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RESEARCH ARTICLE

Academics perception towards various water reuse options: University of Trás-os-Montes e Alto-Douro - UTAD Campus (Portugal) as a case study

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Any strategy of water reuse has to achieve social acceptance to be successful. This paper presents the results of a multiple choice survey that attempted to establish the general attitude toward water reuse by asking academics in UTAD (Portugal) a wide range of questions. The survey included 20 reuse options, which were clustered into three reuse categories, specifically: low, medium and high contact levels. Correlation analysis between the level of support of low, medium and high contact options and demographic characteristics, personal and environmental beliefs was performed.

Results show that a high proportion of the participants supported low and medium contact reuse options. Correlation was found to exist between the income classes and to the level of support of medium and high reuse options and between education level and the support for high contact reuse options.

The responses to the survey suggested that some beliefs influence the level of support.

Keywords: water reuse; public acceptance; academic opinion

1. Introduction

Water is undoubtedly an unquestionable natural resource which needs to be preserved and the main activities that depend on it are also the ones that contribute mostly to its degradation. In Mediterranean countries, uneven distribution of precipitation and runoff spatially and temporarily, requires the construction of costly water storages and higher levels of wastewater treatment (Marecos do Monte 1996). Furthermore, seasonal variability in occupation intensity of the territory leads to a significant stress in coastal areas and requires the deviation of significant volumes of water. So, the main problem in some of these countries could be the high cost of making water available at the right place, at the right time with the right quality and not its scarcity (Marecos do Monte 1996, PNUEA 2001). On the other hand, water resources have been, over decades, intensively over exploited and polluted, and it is estimated that in a few years high values of water stress will be observed in Europe. Alternative water management approaches, such as water reuse strategies, are therefore needed to satisfy further increases of demand (PNUEA 2001).

Portugal is already ranked as a country suffering from medium water stress (10–20%) (Melo-Baptista 2002). Until 1974, wastewater treatment was virtually nonexistent in Portugal. A strong effort was made during the last four decades and nowadays almost all the population is served with wastewater treatment plants. Agriculture irrigation and golf courses irrigation are the main wastewater reuse application in Portugal, mainly in the south of the country (Angelakis *et al.* 1999). These reuse schemes apply the wastewater effluent after being treated in a centralized wastewater treatment plant.

Any strategy of water reuse that involves changes in the people's habits will have to achieve social acceptance to be successful (Friedler *et al.* 2006). Water reuse needs to include community and stakeholder participation from the beginning and so its public acceptance has to be assessed.

Much of the research about water reuse acceptance conducted during the 1970s and 1980s in the USA has been summarized by Bruvold (1998). These studies indicated 90% support of wastewater reuse in recreational parks, golf courses, lawns, gardens and hay pasture irrigation; 80–90% support was often reported for wastewater reuse in irrigation of dairy pastures, orchard, vineyard and vegetable crops; 70–90% support was indicated for household toilet flushing and clothes washing; 60–75% support was reported for reuses like swimming and bathing at home that correspond to high contact options and 30–60% was consistently reported for reuses that involve direct human ingestion, like drinking

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and cooking. As well, in a recent study, Kantanoleon *et al.* (2007) described, results of a survey conducted in Chalkida (Greece), a Mediterranean city, where 76% of the population surveyed supported wastewater reuse in industrial applications. However, as in other studies (Bruvold *et al.* 1981, Bruvold 1984, Denlay and Dowsett 1994, Crook 2003, Jeffrey and Jefferson 2003), the opposition to specific reuse option increased with the degree of contact, for example 69% did not support wastewater reuse in playground irrigation, 80% did not support the use of wastewater in animal crop irrigation, while as much as 94% did not support potable reuse.

In order to evaluate public acceptance of these practices there are three categories of surveys described in the literature. The first attempts to establish the general attitude toward water reuse by asking the public a wide range of questions. The second category seeks public opinion on forthcoming water reuse projects. The third examines public attitude in places where reuse schemes have already been put in place.

Most of the studies belonging to the first category concluded that a large majority of the public supports the concept of water reuse, although this acceptance is reduced when the degree of contact of people with the reclaimed water increases (Bruvold 1984, Denlay and Dowsett 1994, Jeffrey and Jefferson 2003, Crook 2003). Reasons like water conservation, environmental issues, health issues and costs of treatment and distribution of water were also outlined as justification for support or objection options (Bruvold 1988). Studies included in the second category reveal general supportive opinions on water reuse for toilet flushing, clothes washing and garden irrigation (Van der Hoek *et al.* 1999, Marks *et al.* 2003). Studies that examine public attitude in places where reuse schemes have already been put in place (third category) found that cost saving was the most important reason to support water reuse in irrigation, car washing and toilet flushing. This was followed by the positive effects on the environment and saving scarce potable water sources (Marks *et al.* 2003).

Friedler *et al.* (2006) conducted a survey in Haifa (Israel) in order to determine the attitude of a sample of the Israeli urban public towards various water reuse options. The survey clustered the reuse options into three reuse categories, namely: low, medium and high contact levels. The study found that a high proportion of the participants supported medium contact reuse options such as sidewalk landscaping (95%), domestic WC flushing (85%) and firefighting (96%). Higher contact reuse options such as domestic laundry (38%), preserved food industry (13%), and recharge of potable aquifer (11%) found much lesser support. Support for low contact reuse options was lower than expected with 86% for field crop irrigation, 62% for aquifer recharge for agricultural irrigation, and as low as 49% for orchard irrigation. In other studies (Bruvold 1984, EPA 1992, Crook *et al.* 1994, Hartley 2006) high support was given by the participants to the low and medium contact reuse options.

According to Friedler *et al.* (2006) it can be asserted that it is safe to say that the majority of water sector professionals in arid and semi-arid regions favour reusing wastewater effluent in non-potable end-uses, however this cannot be assumed for the public in general. This is related in some cases with insufficient and/or inappropriate dissemination of information to the public and in other cases with a lack of trust in centralized organizations (Jeffrey and Temple 1999). In fact, a different study reveals that people who attended the workshops and activities disseminating information on wastewater reuse supported a wider range of reuse options that those who had not (Simpson 1999).

There are also a few studies that tried to characterize the typical objector to water reuse in potable reuse in terms of age, gender, socioeconomic status and level of education (Bruvold 1984, Marks 2004). Bruvold described the characteristic objector to potable water reuse as having a low socioeconomic status, being older and having low awareness of water and environmental issues. As in Bruvold (1984), Marks (2006) reports that in some surveys females were less supportive than males. Actually, several studies found that age (Stone and Kahle 1974, Lohman and Milliken 1985, McKay and Hurlimann 2003, Hurlimann 2007a, Dolnicar and Schäfer 2009) and gender (Baumann and Kasperson 1974, Lohman and Milliken 1985, Tsagarakis *et al.* 2007, Hurlimann 2007a, Nancarrow *et al.* 2008, Dolnicar and Schäfer 2009) do have an influence on the level of support of recycled water projects. Marks and others also found that higher education tends to be associated with higher support to water reuse options (Bruvold 1972, Stone and Kahle 1974, Lohman and Milliken 1985, Flack and Greenberg 1987, Alhumoud *et al.* 2003, Robinson *et al.* 2005, Menegaki *et al.* 2006, Hurlimann 2007a, Dolnicar and Schäfer 2009). Marks noted that freelance, professional and white collar workers were more receptive to non-potable reuse options. On the other hand recent studies which examined non-potable reuse (Jeffrey and Jefferson 2003, Friedler *et al.* 2006), found no correlation between level of support and age and gender.

In Friedler *et al.*'*s* study (2006) no correlation was found between any demographic characteristic examined and support for medium contact options.

For medium contact options, Friedler *et al.*'*s* study revealed that perceived financial gain (individual and/or communal) and positive public opinion enhances support, while perceived health effects negatively affects the degree of support. Other studies reported that health concern and consequently risk perception, negatively influences attitudes through water reuse projects (Olson *et al.* 1979, Dishman *et al.* 1989, Po *et al.* 2005, Baggett *et al.* 2006,

Marks *et al.* 2006, Hurlimann 2008, Hurlimann *et al.* 2008). Trust in authorities and awareness of water and environmental issues did not have a significant effect on support for medium contact reuse options in Friedler's study. Participants in the survey who identified themselves as supporters of wastewater reuse revealed that the most important reason for their support was 'water saving', followed by 'minimization of importing water from abroad' while 'environmental improvement' ranked as the third most frequent response together with 'infrastructure cost saving'.

On the contrary, in a research carried out in Australia, a conjoint analysis was used to evaluate participant's preferences for various attributes of recycled water (colour, odour, salt content) for various uses and these were found to be prominent reasons to the level of support (Hurlimann and MacKay 2007). Also Domènech and Saurí (2010), found out that the perception of health risks, operation regimes, perceived costs and environmental awareness are, in different degrees, significant determinants of public acceptance. These authors concluded that improving the level of knowledge of these systems among users would reduce the risk of social refusal of the new technology. Public authorities and implementers need to stimulate social learning processes with specific actions, and build trust among residents in the new governance network if decentralised and alternative water supply systems are to find a place in the everyday life of urban populations. In other studies a clear correlation was found between economic gain and trust in authorities and support for water reuse (Lohman and Milliken 1985, Jeffrey and Jefferson 2003, Marks *et al.* 2003, Hurlimann and McKay 2004, Friedler *et al.* 2006, Hurlimann 2007b, 2007c). Hurlimann and McKay (2004) found that the degree of trust that an individual has for a water authority is proportionate to the individual's level of confidence that supply of reused water would not pose risks to their health or garden.

Community acceptance of water reuse may be significantly influenced by regional circumstance (Kahn and Gerrard 2006). In particular severe shortage of freshwater supplies is likely to encourage communities to look for alternative sources. Windhoek (Namibia), for example, suffers a combination of very low rainfall, high evaporation and limited catchment area, and so, the city now recycles water from sewage treatment plants directly to drinking water plants, to supply about one third of its potable requirements (Khan and Gerrard 2006). Another example is Singapore, a small island with extremely limited natural fresh water supplies, being heavily dependent on Malaysia for much of its potable water.

In 2000 Singapore commissioned its first *NEWater* advanced wastewater reclamation plant to supply potable reuse, today, 10 years later and with the 4th *NEWater* treatment plant commissioned in 2010, the *NEWater* initiative supplies 30% of its national water demand. The lesson that can be learnt from Singapore's case is that prospect of secure, self sufficient water supplies combined with trust in authorities lead to high levels of support of water reuse (Macpherson and Law 2003).

It is manifested from the above discussion that acceptance of water reuse schemes in particular communities varies over time and from locality to locality. Therefore, ongoing studies at the local area are always necessary to keep pace with community sentiment in each instance. In fact, whenever exists varying conditions of water availability, climate, culture, socio-economical background there is the implicit need to gather robust data, and so, these is the main motivation to the present research. The study described in this paper aims to help contribute to this knowledge base.

1.1 Research goals

This paper gathers information about a potential issue of academic public support/objection to various types of wastewater reuse. This was established by an opinion survey (Category type I, described in Introduction) using a representative sample of the academic community. The main research goals were:

(1) To estimate the level of opposition to and support for various wastewater reuse options;
(2) To reveal critical issues which concern the academic community regarding the options considered (Table 1) and compare results with the ones found by other studies;
(3) To assess the socioeconomic characteristics of a typical 'objector' to wastewater reuse, such as higher education and compare them with other works.

2. Methods

The methodology applied within the study described in this paper was based on the study carried out by Friedler *et al.* (2006). A multiple choice survey, type I, already described in the introductory section, was conducted on the academics of UTAD Campus. Despite the fact that the research issue and methods proposed in this paper are very similar to those proposed by Friedler *et al.* (2006) the public to be investigated is very different because one refers to a city in Israel and the other to a University Campus in the Northeast of Portugal and so this study aims to evaluate the effect of higher education in the support to water reuse schemes. As indicated in previous research, higher education tends to be associated with supportive attitudes (Marks 2004), moreover, there are several differences in culture, climate, water availability, economy, and in the study scale that may differ from the study carried out by others (Marks 2004, Friedler *et al.* 2006).

Table 1. Reuse options in the survey. Relative weights and average grades.

	Reuse category and option	Relative weight of option[a]	Average Grade[b]	Average Grade (Group)[c]
Low contact	Field crops irrigation	(1/3)	71%	69%
	Aquifer recharge for agricultural reuse	(1/3)	67%	
	Orchard irrigation	(1/3)	67%	
Medium contact	Fire fighting	(1/19)	86%	70%
	Industry	(1/19)	66%	
	Use for construction of buildings	(1/19)	70%	
	Sidewalks irrigation	(1/19)	74%	
	Air-conditioning water	(1/19)	63%	
	Offices toilet flushing	(1/19)	85%	
	Public parks irrigation (urban)	(2/19)	66%	
	Commercial car-wash	(2/19)	71%	
	Private garden irrigation	(3/19)	66%	
	Domestic toilet flushing	(3/19)	84%	
	Commercial Launderettes	(3/19)	52%	
High contact	Domestic washing machine	(1/8)	48%	35%
	Recreational lake-swimming	(1/8)	37%	
	Vegetables irrigation (edible)	(1/8)	27%	
	Aquifer augmentation (drinking water)	(2/8)	16%	
	Use in preserved food industry	(2/8)	32%	
	General cleaning	(1/8)	69%	

Notes: [a] The relative weights indicate the relative importance attached by the authors to each reuse option.
[b] The grade is a simple average of all answers given by the participants to each reuse option, normalized to 0–100% scale.
[c] The grade is a simple average of all answers given by the participants to each group of reuse option (low, medium and high contact), normalized to 0–100% scale.

Such variability makes the transferability of specific findings and conclusions from one study to another impossible as asserted by Friedler *et al.* (2006). The data gathered was analyzed using both descriptive statistics and correlation analysis as explained in further sections.

2.1 The survey

The questionnaires consisted of general instructions, a short explanation of the topic of the survey, and three sections to be filled in by the participant:

(1) Demographic background: Gender, Age (18–30, 31–40, 41–50, 51–60, above 60 years of age), Education (Less than 12 years, 12 years, more than 12 years), Marital status (married, married – with children, single, divorced, other), Income level per month (< 500 EUR; 500–1500 EUR; > 1500 EUR)
(2) Twenty reuse options were considered in the survey (Table 1). These were divided into three categories:

   a. Low contact: Reuse options that have only indirect link to the people. These reuse options are the realistic for Portugal and to the campus water reuse in the near future;
   b. Medium contact: Options that are implemented in close proximity to urban population, but that do not involve intentional contact with humans; although may involve unintentional direct contact with the reclaimed water;
   c. High contact: Options that involve intensive contact with the urban population, e.g.: intentional body contact, indirect drinking.Participants were asked to grade the reuse option on a scale from zero to four (0 - strongly oppose; 1 - oppose; 2 - indifferent; 3 - support, 4 - strongly support).

(3) Environmental perceptions: Participants were asked to grade (in a manner similar to the above) seven questions that were used to identify their perceptions on water and environmental issues:

   a. Their opinion on the state of the water sector in Portugal;
   b. Their opinion regarding the ability of current wastewater technologies to produce effluents suitable for the proposed wastewater reuse options;
   c. Their opinion regarding whether the urban public of Vila Real where UTAD is situated, would support the described reuse options;
   d. The extent of economic benefits to Vila Real city from wastewater reuse.
   e. The extent of the health risk associated with reuse;
   f. The extent of their belief that the relevant authorities are capable of maintaining a high effluent quality;
   g. The extent that the individual will gain economically from the implementation of reuse schemes in Vila Real;
   h. Degree of pollution of water resources in Portugal.

(4) Reasons for support: Participants who identified themselves as supporters of wastewater reuse were asked to grade (in the same manner as before) how each of the following reasons affected their support:
   a. Urban wastewater reuse would reduce infrastructure costs and improve the economy;
   b. Wastewater reuse is good for the environment;
   c. Wastewater reuse will save water;
   d. Wastewater reuse would minimize Portugal's dependency on imported water.The questionnaires were delivered and collected 'door to door', in the offices and other work areas, between September of 2009 and February of 2010, in all buildings in UTAD campus. The researchers stayed with the participants while they were filling the questionnaire. They clarified the terms used in the questionnaires (when asked), without revealing any personal opinion. The participants were assured of anonymity (no identifying personal details were collected).

2.2 *Data analysis*

In order to grade an individual reuse option, a simple average of all the answers regarding that option was used, normalized for a scale of 0–100, where 0 is complete rejection and 100 is complete acceptance. Weighted grades were used in an attempt to correlate between level of support and demographic characteristics, between level of support and personal opinion/beliefs, and to analyze differences between the three reuse categories (low, medium and high contact). The weighted grades were calculated considering that each reuse option received a relative weighting factor within its category (shown in Table 1), proportional to its impact or the probability of personal contact (intentional or unintentional) as perceived by the authors (the sum of all weighting factors in each category is 1). For example:

- Low contact: All three reuse options received the same weighting factor (1/3). The motive for this is because their impact and possibility of personal contact were thought to be nearly the same;
- Medium contact: The various options were graded by the authors according to their possible contact with the population, but also taking into consideration other factors. The first six options received 1/19 of weighting factor, the second two options 2/19 and the final three options 3/19. These branches from a higher possible contact in the second reuse options and higher risk of cross connections. For example, the option of "reuse for office toilet flushing" received a weighting factor of 1/19, while 'reuse for domestic toilet flushing' received a factor of 3/19. The difference between the weighting factors of these two options stems from the different probabilities of accidental cross connections between potable water and reclaimed water. Office buildings are usually centrally operated and maintained, while in many cases the owners themselves are responsible for the upkeep of their flats. Thus, the probability of an imprudent cross connection occurring in residential flats is higher than the probability of cross connections occurring in centrally maintained buildings (Friedler *et al.* 2006). Following a similar logic to 'irrigation of urban public parks' was established with a weighting factor of 2/19, while 'irrigation of private gardens' received a factor of 3/19. This stems from a greater possible contact in the latter reuse option and a higher risk of cross connections (Friedler *et al.* 2006, Marks *et al.* 2003);
- High contact: between 1/8 and 2/8, since the first options were thought to have a higher impact.

The weighted grade (G_c) was calculated using the equation presented by Friedler *et al.* (2006):

$$G_c = 100\sum_{i=1}^{n}\left(\frac{S_i W_i}{4\sum_{i=1}^{n} W_i}\right)$$

Where:

- S_i-score of a particular reuse option of participant i;
- W_i- Weighting factor of each reuse option within its reuse category;
- n- number of reuse options in each reuse category.

A weighted grade above 56% was considered supportive, below 44% the individual was considered opposed, and

Table 2. Demographic data of Vila Real City (INE 2011).

Age		Gender		Education		Marital Status		Income Level
Range	(%)	Type	(%)	Range	(%)	Status	(%)	Mean (€ in 2009)
0–14	13.8	M	48.5	12 years	73.4	Single	39.5	873.8
15–24	13.8	F	51.5	>12 years	26.6	Married	49.0	
25–64	52.1					Divorced	4.5	
>65	20.3					Widow	7.0	

Table 3. Demographic data of the survey participants.

Age		Gender		Education		Marital Status		Income Level	
Range	(%)	Type	(%)	Range	(%)	Status	(%)	Range	(%)
18–30	6.16	M	51.37	<12 years	8.22	Single	19.18	<500 EUR	5.48
31–40	34.25	F	48.63	= 12 years	21.23	Married	16.44	500–1500	41.10
41–50	39.04			>12 years	70.55	Married + Children	46.58	>1500	53.42
51–60	16.44					Divorced	7.53		
>60	4.11					Other	10.27		

Note: There were no empty results.

between 44% and 56% was considered as having no firm opinion regarding the notion of wastewater reuse.

3. Results and discussion

A total of 146 people, 75 males (51.4%) and 71 females (48.6%) completed the questionnaire. All people who were asked to participate agreed to do so. This is unlike other studies, where the response rate was much lower and probably stems from the fact that the survey was conducted in a university. A summary of the demographic characteristics of the Vila Real City population and of the survey participants is given in Tables 2 and 3.

Overall, comparing both tables it is possible to say that the demographic data of the participants falls within the demographic data of the Vila Real population itself.

The age distributions reveal a higher proportion of middle age participants (31–50 years old). The income level is in accordance with the education level. Most of the participants are married with children (Table 3).

The proportion of the supportive, indifferent and opposed participants to the 20 reuse options is shown in Figure 1. Table 1 lists the average grade that was given by all of the participants to each option in the survey.

It is clear, as suggested by Khan and Gerrard (2006), that the degree of close human contact is important in

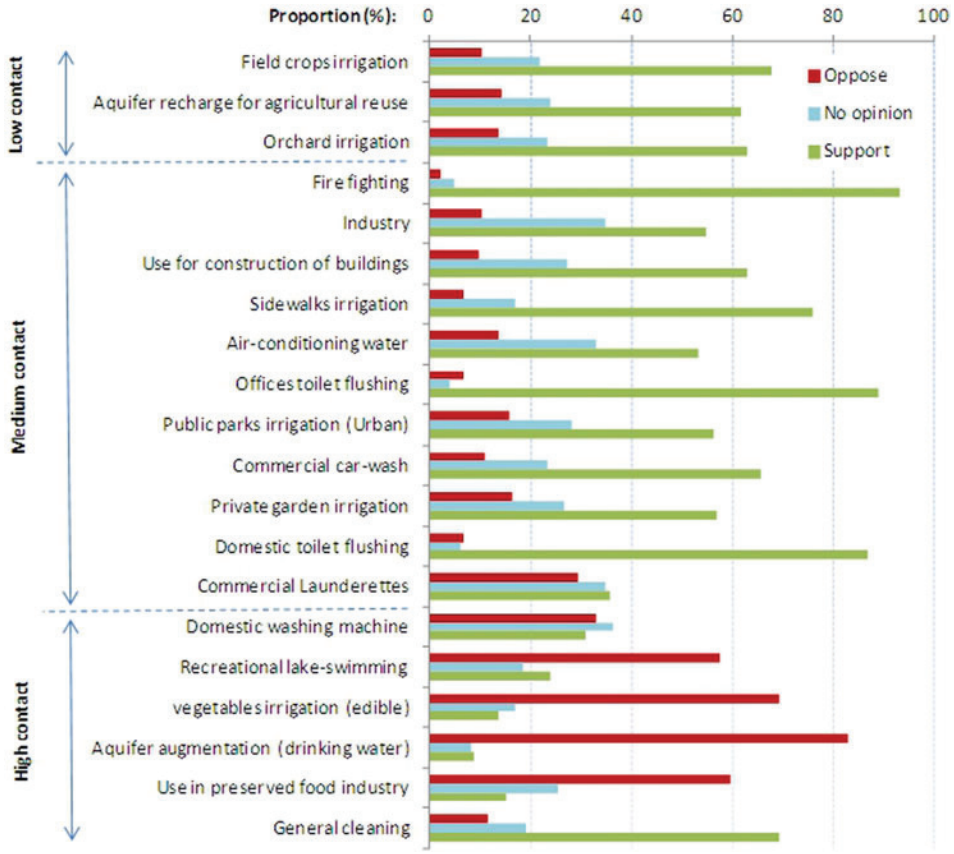

Figure 1. Proportion of the participants supportive, indifferent and opposed to the 20 reuse options considered.

determining community acceptance of water reuse schemes.

Results from the present study seem to parallel those of other studies (Bruvold 1984, EPA 1992, Crook *et al.* 1994, Friedler *et al.* 2006, Hartley 2006), high support was given by the participants to the low and medium contact reuse options. High contact options received low support with the exception of general cleaning option, maybe because it was perceived as a low/medium contact option.

In fact, a survey and a case study research since the 1970s has found that the public in some states of the USA, support the general concept of non-potable reuse initiatives (EPA 1992, Hartley 2006). However, when the degree of contact increases, attitudes change, and the public support wanes (Bruvold *et al.* 1981).

In the present study, no differences in support of office and domestic toilet flushing and between public parks and private gardens irrigation were observed. This finding is

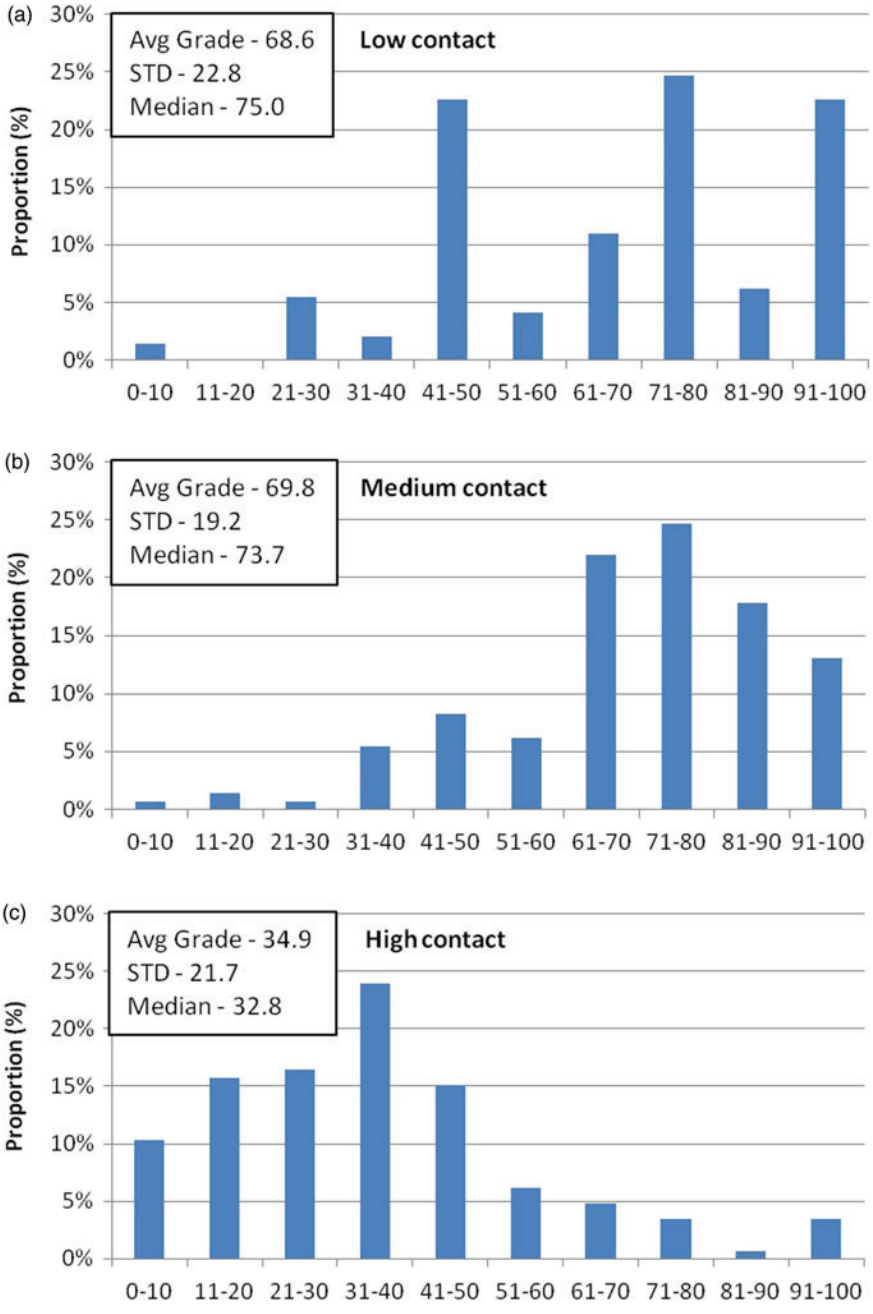

Figure 2. Histogram distribution of the weighted grade frequencies for low (a), medium (b) and high (c) contact reuse option.

somewhat different from others and deserves some discussion. As previously mentioned, irrigation is the main wastewater reuse application in Portugal. According to Marks (2006) the public already exposed to a risk may be in denial of the risk therefore, the hazard becomes familiar and the threat disappears and so, the public exposed supports the option. This can explain the lack of differences between public and private irrigation. In relation with toilet flushing authors think that, as both reuse options are of medium contact, the risk is taken as being the same.

Combining the responses to low and medium contact categories and analyzing the lumped results by a histogram type distribution (Figures 2a–c) shows that low and medium contact options got similar support levels, although both get less support than expected.

However, some results reveal different perceptions of the respondents with regards to low contact reuse options. In fact, the average grade of low contact reuse was 68.6% (Figure 2a). The histogram distribution of the level of support to low contact options is erratic, with 78% of the participants giving these options 71–80 or higher, while as many as 33% gave an average grade of 41–50.

As previously mentioned, participants expressed medium support towards medium contact reuse (Figure 2b) with an average grade of approximately 70%, similar to low contact options. A high proportion of participants (65%) gave medium contact reuse a weighted grade of 71–80 or higher. These results reveal that the participants are not unconditional supporters either strongly objecting to the concept of medium contact reuse.

The histogram distribution of support of high contact reuse options (Figure 2c) is almost a mirror image of that of medium contact options, with 97% of the participants generally rejecting high contact reuse (giving a grade < 40). It should be noted however, that these results reveal lower resistance to high contact reuse options than the ones found by Friedler *et al.* (2005). This may be explained by the fact that most participants were highly educated, having better information and awareness on environmental and social issues.

Grouping the weighted grades into three categories allows to generally quantify the support/objection proportions of the academics (Figure 3) where it can be seen that the average academic support as reflected by the survey was 68%, 80%, 15% for low, medium and high contact reuse types, respectively. The opposition to these reuse types was 13%, 12% and 77%.

Table 4 presents correlation analysis between the level of support of low, medium and high contact options and personal and environmental beliefs. Negative correlation was found between the belief that wastewater reuse can cause negative health effects and the level of support of medium and low contact reuse. As previously said, this finding was also reported in other studies that state that

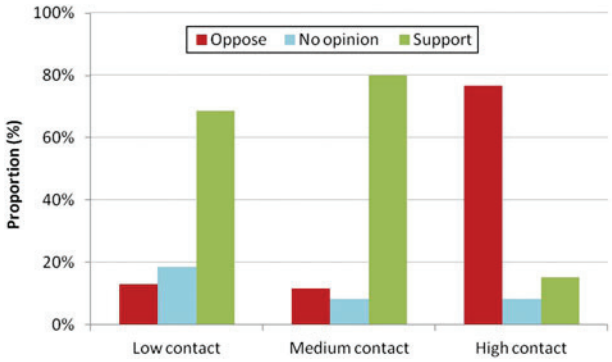

Figure 3. Proportion of participants defined as supportive, no opinion, and opposed to low, medium and high contact reuse options (Opposed = weighted grade 0–44; No opinion = weighted grade 45–55; Supportive = weighted grade 56–100).

health concerns and consequently risk perception, negatively influences attitudes through water reuse projects (Olson *et al.* 1979, Dishman *et al.* 1989, Po *et al.* 2005, Baggett *et al.* 2006, Marks *et al.* 2006, Hurlimann 2008, Hurlimann *et al.* 2008). Oddly, this could not be established for high contact reuse options.

As expected, positive correlation was found between the beliefs B2, B4, B6 and B7 and the level of support of all reuse options. These results corroborate a number of studies that found a clear correlation between economic gain and trust in authorities and support for water reuse (Lohman and Milliken 1985, Jeffrey and Jefferson 2003, Marks *et al.* 2003, Hurlimann and McKay 2004, Friedler *et al.* 2006, Hurlimann 2007b, 2007c).

Participants that believe that academics support a reuse scheme, support low and high reuse options. It was described by Khan and Gerrard in 2006, that the influence of others is a key factor for the acceptance of these schemes. According to this study, understanding that others practice water reuse can be powerful endorsement. This could not be proved for medium reuse options.

People that trust in the progress of the water sector in Portugal support medium and low contact options. Although there is no correlation between this belief and the high contact reuse support.

Table 5 shows the results of correlation analysis carried out between demographic characteristics and support of low, medium and high reuse, respectively. The survey showed no correlation between level of support and age and gender, in agreement with some other studies (Jeffrey and Jefferson 2003, Friedler *et al.* 2006). As said, there were some studies that found that age (Stone and Kahle 1974, Lohman and Milliken 1985, McKay and Hurlimann 2003, Hurlimann 2007a, Dolnicar and Schäfer 2009) and gender (Baumann and Kasperson 1974, Lohman and Milliken 1985, Hurlimann 2007a, Tsagarakis *et al.* 2007, Nancarrow *et al.* 2008, Dolnicar and Schäfer 2009)

Table 4. Contact reuse: Statistical analysis of opinion distribution as a function of personal beliefs/perceptions (Statistical Test Spearman rank-order correlation).

Belief		Oppose (%)	No Opinion (%)	Support (%)	Total no.	Correlation coefficient	Significance
B1 Progress of the water sector in Portugal							
Low contact reuse	NA -	7.5	7.5	11.8	45	0.285	**< 0.01**
	MA =	4.8	4.8	23.3	48		
	HA +	0.7	6.2	29.5	53		
Medium contact reuse	NA -	4.1	4.1	22.6	45	0.219	**< 0.01**
	MA =	6.2	3.4	23.3	48		
	HA +	1.4	0.7	34.2	53		
High contact reuse	NA -	26.0	2.7	2.1	45	0.150	0.071
	MA =	25.3	2.1	5.5	48		
	HA +	25.3	3.4	7.5	53		
B2 Appropriate technology							
Low contact reuse	NA -	8.2	4.8	13.7	39	0.292	*< 0.01*
	MA =	3.4	9.6	27.4	59		
	HA +	1.4	4.1	27.4	48		
Medium contact reuse	NA -	6.8	5.5	14.4	39	0.314	**< 0.01**
	MA =	2.1	2.1	36.3	59		
	HA +	2.7	0.7	29.5	48		
High contact reuse	NA -	24.0	1.4	1.4	39	0.259	**< 0.01**
	MA =	32.2	3.4	4.8	59		
	HA +	20.5	3.4	8.9	48		
B3 Public Opinion							
Low contact reuse	NA -	5.5	3.4	6.2	22	0.228	**< 0.01**
	MA =	2.7	7.5	23.3	49		
	HA +	4.8	7.5	39.0	75		
Medium contact reuse	NA -	4.1	2.1	8.9	22	0.137	0.09
	MA =	3.4	1.4	28.8	49		
	HA +	4.1	4.8	42.5	75		
High contact reuse	NA -	13.7	1.4	0.0	22	0.331	**< 0.01**
	MA =	30.8	0.7	2.1	49		
	HA +	32.2	6.2	13.0	75		
B4 Economic benefits to the city							
Low contact reuse	NA -	8.2	6.2	15.1	43	0.300	**< 0.01**
	MA =	2.7	7.5	20.5	45		
	HA +	2.1	4.8	32.9	58		
Medium contact reuse	NA -	7.5	3.4	18.5	43	0.253	**< 0.01**
	MA =	2.1	2.1	26.7	45		
	HA +	2.1	2.7	34.9	58		
High contact reuse	NA -	26.0	2.1	1.4	43	0.344	**< 0.01**
	MA =	28.1	1.4	1.4	45		
	HA +	22.6	4.8	12.3	58		
B5 Effects on public health							
Low contact reuse	NA -	2.7	3.4	19.9	38	− 0.274	**< 0.01**
	MA =	2.7	6.2	30.1	57		
	HA +	7.5	8.9	18.5	51		
Medium contact reuse	NA -	1.4	2.7	21.9	38	− 0.223	**< 0.01**
	MA =	2.7	0.7	35.6	57		
	HA +	7.5	4.8	22.6	51		
High contact reuse	NA -	20.5	2.7	2.7	38	− 0.007	0.937
	MA =	28.1	4.8	6.2	57		
	HA +	28.1	0.7	6.2	51		
B6 Trust in management companies							
Low contact reuse	NA-	7.5	4.1	7.5	28	0.310	**< 0.01**
	MA =	4.1	8.2	31.5	64		
	HA +	1.4	6.2	29.5	54		
Medium contact reuse	NA -	6.2	2.7	10.3	28	0.224	**< 0.01**
	MA =	2.1	3.4	38.4	64		
	HA +	3.4	2.1	31.5	54		
High contact reuse	NA -	17.1	0.7	1.4	28	0.221	**< 0.01**
	MA =	35.6	2.7	5.5	64		
	HA +	24.0	4.8	8.2	54		

Table 4 – *continued*

Belief		Oppose (%)	No Opinion (%)	Support (%)	Total no.	Correlation coefficient	Significance
B7 Individual economic gain							
Low contact reuse	NA -	8.2	6.2	15.1	43	0.259	**< 0.01**
	MA =	2.1	7.5	24.0	49		
	HA +	2.7	4.8	29.5	54		
Medium contact reuse	NA -	7.5	3.4	18.5	43	0.217	**< 0.01**
	MA =	1.4	2.1	30.1	49		
	HA +	2.7	2.7	31.5	54		
High contact reuse	NA-	26.7	0.7	2.1	43	0.306	**< 0.01**
	MA =	28.1	2.1	3.4	49		
	HA +	21.9	5.5	9.6	54		
B8 Degree of Pollution of water resources in Portugal							
Low contact reuse	NA -	3.4	6.8	21.9	47	− 0.044	0.596
	MA =	4.1	6.2	26.7	54		
	HA +	5.5	5.5	19.9	45		
Medium contact reuse	NA -	4.1	1.4	26.7	47	− 0.080	0.338
	MA =	4.1	2.1	30.8	54		
	HA +	3.4	4.8	22.6	45		
High contact reuse	NA -	24.7	2.7	4.8	47	− 0.056	0.504
	MA =	26.7	2.7	7.5	54		
	HÁ +	25.3	2.7	2.7	45		

Notes: Opposed = weighted grade 0–44; No opinion = weighted grade 45–55; Supportive = weighted grade 56–100. Statistically significant correlations appear bold.
NA - Not aware; MA - Medium awareness; HA - High awareness.

did have influence on the level of support of recycled water projects.

A correlation was found to exist between the income classes and the level of support of medium and high reuse options. In this case the income level is related to the education level, however the survey was undertaken in a campus where the most qualified people are the ones with higher incomes. Similarly, significant correlation was found between education level and the support for high contact reuse options. Several studies in the literature point out education level as a factor that positively influences attitudes towards water reuse (Bruvold 1972, Stone and Kahle 1974, Flack and Greenberg 1987, Lohman and Milliken 1985, Alhumoud *et al.* 2003, Robinson *et al.* 2005, Menegaki *et al.* 2006, Hurlimann 2007a, Dolnicar and Schäfer 2009). No correlation was established between marital status and support of all types of contact reuse options. Moreover in the present study, married individuals having young children at home were not found to be less supportive of water reuse schemes than ones with no children at home.

Table 5. Correlation between demographic classification and level of support the several contact reuse options.

Independent variable	Contact reuse	Type	Statistical test	Results
Gender	Low	Dichotomic	Independent samples t test	$P = 0.434 > 0.05$
	Medium	Dichotomic	Independent samples t test	$P = 0.928 > 0.05$
	High	Dichotomic	Independent samples t test	$P = 0.617 > 0.05$
Marital status	Low	Categorial (X categories)	One-way Anova	$P = 0.868 > 0.05$
	Medium	Categorial (5 categories)	One-way Anova	$P = 0.369 > 0.05$
	High	Categorial (X categories)	One-way Anova	$P = 0.912 > 0.05$
Age	Low	Categorial (X categories)	One-way Anova	$P = 0.900 > 0.05$
	Medium	Categorial (5 categories)	One-way Anova	$P = 0.252 > 0.05$
	High	Categorial (X categories)	One-way Anova	$P = 0.531 > 0.05$
Education	Low	Categorial (X categories)	One-way Anova	$P = 0.573 > 0.05$
	Medium	Categorial (3 categories)	One-way Anova	$P = 0.274 > 0.05$
	High	Categorial (X categories)	One-way Anova	$P = 0.028 < 0.05$*
Income	Low	Categorial (X categories)	One-way Anova	$P = 0.155 > 0.05$
	Medium	Categorial (3 categories)	One-way Anova	$P = 0.038 < 0.05$*
	High	Categorial (X categories)	One-way Anova	$P = 0.025 < 0.05$*

Note: *Significant correlation.

4. Conclusions

This paper has presented a study that shows a substantial support for the idea of wastewater reuse systems by an academic community at a University in Portugal. More specifically, options that were defined in the study as low and medium contact found high support.

The following key findings emerged from this study:

- As in other studies, our results demonstrated negative correlation between the belief that water reuse will have an impact on public health and the level of support. This negative correlation is in contrast to other studies that found that health effects are not important when medium contact reuse options are considered;
- The belief of an economic benefit of these projects and the trust in management companies increase the level of support;
- Some of the factors shown as being associated with public acceptance, like age, gender or marital status do not appear to be the main drivers in this case;
- Our results support other studies that found that education level is a factor that influences the level of support. Associated with this finding is the income level;

In conclusion, while some people believe that water reuse is feasible and often desirable, the acceptance within the scientific and technical communities is far from uniform, especially when the degree of contact increases. Although, in cases like this, where the public has a high level of education it is clear that there is a high level of support.

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