse have (e.g. conserve high-quality water, reduce fertlizer application…)

2) Wastewater can be treated in central and decentralized systems. We assume that decentralized systems serve less than 5000 residents and allow for a local reuse of the treated WW. Let's assume a municipality without central plant and sewerage system in place.

   a. Do you think decentralised WWTP are a good idea?
   b. Assuming same overall unit cost for centralized and decentralized WWTP, under which conditions would you go for a decentralized solution? (local demand for treated WW, improved local protection of aquifers…).
   c. Would there be reasons not to go for decentralized solutions if overall costs were lower than for centralized solutions? If so, what are they? (institutional impediments, no local demand for reuse)

3) Which municipalities in our investigation area, do you think, would be most in need for a decentralised WWTP? (bear in mind climate, distance to existing WWTP and potential use of water). [we will present a map]

4) Are there any/further impediments towards decentralised solutions, and if so, what are they?

APPENDIX II

Questionnaire Guide for Village Councils

1) How do households dispose their wastewater?
   a. Is there any special person in the village that maintains this system?
   b. Who operates the tankers?
   c. Where do the tanker dump the wastewater?

2) In your view, is there a demand for treated wastewater in your village?
   a) For which uses (irrigation, landscaping, groundwater recharge, industrial use, environmental enhancement)?
   b) What is the relative importance of the respective uses, now and in future?
   c) What benefits does water reuse have (e.g. conserve high-quality water, reduce fertilizer application…)

3) Wastewater can be treated in central and decentralized systems. We assume that decentralised systems serve less than 5000 residents and allow for a local reuse of the treated WW.
   a. Do you think decentralised WWTP would be a good idea for your village?
   b. Assuming same overall unit cost for centralised and decentralised WWTP, under which conditions would you go for a decentralised solution? (local demand for treated WW, improved local protection of aquifers…).
   c. Would there be reasons not to go for decentralised solutions if overall costs were lower than for centralised solutions? If so, what are they? (institutional impediments, no local demand for reuse)

4) How many people live in the village at present?

5) Are there any large water users in your village (industry, agriculture etc.)?

6) Would there be any space available for a wastewater treatment plant in your village?

APPENDIX III

Focus Group Guidelines

A: STATUS QUO QUESTIONS

First of all we would like to find out how you feel about the current way of disposing your wastewater.

1) In what way do you currently dispose your wastewater? Advantages, disadvantages?

2) What do you do with the sludge that accumulates on the bottom of the cesspit/soakaway?

B: WWTP IN THE VILLAGE

If a wastewater treatment plant was installed in your village, this would have several advantages:

1) wastewater can be locally re-used

2) your wastewater would be disposed by pipe

3) groundwater would be better protected

4) no odour in your backyard

3) Do think a WWTP in your village would be a good idea? Why?

4) In your view, is there demand for the use of treated wastewater in your village? For which uses?

5) There are two different types of treatment plants:

1) one treatment plant for the entire village

2) several small treatment plants shared by 2 or 3 houses.

Which option would you prefer?

C: CONNECTION TO PIPES

We would now like to ask you some questions about the disposal of your wastewater and how this would be different if a treatment plant was installed in your village. Instead of cesspits or soakaways your house would be connected to a pipe, which automatically diverts the wastewater to the treatment plant.

6) Would you prefer this option to the current way of disposing your wastewater?

7) Obviously getting connected to the pipe cost your household money.

We would like to know whether your household would be willing to pay anything for this service. Remember that you would save the money you pay the tanker.

How many JD per month?

If nobody wants to pay:

8) Assuming the same costs as you currently have for your wastewater

disposal, under which conditions would you agree to connect your house to such a treatment plant?

D: INTEREST IN RE-USE

9) Would you be interested in re-using the wastewater from a WWTP?

10) For which uses?

11) As we mentioned earlier, building the treatment plant and treating wastewater costs money.

We would now like to know what would be the most your household would be willing to pay per cubic meter of treated wastewater.

IF PEOPLE DO NOT WANT TO PAY

12) Treated wastewater for agricultural use is currently priced at 10 Fils/m³.

Would you pay this amount?