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User satisfaction in large-scale, urban dry sanitation programs in Mexico

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Dry sanitation (DS) may be part of the solution to water scarcity, water quality deterioration and lack of resources to provide or maintain waterborne sewage systems. However, the worldwide paucity of large-scale, urban case studies makes assessment of DS as a potential urban water management strategy difficult. Urban DS viability depends in part on urban users' satisfaction with dry toilets (DTs) and whether they would accept them as long-term sanitation options. We analyze user acceptance and satisfaction with DS in five Mexican cities. When toilets functioned well (four out of five sites), users were highly satisfied. Similar levels of satisfaction were found under conditions of different DT models, types of DS program and income-level of the population. User motivation, choice and adequate support services were positively associated with satisfaction. Incentives such as indoor, aesthetic DTs, maintenance and end-product collection services, as well as higher water supply pricing, would encourage people to accept DS as a long-term option. We discuss reasons for dissatisfaction at one of the study sites.

Keywords: Appropriate technology; Composting toilets; Dry toilets (DTs); Ecological sanitation; On-site sanitation; Peri-urban; Water management in cities

1. Introduction

Half of the world's population live in urban areas and the sizes of urban populations worldwide are expected to continue growing in the coming decades (Habitat 2001a, 2001b). Urban concentrations necessitate effective sanitation systems. Many cities, in both developed and developing nations, are currently facing problems such as increased needs for water supply, dwindling sources of water, lack of economic resources to adequately treat domestic wastewater, lack of economic, technical or qualified human resources to provide sanitation services to rapidly growing urban and peri-urban populations, public health risks due to inadequate water and sanitation provision and nutrient loading in water bodies due to insufficient treatment at wastewater treatment plants or failing septic systems (Costner *et al.* 1990, Esrey *et al.* 1998, Niemczynowicz 1999a, Habitat 2001a). Lack of resources to provide water, or treat wastewater, is more prevalent in developing countries; however, many developed nations are also facing these problems (Habitat 2001a, Revkin 2002). Dwindling sources of water supply affect cities in both developed and developing nations (Postel 1984, Reisner 1993, Habitat 2001a, Jehl 2002). Finally, inequitable distribution of scarce water resources within cities is often the cause of social conflict (Bennett 1995, Swyngedouw 1997).

Dry forms of sanitation provide one potential alternative to address urban sanitation needs. Through waterless, on-site treatment of excreta, these systems reduce water supply needs for cities, protect water quality from high nutrient and pathogen-laden discharges and produce a soil amendment material, free from urban runoff and industrial contaminants, that can be reutilized in agriculture (Stoner 1977, Van der Ryn 1995, Esrey *et al.* 1998, Lenton and Thunberg 2000). Dry sanitation (DS) systems also allow for economic savings, due to the volumes of water that are no longer necessary to supply, treat, distribute, collect and

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treat again, and due to the lower capital investment costs that they can imply (Costner *et al*. 1990, Añorve 1994, Van der Ryn 1995, Otterpohl *et al*. 1997, Pollard Kohlenberg and Davison 1997, Esrey *et al*. 1998, Del Porto and Steinfeld 1999). Finally, DS systems are useful for geohydrological conditions not favorable for sewage and septic systems such as karst terrain, hard bedrock and/or high water tables.

DS has been promoted in its modern form since the 1940s with the creation of the Swedish 'Clivus Multrum' and its commercialization, initially for remote and waterfront cottages (Costner *et al*. 1990, Esrey *et al*. 1998). It has gained worldwide momentum since the 1970s amongst individuals with 'back-to-the-land', self-sufficiency and environmental philosophies, as well as with the appropriate technology drive for low-income sanitation provision (Kalbermatten *et al*. 1980, Winblad and Kilama 1985, Van der Ryn 1995, Pollard *et al*. 1997, Esrey *et al*. 1998). During the 1990s, interest in DS grew further and the number of both DT sales and providers increased significantly (Del Porto and Steinfeld 1999). Despite this growing interest, it is still a common perception that DS is worth considering only in situations of low housing density, remoteness or geohydrological conditions unsuitable for waterborne sanitation. It is common for water management and urban planning professionals to consider DS unsuitable, unfeasible or inappropriate for high density, urban settings (e.g. Pollard 1997, Tiberghien 2002). Issues of acceptance, maintenance, and regulations have tended to factor out DS from conventional developments (Del Porto and Steinfeld 1999) although the 1990s have seen the design and construction of urban ecological developments that begin to counteract this trend (Otterpohl *et al*. 1997, Ingvar-Nilsson 2001). In view of the water scarcity and water quality problems, and the lack of resources to provide waterborne sanitation and treatment, affecting cities around the globe, we have been studying the feasibility of large-scale urban DS (Cordova 2001, 2003). We do not argue that all cities should transform completely to DS, but rather that DS can be an effective complement or option for many cities both in developed and developing countries, and that as such, its urban implementation needs to be studied. Others have also recommended the study of urban DS and the barriers to its wider application, in both developed and developing countries (Fittschen and Niemczynowicz 1997, Holmberg 1998, Niemczynowicz 1999a, First International Conference on Ecological Sanitation 2001, Stockholm Water Front 2001).

1.1 *User acceptance and satisfaction*

The implementation of urban DS at scales beyond a few households has begun only recently. In Mexico, the first experiences date to the mid-1980s, and the larger-scale ones to the 1990s (Córdova y Vázquez 2000). In Sweden, ecovillage type developments with DS date from the 1990s (Drangert 1997, Fittschen and Niemczynowicz 1997). To a large degree, DS implementation in urban settings has been rudimentary, experimental or at the pilot level. Critical elements for the success of implementing DS at a large scale in urban areas are user acceptance and satisfaction, both with the technology and with the associated support services. This paper focuses on both of these themes.

Several books provide accounts of positive user experiences with dry toilets (DTs) (Añorve 1994, Esrey *et al*. 1998, Del Porto and Steinfeld 1999, Jenkins 1999). These are representative and detailed accounts, but do not include broad populations of users. Stoner (1977) surveyed 125 composting toilet users in the 1970s. She found mostly favorable reactions and reported that most respondents said 'they would buy (or build) another composting unit if the need should ever arise' (p. 208). Most of the users surveyed were either vacation homeowners and/or people motivated by environmental or public health concerns about waterborne sanitation systems. Several studies on experiences and perceptions amongst Swedish DT users—many in ecovillage developments—have been reported (Drangert 1997, Fittschen and Niemczynowicz 1997, Del Porto and Steinfeld 1999). Satisfaction was highest with urine-diverting toilets, while some non-diverting toilets faced user dissatisfaction (Drangert 1997). Poor user acceptance was found when toilets operated poorly, when users did not understand toilet operation and/or when users had not chosen to have the DTs (Fittschen and Niemczynowicz 1997, Del Porto and Steinfeld 1999). Pollard (1997) conducted a mail survey with 89 DT users in rural Lismore, NSW, Australia. She found that satisfaction was in general very high, and that toilet model was not a determining factor in level of satisfaction. Most of the Lismore users were motivated by self-sufficiency and environmental philosophies. A survey conducted among 62 households with double-vault urine-diverting toilets in a low-income area of San Salvador city found overall good satisfaction among users, with over half the households reporting that they were 'moderately to very satisfied with the system' (Milburn *et al*. 2002, p. 196). However, how satisfaction related to socio-demographics and other variables was not reported.

We describe user satisfaction in five different DS experiences in urban and peri-urban areas in Mexico. We assess user satisfaction among various income levels and under different program characteristics. We assess the relationship between user satisfaction and several programmatic and user history variables. We also identify types of incentives that might be most effective in encouraging user acceptance of DTs as a long-term sanitation option. Our study adds to the current literature on DT user satisfaction because: (a) it is a multiple-site study; (b) all users are full-time

residents of urban and peri-urban areas; (c) it represents the largest sample of urban DS populations reported to date; (d) it includes a diversity of user populations with various motivations and income-levels; (e) it relates satisfaction levels with program and user variables; and (f) it assesses several incentives for long-term acceptance.

Mexico provided an appropriate context within which to study policy aspects of DS implementation because it has a large number of DS experiences, including some of the largest-scale urban experiences in the world. In addition to the high number of DTs installed in the country, a large diversity of toilet models have been used in a wide variety of program modalities. The diversity of social, institutional, technical and climatic conditions covered increase the relevance of the results for cities in societies beyond Mexico.

This research is an effort to: improve the basis for systematic analysis of DS program implementation as DS experiences become more widespread; provide recommendations to policy-makers and practitioners that may improve the long-term success of current and future DS programs; and communicate to water management professionals the satisfaction potential that DS can have among urban and peri-urban users, so that professionals and communities may expand the repertoire of options used in urban water management planning.

2. Site description and methods

The survey design and implementation for this research were conducted between June and December 2000. Prior to survey development, eleven months of qualitative research* on DS experiences throughout Mexico had provided valuable information on the types of DS programs in the country (urban and rural, large-scale and small) as well as on the contextual influences on program success (Cordova 2001, Cordova 2003). Of the DS experiences identified in the country, we selected the largest-scale and most-recent urban cases to research in greater depth. At five of these sites, we implemented a survey on users' experience with DTs and DS programs. The sites surveyed were: Ciudad Juárez, Chihuahua; León, Guanajuato; Puerto Morelos, Quintana Roo; Tepoztlán, Morelos; and Xochimilco, Mexico City (figure 1). At the Puerto Morelos site, we studied two parallel programs which we denote as PMR and PMU**.

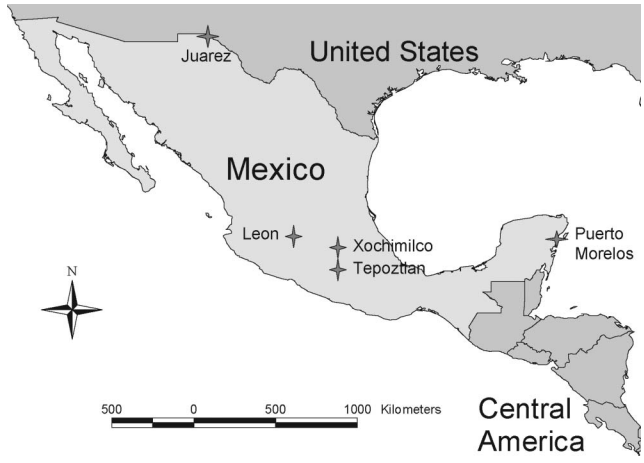

Figure 1. Dry sanitation study sites.

This sample covered a wide range of climatic conditions across the country, large and small cities and a diversity of program modalities. The sites all shared being participants of recent, urban initiatives, mostly under the auspices of an organization or government agency. Additionally, they differed in many aspects, including number of toilets, toilet model, principal program promoter, program motivation and philosophy, type of settlement, user income level and type of program (table 1).

We designed a survey instrument based on content analysis of the qualitative research phase, complemented with questionnaires used in previous research by other organizations†. The instrument was reviewed by community DT users and expert promoters from several programs for construct validity and language appropriateness. At each site, we consulted or helped construct a directory of homes with DTs from which we randomly selected homes for application of the survey. The questionnaire was applied in person and had 233 items, addressing a diverse array of users' experience with the toilets and with the program implementation. Specific questionnaire themes included user satisfaction and expectations, problems and benefits of the DTs, training and follow-up support, user motivation to install or accept a DT, toilet operation, comparisons of DTs with other sanitation options and barriers to DT acceptance‡. Redundancy was built into the questionnaire to test consistency of user responses. In addition to speaking with the users, we visited the DTs and checked a list of features at each one. The duration of each interview was 40

*In-depth interviews with program promoters, collection and analysis of program documentation, site visits and informal conversations with DT users at various urban sites in Mexico.

**Both programs were managed by the same organizations, used the same type of toilets and had the same training and follow-up, but differed as follows. PMR included typically, though not exclusively, middle to upper income residences and hotels and was a diffusion-style program. PMU was conducted in collaboration with UNICEF, targeted very low income families with children and was institutionally promoted. Because of their shared features, we often refer to them as one single program (PM), except as explained in the text.

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‡For a more detailed explanation of survey instrument and implementation, see Cordova (2003).

Table 1. Urban dry sanitation program characteristics.

Site	Project initiation	# Toilets installed[1]	Toilet model[2]	Principal promoters	Promoter motivations	Type of settlement	User income level
Cd. Juárez	1999	300	SIRDO	US University; US Private Foundation; Local Community Based Organizations	Provision of water and sanitation services; public health	Irregular and in process of regularization; high-risk areas (riverbeds); rocky terrain	Low and very low
Tepoztlán[3]	1985	18	SES-Cuer	Local Non-Governmental Organizations and innovative individuals	Water quality; environmental protection; health; community development; self-governance	Regularized urban settlements with and without sewage service; irregular peri-urban without sewage; semi-rural	Low, middle, high
León	1996	600	SES-Leon	Local Government	Provision of housing to inhabitants of irregular settlements in high-risk areas (riverbeds)	Urban low-income housing development, regularized, in an area originally far away from the city water and sewage system	Low
Puerto Morelos, Riviera (PMR)[4]	1993	30	Nahi Xix	US and Local Non-Governmental Organizations	Protection of water quality and coral reef ecosystem	Homes and hotels in developments that are adjacent to coasts, lagoons and underground water bodies (“cenotes”)	Low, middle, high
Puerto Morelos, Unicef (PMU)[4]	1999	43	Nahi Xix	US and Local NGOs, Multilateral Agency	Protection of water quality and coral reef ecosystem; provision of sanitation services; children	Regularized urban and peri-urban, without sewage services	Very low
Xochimilco	1999	166	SIRDO	Local Government	Protection of ground water and Xochimilco canals	Areas in process of regularization or in ecological reserve zones	Low, middle

Table adapted from Cordova (2001).

[1]This refers to the number of toilets installed, by November 2000, in *urban or peri-urban areas*. Some of the programs (Tepoztlán and Puerto Morelos) also installed toilets in rural areas, and those toilets are neither accounted for nor analyzed in this study.

[2]A brief description of each model follows (for further detail, see Cordova 2001):

- SIRDO – continuous flow, composting toilet with urine evaporation.
- SES-Cuer – double vault, desiccating toilet with urine diversion.
- SES-León – double vault, desiccating toilet. Urine is not diverted, but drains out from the bottom of vault through a hose.
- Nahi Xix – continuous flow, composting toilets that drain the urine (and optionally water) through a filter on the bottom of the inclined composting surface.

[3]Non-formal, diffusion-style program.

[4]As explained in the text, both Puerto Morelos programs were managed by the same organizations, but had some important differences in program type and population characteristics.

minutes on average. The survey was applied to 284 users, distributed among the five sites, representing 21–41% of the user population at each site (table 2).

Questionnaire data were entered into a Statistical Package for the Social Sciences (SPSS, Inc. 1999) database. Descriptive and inferential statistics were used to analyze the data and to test similarities and differences between the sites on 47 variables of interest. Because variances were often non-homogenous and transformations could not remedy this, non-parametric Kruskal–Wallis tests were used for testing differences between means (continuous variables). ANOVAs and *t*-tests were used when the data satisfied the required assumptions. Cross-tabulations, followed by Chi-square tests were used to test independence between the site variable and several categorical variables. When the data were sparse or unbalanced, exact *p*-values were calculated using StatXact software (Cytel Software Corporation 1988). When more than two statistically significant tests were performed on a same set of data, Bonferroni adjustments to the *p*-value were made.

3. Results

3.1 *Response rates*

Participation in the survey was voluntary, and no one refused to participate. Of 284 completed questionnaires, only 4 people chose not allow us to physically inspect their toilet. In 12 cases, respondents were not found after three visits to the household, and 12 additional households were selected randomly. Because the unreachable users and those who did not allow a visit to their toilet were such a small proportion of the total sample (4% and 1.4%, respectively), no further effort was devoted to analyzing participant/non-participant effects.

Overall, 77% of the respondents were female and 23% male. However, these proportions varied by site as follows: Juárez, 85% female; León, 82% female; Xochimilco, 65% female; Puerto Morelos, 54% female; and Tepoztlán, 40% female.

3.2 *Typology of sites*

In evaluating the effect of different variables on user satisfaction, it was necessary to perform the analyses on a site-by-site basis. Sites were unique in many important variables, such as toilet model being used, population characteristics, emphasis and motivation of program implementation, and presented distinctly different results trends. In particular, two factors summarized important distinctions by site: 'DS Program Characteristics' and 'Level of User Choice in Installing a Dry Toilet' (table 3).

3.2.1 Scale and type of program. Small-scale, diffusion-style programs had 17–30 toilets per site, installed over a period of 6–14 years. Users typically heard about the DTs by word-of-mouth or public talks about these toilets, or were seeking an environmentally friendly sanitation option and on their own initiative sought out DT promoters. These programs were characterized by high user involvement in decision-making, user payment of the full cost of the toilet, and in the case of Tepoztlán, high level of user self-training and user initiative in seeking the follow-up they needed. In PMR, the program implementer provided somewhat more systematic follow-up and technical support, though users might have to seek the promoter if they had problems in toilet operation.

Large-scale programs installed 43–300 DTs within a year. There was moderate user training, and moderate technical and follow-up support. Follow-up was greatly hindered by lack of budgeted funds and personnel, but conducted *ad hoc* as best as promoters could. These programs had intermediate levels of operation problems.

Finally, León was a very large-scale program, installing 600 DTs in contiguous homes, in a period of 2 years. The main purpose of the program was to provide alternative housing for illegal dwellers in high-risk river-bank areas. The project was mainly a housing project, with a creative financial and labor scheme which would facilitate the ownership of the homes by the residents. Because it was developed in an area far from the city water and sewer lines, it included dry sanitation and graywater filtration systems. The attraction of home-owners to the project was based on giving up their previous home and participating in the finance and labor scheme to purchase the new home. Training for the DT operation was a brief part of program induction; it was neither a main part of the program nor a main interest of the users—simply a component of the overall arrangement.

Table 2. Number of interviews conducted at each site and proportion they represent of the total population of DT users.

	Sites					
	Juárez	León	Puerto Morelos	Tepoztlán	Xochimilco	All Sites
# of interviews/total DT population	81/300	128/600	30/73	5/18	40/166	284/1156
% of total DT population	27%	21%	41%	28%	24%	25%

Table 3. Typology of sites, based on DS program characteristics and level of user choice in installing a dry toilet.

Program characteristics	Level of user choice		
	Active choice	Passive choice	No choice
Small-scale, diffusion	Tepoztlán, PMR		
Large-scale, institutional		Juárez, PMU, Xochimilco	
Large-scale, multiple-goal, institutional			León

3.2.2 User choice. Active choice indicates the user actively sought out a DT promoter in order to install a DT. Many of these users (Tepoztlán and PMR) also had the economic means to install other on-site sanitation options such as septic systems, and in many cases, these users had considered a variety of on-site options before choosing the DT. Passive choice implies that the users were in an area where an organization or agency was promoting DTs, and the users had the option to decline the DT if they did not want it. In these cases, the users did not initiate contact with the promoters,* and in many cases were subject to being selected by program implementers, based on criteria such as large number of children and very low income. In this category, most of the people who received a DT wanted at least to try it out. However, due to limited program funds and number of toilets offered, many people in these neighborhoods who later *wanted* a DT could not get one.

Active and passive choices included the users' ability to install another on-site sanitation option if desired (hindered in many cases, but not prevented, by economic means of the user). In most cases, however, even if users were aware of more than one on-site sanitation option, they were usually not aware of more than one DS option (i.e. more than one DT model). Most of the users did not have conventional sewage as an option. The only site where users did not have any choice in type of sanitation was in León. This was a housing program, in which all the houses already had DTs, and users were not allowed to introduce any other type of sanitation.

3.2.3 Income level and toilet payment. Tepoztlán and PMR users consisted mostly of middle or upper class† households who had paid for the full cost of the toilets themselves. Juárez, Xochimilco and PMU were large-scale institutional programs directed to poor, peri-urban residents who received the DTs for free, under favorable—and later forgiven—financing schemes, or with user contribution of walls and roof for the toilet room. León users were resettled low-income residents who paid for their house, including the toilet, with their labor and a financing scheme.

*For the most part; in some cases, users heard toilets were being given away once the program had started and then signed up to get one.

†There were a few low-income houses at these sites, which also paid the full cost.

3.3 *Satisfaction and associated variables*

León was both the most different site on satisfaction measures, as well as by far the largest size sample. This greatly skewed results when the dataset was analyzed as a whole. The other four sites tended to be in closer agreement across most variables; however, they also showed some differences. Because of these differences, we present results on a site-by-site basis. Although under different modalities, PMR and PMU programs had been implemented by the same organization and shared the same toilet model, program training, and follow-up. They showed statistically similar responses to most variables reported in this paper (41/47). For this reason they are reported in the aggregate form of PM in all cases except for those (6) where they tested significantly different (at $p < 0.05$). In those cases, PMR and PMU are disaggregated in the results tables.

3.3.1 Overall satisfaction. Satisfaction with the DT was high and consistent across all sites (approximately 8.7 on a 10-point scale) except for León (5.5 on a 10-point scale) (table 4). No significant differences were observed in the satisfaction levels between male and female interviewees at each site.

In the following tables, we present the differences between sites along a set of variables that might influence satisfaction. In each table, we include 'Overall Satisfaction' values to facilitate the comparison of the different variables with satisfaction levels.

3.3.2 User perception of DT problems and benefits. Overall satisfaction by site appeared to be associated positively with whether users felt the DT had given them more benefits than problems. It also associated well with measures of end-product handling—how pleasant or unpleasant it was to empty the toilet contents, and whether the user perceived the end-product to be a cost or a benefit to them (table 5).

León users, who were most unsatisfied with their DTs, expressed that the DTs were more of a problem than of a benefit, the end-product was unpleasant to handle and very definitely represented a cost to them. In contrast, users at the four other sites, who were overall more satisfied with their DTs, considered the DT and the end-product much

Table 4. Degree of user satisfaction with their DT, by site.

	Sites					
	León	Tepoz	PM	Juárez	Xochi	Full Database
N[1]	127	5	26	75	35	268
Mean satisfaction (1–10)[2]	5.47[a]	8.70[b]	8.79[b]	8.73[b]	8.90[b]	7.21
Standard error	0.21	0.58	0.37	0.17	0.16	0.16
Range	1–10	7–10	3–10	3–10	7–10	1–10

[1]Number of people who answered the question: "From 1–10 (10 being highest), what is your satisfaction with your dry toilet (in other words, how happy are you with your toilet)?"
[2]Sites with different superscripts are significantly different from each other at $p < 0.001$.

Table 5. User perception of DT problems and benefits and overall satisfaction, by site.

User perception of problems and benefits	Sites				
	León N (104–127)	Tepoz N (1–5)	PM N (17–26)	Juárez N (52–75)	Xochi N (11–35)
The DT is more of a benefit (10) or more of a problem (0)	2.16[a]	10.0[b]	8.27[b]	9.13[b]	9.17[b]
Sensation of end-product handling (1–10)[1]	4.5[a]	10[b]	8.0[b]	8.0[b]	8.3[b]
The end-product is more of a cost (0) or more of a benefit (10)	0.67[a]	10*	9.4[b]	8.33[b]	9.62[b]
Overall satisfaction (1–10)	*N = 127* *5.47*[a]	*N = 5* *8.70*[b]	*N = 26* *8.79*[b]	*N = 75* *8.73*[b]	*N = 35* *8.90*[b]

[a,b]Within each row, sites with different superscripts are significantly different from each other at $p < 0.001$.
[1]1 indicates respondents felt it was disgusting to empty the toilet end-product, 10 indicates it was pleasant.
*$N = 1$ for this question. This was not considered representative and therefore it was not tested.

more of a benefit, and rated handling of the end-product as pleasant.

3.3.3 User motivation to install or accept a DT. Several questionnaire items measured motivation. Of these, we distinguished four classes: ideological motivations, awareness, demand and pragmatic motivations.

Ideological motivations included innovativeness, strong environmental consciousness and a commitment to the DT. Awareness variables included understanding that DTs saved water, protected water quality or were beneficial for health/hygiene (even if that was not necessarily *why* the user acquired the DT). Lack of awareness was measured by statements such as 'I don't know why the DTs are good' or 'The trainers didn't tell me why the DTs are good'.

Demand was measured by users' search for sanitation prior to the appearance of the DS program. Pragmatic motivations included health and hygiene reasons, knowing other people who had DTs, perceiving DTs as a good or temporary solution for users' sanitation needs, accepting a DT because it was cheap or free, or having a DT because it was already in the house when they moved there (table 6).

On the ideological scale, Tepoztlán and PM users consistently had the highest ratings on commitment to the environment and to the DTs. In some cases there was a significant difference between users at PMR and PMU, with PMR rating higher than PMU. However, even in those cases, users in PMU rated higher than users in Juárez and/or Xochimilco, even though Juárez and Xochimilco had similar income and settlement characteristics as PMU. Juárez and Xochimilco had considerable size populations (27–41%) who claimed that they really *wanted* a DT, did not just have the DT because they lacked conventional sewage and that they would buy or build a DT if they moved to a new place that had sewage. In sharp contrast, no León user mentioned they really *wanted* a DT, and only 2% mentioned they would build a DT in another place if conventional sewage was available there.

On the awareness scale, we observed a similar trend. Tepoztlán and PM users consistently had the highest rankings, with Xochimilco users closely behind and Juárez respondents somewhat farther behind, but still demonstrating significant environmental awareness. In this case PMU was indistinguishable from PMR. Users in Juárez had the highest ratings for health and hygiene awareness, likely because a school of public health promoted this program. Again, León users consistently showed very low ratings. They were also the least informed and less well-trained

Table 6. Variables of user motivation to install or accept a DT, by class and by site.

Motivations	% of Respondents at site				
	León N (99–128)	Tepoz N (4–5)	PM[1] N (24–30)	Juárez N (51–81)	Xochi N (35–40)
Ideological					
I wanted to try something new	NA[2]	0%[a]	3%[a]	6%[a]	0%[a]
I wanted to protect the environment	NA[2]	60%[b]	PMR 50%[b] PMU 17%[b]	5%[a]	30%[b]
I *wanted* a DT; I didn't accept it only because I don't have sewage	0%[a]	100%[b]	PMR 91%[b] PMU 64%[c]	39%[c]	34%[c]
I would buy/build a DT like this one if I moved to another place, *even if there was normal sewage there*[3].	2%[a]	100%[b]	75%[b]	27%[c]	41%[c]
Awareness					
The trainers said the DT is good because it avoids water pollution	10%[a]	80%[c]	80%[c]	37%[b]	68%[c]
I know this type of toilet pollutes water less than other types of toilets	36%[a]	100%[b]	93%[b]	79%[b]	90%[b]
The trainers said the DT is good because it saves water	20%[a]	60%[b]	37%[b]	27%[b]	38%[b]
The trainers said the DT was good for health and/or hygiene	7%[c]	0%[c]	10%[c]	52%[a]	25%[b]
I don't know, [or] the trainers didn't tell me why the DT is good	22%[a]	0%[c]	0%[c]	4%[b]	0%[c]
Demand					
Before the DT opportunity came up I was already looking for a solution to my sanitation needs	8%[a]	80%[b]	59%[b]	70%[b]	68%[b]
Pragmatic					
I wanted to have better health and/or hygiene	NA[2]	0%[a]	0%[a]	10%[a]	3%[a]
I knew people who had a DT	NA[2]	0%[a]	0%[a]	5%[a]	3%[a]
The DT is a good solution for our sanitation needs	NA[2]	0%[a]	13%[a]	31%[a]	38%[a]
The DT is a temporary solution for our sanitation needs	NA[2]	0%[a]	0%[a]	12%[a]	5%[a]
The DT was cheap	NA[2]	20%[a]	PMR 17%[a] PMU 6%[a]	3%[a]	8%[a]
The DT was free	NA[2]	0%[b]	PMR 0%[b] PMU 50%[a]	19%[b]	8%[b]
The DT was already in the house when I moved there	100%[a]	0%[b]	7%[b]	3%[b]	0%[b]

[a,b]Within each row, sites with different superscripts are significantly different from each other at $p < 0.01$.
[1]Values are given for both PM sub-programs (PMR and PMU) when their individual values are significantly different ($p < 0.05$), and the joint PM average would otherwise be misleading.
[2]NA indicates we did not ask these questions in León. Since the houses people were sold in León already came with the DT, it was not an active choice of the user to install or accept the toilet. León users were automatically assigned "DT was already there" in one set of motivation questions.
[3]This percentage include users who answered "yes" or "yes, but I don't have the money".

group with 22% of users reporting 'I don't know …' or 'the trainers didn't tell me why the DTs were good'.

Demand for sanitation prior to the appearance of the DS program was greatest in Juárez, Xochimilco and Tepoztlán. In León, very few users expressed having had a demand for sanitation prior to the program.

Pragmatic motivations varied by site, but were more predominant for users in Juárez, Xochimilco and PMU. Juárez and Xochimilco had a considerable population that accepted the DTs because they were a good solution for their sanitation needs (31–38%). In Xochimilco, Juárez and PMU, 8–50% of users accepted the DT because it was free. The low cost of DTs was a motivating factor for 17–20% of users in Tepoztlán and PMR.

Innovativeness, diffusion, and health/hygiene were not major motivations interviewees expressed as reasons why they installed or accepted their DTs.

3.3.4 Effect of previous toilet on current satisfaction. It is difficult to determine with this dataset the effect of previous toilet on current satisfaction (table 7). Most of the people who previously had a WC (access to conventional sewage)

were overwhelmingly in the León site, and at this site only 11/128 users did not previously have access to a WC. At the others sites, previous WC owners constituted very small sample sizes (1, 2 or 9 people per site). Only PM and León had enough data to adequately test the intra-site difference between previous WC and non-WC owners, and the differences proved not significantly different ($p < 0.05$). Previous WC-users were within the characteristically high (or low) range of DT satisfaction of their site. This may suggest a site/program effect on satisfaction rather than a previous-toilet effect. However, caution must be heeded in drawing conclusions due to the very small sample sizes.

Although effect of previous WC use on current satisfaction was difficult to assess in this dataset, we asked other questions comparing previous toilets to current DTs (table 8). We asked users to rate their satisfaction with their previous toilet, which toilet was more problematic (the current DT or their previous option) and which of the two options they preferred.

Satisfaction with previous toilet tended to be high when current satisfaction was low (León) and low when current satisfaction was high (the rest of the sites). Whereas users in León found the DT to be most problematic and preferred their previous toilet, users at the rest of the sites found the DT less problematic and preferred the DT. The only deviation to this trend was PMR, where users found both toilets equally problematic, yet still preferred the DT.

3.3.5 Adequate toilet operation. To assess whether better-functioning toilets affected user satisfaction, we asked users to enumerate freely the problems their DTs posed for them. Between 14 and 40% of respondents reported no problems; the rest mentioned a variety of problems. We list the most frequently mentioned problems in table 9. Since user operation can affect the type and level of problems the toilets present, we include in the table observations of whether the last fecal deposition was covered.

Once again, León fares poorly relative to other sites. It is the site with fewest reports of 'no problems' and significantly higher ratings of bad odors, excessive humidity and too much work. It was the only site where users considered the DT to be unsanitary. Juárez and Xochimilco had the highest complaint rates about small room and uncomfortable toilet. They were the only sites where small booth, prefabricated toilets were installed. Juárez had the highest complaint rates of lack of cover material, which is also reflected in the slightly higher percentages of uncovered feces at that site. From the table, it appears that

Table 7. Current satisfaction with DT, based on previous toilet ownership, by site.

	Sites				
Satisfaction based on previous toilet	León	Tepoz	PM	Juárez	Xochi
Previously used a WC	N = 117	N = 1	N = 9	N = 2	N = 1
	5.3	10.0*	8.5	9.5	10.0*
Previously used a non-WC option[1]	N = 11	N = 4	N = 17	N = 73	N = 35
	6.5	8.4	8.9	8.7	8.8
Overall satisfaction (1–10)	*N = 127*	*N = 5*	*N = 26*	*N = 75*	*N = 35*
	5.47	*8.70*	*8.79*	*8.73*	*8.90*

Within each column, subpopulations were not significantly different from each other at $p = 0.05$.
[1]non-WC options included: bush, latrine, septic system/hole.
*In cases where $n = 1$, small sample size was considered not representative and tests were not performed.

Table 8. Comparisons between current DT and previous toilet option, by site.

	Sites				
Comparisons	León N (113–126)	Tepoz N (5)	PM N (26–29)	Juárez N (69–80)	Xochi N (33–40)
Which toilet is more problematic? DT (0), previous toilet (10)	0.72^{a}	9.0^{c}	PMR 5.25^{b} PMU 9.0^{c}	8.45^{c}	8.97^{c}
Which toilet do you prefer? DT (10), previous toilet (0)	0.71^{a}	10^{b}	PMR 9.17^{b} PMU 8.82^{b}	8.48^{b}	8.18^{b}
Satisfaction with previous toilet (1–10)	8.6^{a}	3.6^{b}	4.9^{b}	5.2^{b}	5.0^{b}
Overall satisfaction with DT (1–10)	*N = 127*	*N = 5*	*N = 26*	*N = 75*	*N = 35*
	5.47[b]	*8.70*[b]	*8.79*[b]	*8.73*[b]	*8.90*[b]

[a,b]Within each row, sites with different superscripts are significantly different from each other at $p < 0.05$.

excessive moisture is more proportional to bad odors than to uncovered feces, whereas the presence of flies and insects seems to be proportional to uncovered feces.

3.3.6 Training. We asked DT users whether the training talks and materials they had received had been easy or difficult to understand and whether they had been useful or not (table 10). Overall, talks and written materials were easy to understand and for the most part useful. This is one of the few cases where León users rank similarly to those at other sites. León users found the materials and talks easy to understand, but somewhat less useful. In Juárez, users tended to find the talks slightly less easy to understand than at the rest of the sites. In the whole dataset, there were very few people who considered either the talks or the materials to be difficult to understand ($<3\%$) or not useful at all ($\leqslant 2\%$).

3.3.7 Follow-up. We inquired into the adequacy and helpfulness of follow-up services from the users' perspectives (table 11). León users rated significantly lower than the rest of the sites in three out of the four questions: receiving enough follow-up visits, receiving effective help in solving problems that arose, and understanding explanations. Xochimilco users rated poorly on receiving enough follow-up visits and knowing whom to contact in case of problems with the DT. In contrast, Tepoztlán, PM, and Juárez users knew whom to contact and were almost always helped by the people they contacted.

3.4 *Incentives needed to encourage DT acceptance*

The lack of aesthetics and the inconvenience of outdoor DTs, the labor investment required for maintenance and end-product management, and the lack of an economic

Table 9. Toilet operation problems, by site.

	Sites				
% Users reporting operation problems	León N (111–128)	Tepoz N (5)	PM N (25–30)	Juárez N (72–81)	Xochi N (33–40)
I do not have any problems with my DT	14%[a]	40%[b]	40%[b]	33%[b]	38%[b]
DT smells bad	45%[a]	20%[b]	13%[b]	5%[b]	5%[b]
DT chamber is too humid	39%[a]	20%[b]	3%[b]	3%[b]	5%[b]
DT has flies/insects	19%[a]	0%[a]	3%[a]	16%[a]	23%[a]
DT is too much work	22%[a]	0%[b]	10%[b]	3%[b]	3%[b]
DT room is too small	3%[b]	0%[b]	0%[b]	27%[a]	23%[a]
DT is uncomfortable	7%[b]	0%[b]	0%[b]	17%[a]	18%[a]
DT is unsanitary	15%[a]	0%[b]	0%[b]	0%[b]	0%[b]
I do not have enough cover/texture material	5%[b]	0%[b]	4%[b]	24%[a]	18%[a]
% DTs where last fecal deposition was NOT covered (observation)	23%[a]	20%[a]	NR[1]	34%[a]	25%[a]
Overall satisfaction (1–10)	*N = 127* *5.47*[b]	*N = 5* *8.70*[b]	*N = 26* *8.79*[b]	*N = 75* *8.73*[b]	*N = 35* *8.90*[b]

[a,b]Sites with different superscripts are significantly different from each other at $p < 0.05$.
[1]In Clivus Multrum-type toilets, such as those used in PM, fecal depositions need not be covered immediately for adequate operation. This measure is thus not a relevant 'toilet operation' variable for the PM site.

Table 10. Training variables and DT user satisfaction, by site.

	Sites				
Training variables	León N (94–96)	Tepoz N (2–3)	PM N (1–25)	Juárez N (67–77)	Xochi N (32–38)
The talks were easy (10), so-so (5), difficult (0) to understand.	9.6[b]	10[b]	9.6[b]	8.4[a]	9.1[b]
Were the talks useful? (0,5,10)	8.9[a]	10[a]	10[a]	8.8[a]	9.2[a]
Were the written materials easy to understand? (0,5,10)	9.6[a]	10[a]	10[a]	9.0[a]	8.4[a]
Were the written materials useful? (0,5,10)	8.6[a]	10[a]	5*	9.2[a]	8.9[a]
Overall satisfaction (1–10)	*N = 127* *5.47*[a]	*N = 5* *8.70*[b]	*N = 26* *8.79*[b]	*N = 75* *8.73*[b]	*N = 35* *8.90*[b]

[a,b]Within each row, sites with different superscripts are significantly different from each other at $p < 0.01$.
*$N = 1$ for this question. This was not considered representative, and therefore it was not tested.

incentive are three sets of deterrents that we have observed in DT adoption. In order to assess the degree to which these three sets of factors presented an obstacle to DT acceptance by users, we asked a sequence of hypothetical questions. The questions were based on the assumption that providing DTs and a graywater collection with treatment system to a community is less expensive than providing conventional sewage with sewage treatment plant (Otterpohl *et al*. 1997), and that those savings could be passed on to the users. We first asked people whether they could prefer a DT over conventional sewage if: (a) the DT was in a beautiful and comfortable indoor bathroom, along with a graywater collection system for their home; and (b) the cost to them of the DT/graywater system was lower than conventional sewage (**yes1**). If they answered yes, we skipped the following two questions. If they answered no, we asked the second question, which addressed the labor component: if, in addition to the option described above, there was a maintenance service for any DT malfunctions, and a collection service for the toilet end-product, would they be more interested in the option of the DT inside the house with the graywater collection system, over the conventional sewage system, assuming a lower investment cost for them? (**yes2**). If they still said no, we added the water pricing element: if the piped water to the house cost a lot of money, and therefore flushing the toilet would be 'expensive', would they be more interested in the option of the DT inside the house with the graywater collection system, over the conventional sewage system? (**yes3**). Table 12 displays the results of these questions.

The first set of incentives (**yes1**) was sufficient for practically all users in Tepoztlán and PM, and for 59–66% of users in Juárez and Xochimilco to accept DS as a long-term solution. Providing maintenance and collection services in addition to the first set of incentives (**yes2**) attracted 39% and 15% of the remaining populations in Juárez and Xochimilco, respectively. A proposed increase in water supply costs (**yes3**) attracted almost half of the population in Juárez and Xochimilco that had not already been interested with the previous two sets of incentives. The

Table 11. Follow-up variables and DT user satisfaction, by site.

	Sites				
Follow-up variables: % of users responding 'yes'	León N (99–120)	Tepoz N (5)	PM N (26–30)	Juárez N (72–79)	Xochi N (26–40)
Did you receive enough follow-up visits? (yes)	23%[a]	NA[1]	86%[c]	74%[c]	56%[b]
Did you understand explanations? (yes)	77%[a]	NA[1]	100%[b]	85%[b]	85%[b]
Do you know who to contact in case of problems? (yes)	79%[b]	100%[c]	97%[c]	90%[c]	70%[a]
Do the people you contact solve your problems? (yes)	51%[a]	100%[c]	93%[c]	97%[c]	72%[b]
Overall satisfaction (1–10)	*N = 127* *5.47*[a]	*N = 5* *8.70*[b]	*N = 26* *8.79*[b]	*N = 75* *8.73*[b]	*N = 35* *8.90*[b]

[a,b]Within each row, sites with different superscripts are significantly different from each other at $p < 0.05$.
[1]There was no formal follow-up in Tepoztlán.

Table 12. Percentage of users who would accept various incentives schemes designed to encourage DT acceptance, by site.

	% of user acceptance by site				
Incentives	León	Tepoz	PM	Juárez	Xochi
Indoor, aesthetic DT with graywater system & lower cost than CS (**yes1**).	(N = 127) 5%[a]	(N = 5) 100%[b]	(N = 29) 97%[b]	(N = 75) 59%[c]	(N = 38) 66%[c]
All of the above + maintenance + end-product collection (**yes2**).	(N = 121) 9%[b]	NA	NA[1]	(N = 31) 39%[a]	(N = 13) 15%[b]
All of the above + high water supply price (**yes3**).	(N = 110) 19%[b]	NA	NA	(N = 19) 50%[a]	(N = 11) 41%[b]
Aggregate % of users who said Yes	(N = 127) 30%[a]	(N = 5) 100%[b]	(N = 29) 97%[b]	(N = 75) 87%[b]	(N = 38) 76%[b]
Overall satisfaction (1–10)	*N = 127* *5.47*[a]	*N = 5* *8.70*[b]	*N = 26* *8.79*[b]	*N = 75* *8.73*[b]	*N = 35* *8.90*[b]

[a,b]Within each row, sites with different superscripts are significantly different from each other at $p = 0.01$.
[1]1 person in PM responded "don't know" to all three questions. Hence the following two questions did not have any possible remaining 'yes' responses.

acceptance rates in León were lower overall. Only 5–20% of the respondents to each question would be interested in DT as a long-term solution based on these sets of incentives. The water pricing incentive proved to attract the greatest number of León users, followed by the labor reduction incentives. Combining all three sets of incentives, only 30% of total users in León could be interested in DS as a long-term solution, compared to 76–100% at the four other sites.

4. Discussion

4.1 *Response rates*

We attribute the high response rates in our survey to several potential causes. Owning a DT has a noticeable daily impact on people's lives; whether the experience has been negative or positive, it has usually implied a high level of user involvement. DT owners today generally have few peers with whom they can discuss issues that are raised in DT use; having an opportunity to discuss experiences with a polite and knowledgeable person, who can also provide useful insights is then welcome. Sensitivity on the part of the interviewer is likely an important element in respondent comfort level, and interviewer training emphasized this heavily.

4.2 *Satisfaction and influences on satisfaction*

4.2.1 Overall satisfaction. Two general observations emerge from our results: (a) four sites had practically identical (and very high) user satisfaction levels, despite widely varying programmatic, technical, and population characteristics; and (b) one site (León) had a much lower and significantly different satisfaction rate from the other sites studied.

(a) High satisfaction rates and the independence of satisfaction from specific variables—such as specific DT characteristics—is not unusual. Stoner (1977), and Pollard and her colleagues (Pollard 1997, Pollard *et al*. 1997) found high DT user satisfaction rates across a diversity of DT models (including prefabricated vs. built on-site, batch vs. continuous flow, and large containers versus small ones).

Our results suggest that different combinations of factors can lead to similar satisfaction levels and that satisfaction is likely multi-dimensional. This is consistent with findings in other research on satisfaction (Connelly 1987) and implies that satisfaction can be increased by efforts on diverse and multiple fronts. Knowledge about the various factors that influence satisfaction can give program implementers guidance regarding specific components to address in improving DS programs.

(b) Although it is not unusual that one site (León) had different satisfaction levels from other sites, the fact that the satisfaction levels in León were so comparatively low warrants discussion.

The León case was a housing project, with relatively little emphasis on DS—both from the promoters' and the users' perspectives—where users had no choice in the sanitation system, and with important design and program deficiencies. Design and construction errors led to accumulation of liquids in the processing chambers and toilet malfunction; changes in administration interrupted technical and political support; social conflict in the housing development also contributed to the great difficulties of this program. Collectively, these issues may explain a great amount of the lower satisfaction rates at this site. León users considered their DT to be much more of a problem than a benefit, the end-product management was unpleasant and it was a cost with no perceived benefits. This is not surprising considering there was a high percentage of liquid accumulation and malfunction of the toilets, users had little unpaved space on their property to apply the end-product had they wanted to (though some people did) and many people hired someone to empty the DT for them when it was full, so that, if anything, the end-product represented a cost to them. León users expressed more problems of bad odors, excessive humidity and more work than users at other sites, and were the only users to express that the DTs were unsanitary. Overall, León users found their current toilet to be much more problematic than their previous one and preferred the previous one. On the motivation scales, no León user mentioned they *really* wanted a DT, and a very large number of users were not aware of why the DTs were 'good'. Again, this is not surprising considering the users were looking for housing, not sanitation, and the DT training was secondary to other issues in the program. It is, however, indicative of the importance of motivation, awareness, and understanding. Users in León found training easy to understand and mostly useful. However, follow-up support was considered inadequate and insufficient. Finally, 2/3 of León users could not be convinced to accept a DT as a permanent option in a hypothetical scenario, even with various incentives offered. This is understandable, considering all the problems the toilets posed for them, and the fact that they were likely not able to imagine a convenient and functional DT. Overall, then, León users perceived significantly fewer benefits and more problems associated with the DT relative to users in other programs.

To have studied León by itself would have given a dismal appreciation of user satisfaction in large-scale urban DS and studying any of the other sites by themselves may have given an overly optimistic view. The value of multiple case studies is that best-practice and worst-practice perspectives can be obtained. On the criterion of *user satisfaction*, León serves as a worst-case scenario, illustrating how not to do things. And yet the program overall still had many positive

elements.* DT satisfaction in León was widely distributed across the users and 39% of respondents reported a satisfaction level between 7 and 10. Future research might evaluate what factors within this site influenced those users who were more satisfied.

The characteristics of the Léon program as well as the consistently low ratings on most of the variables measured explain why León users had such low satisfaction rates. In the following sections, we discuss how the same variables differed among the four other sites, both in contrast to León as well as between themselves.

4.2.2 Motivations. The four remaining sites are distinguished most clearly from León by some level of user choice, indicating the importance of voluntary adoption in DT user satisfaction, an observation consistent with previous research (Drangert 1997, Fittschen and Niemczynowicz 1997, Del Porto and Steinfeld 1999). Users at these sites tended to be more aware of the benefits of DTs and were more ideologically motivated, particularly in Tepoztlán and PMR. It is not surprising that ideological motivations would be prevalent among self-directed users under a diffusion-style program, as in the case of Tepoztlán and PMR. Ideological motivation was also present significantly in PMU, an institutionally promoted program. PMU users were very low-income people who lived in the same community where wealthy PMR users had previously installed DTs. Therefore, in addition to solving lack of sanitation, DTs had some socio-economic status in this community. This may be related to the high commitment of PMU users to their DTs.

Across all four sites, innovativeness and diffusion were not major motivations people expressed as reasons why they installed or accepted their DTs. This can be explained easily in the case of the large institutional programs: they only had budgets for a set number of toilets, in many cases the program implementers defined selection criteria for eligibility, and the toilets were usually installed in a short period of time after which there were no more installations. The diffusion of innovations model does not apply well to these cases, where there is not a continuous source of availability, and where there was not a long enough period for people to see toilets functioning and then request one for themselves. In contrast, one might have expected such a motivation in the Tepoztlán and PMR diffusion-style programs, yet most users at those sites did not mention wanting to try something new or knowing someone who had a DT as the reasons why they chose to install DTs.

*Solutions to various large-scale issues associated to urban DS programs were eventually developed in León, such as a biweekly free curbside collection service of the end-product by the local government and the informal creation of a job for one person to empty the toilets, for example.

Demand for sanitation was shared by users in these four sites and differed significantly from León users. None of the sites (including León) had general access to conventional sewage, yet users in Tepoztlán and PMR had economic access to highly sophisticated septic systems with all the conveniences of flush toilets, and chose and preferred DT instead. Some users in Juárez and Xochimilco could have installed septic holes, but did not have the water supply or were concerned about polluting the groundwater (Xochimilco). Demand for sanitation was thus created through lack of conventional sanitation, lack of water, and/or environmental awareness. In many sites, environmental awareness was created through DS program training. For example, Xochimilco and PM implementers emphasized protection of groundwater and canal/coastal waters. In other programs, training emphasized health and hygiene (e.g. Juárez).

Pragmatic motivations varied by site, but were more predominant in Juárez, Xochimilco and PMU, which were also the low-income populations who likely had less access to attractive alternative sanitation options than users in Tepoztlán or PMR. In Juárez and Xochimilco, 31–38% of the users indicated they accepted the DT because they needed sanitation; 19% and 50% of users in Juárez and PMU, respectively, indicated they accepted the DT because it was free. Juárez had the highest ratings for health and hygiene awareness, yet health and hygiene were not major initial motivators in acquiring a DT (3–10%). The low ranking of health among the most common reasons people invest in sanitation is consistent with other reports, which cite dignity, convenience, privacy, clean environment and social status as more important motivators for users (Wegelin-Schuringa 2000, WHO and UNICEF 2000).

4.2.3 Adequate toilet operation and follow-up. Besides various degrees of user motivation and choice, the four sites shared relatively well-functioning toilets and effective follow-up support. The users at these sites also generally considered their DT to be more of a benefit than a problem and preferred the DT to their previous sanitation option.

4.2.4 Effect of previous toilet on current satisfaction. It is not clear from our dataset what the effect of previous toilet is on current satisfaction, due to the small sample sizes of different previous toilet options, particularly of previous WC use. It also appears that in our dataset, the effect of this variable is confounded with site/program effects, as well as with user motivations. If people are well-educated about the DTs, convinced they want to have one, and the DT functions well, it is not surprising that they would be satisfied with the DT even if they previously used a WC (which might appear on the surface as less problematic to

the user*). In the four sites with highly satisfied users, the problems posed by the DT were not very large, and the extra attention they required (*vis-à-vis* a WC) was not the determining factor in satisfaction. The interesting case in this set was PMR. Although the DT was as problematic to users as their previous toilet (more problems that the rest of the sites, excluding León), they still preferred the DT to their previous toilet option. Further research among other DT user populations where previous history is more balanced will be necessary to understand the effects of this variable on current user satisfaction.

4.3 *Incentives to encourage user acceptance*

Between 76 and 100% of users at the four satisfied sites would be interested in accepting DTs over the long term and over a somewhat more expensive conventional sewage option. For Tepoztlán and PM, the first set of incentives (indoor, aesthetic toilet and graywater system) was sufficient. In Juárez and Xochimilco, additional maintenance and collection services, and pricing disincentives were still considerably important. In León, 2/3 of the users would not be interested in accepting a DT for the long term, even with all three sets of incentives. It would seem that, provided the DTs work well, up to 24% of people would have needed other incentives besides the three sets evaluated here to accept DTs as a long-term option. In cases where the toilets did not work well (León), this proportion rose to 70%. We discuss each set of incentives in turn.

Practically all users in PM and Tepoztlán accepted DTs based on the first incentive. The DTs at these two sites were already very aesthetic, and many had already been built inside the homes, in contrast to the DTs in Juárez, Xochimilco, and León, where the toilets were unattractive, uncomfortable and outdoors. It is possible that people who have had a personal experience with beautiful/indoor DTs may more easily accept them as a long-term option than users who have never seen such DTs and who might have a more difficult time imagining them. Social status may also be at play in the differential acceptance of this incentive across the five sites. Juárez, Xochimilco and León happened to be mainly low-income populations, whereas Tepoztlán and PM covered the socio-economic spectrum more broadly. Within these two sites, PMU was the only low-income population under an institutionalized program and PMU users had a significantly higher acceptance than users in Juárez, Xochimilco and León. In those three sites, some people who would not accept the DTs mentioned that they wanted a WC because they wanted a 'normal' home or toilet, 'the way it's supposed to be' (survey open-ended responses). It is worth considering whether the fact that PMU users knew they were receiving the same type of toilets wealthy people in the community were receiving was also a factor in their acceptance of the DT for the long term. Unattractive outdoor toilets did not seem to fit people's perceptions of a 'normal' urban home. This dataset cannot decouple unattractive toilets from toilets-only-for-poor-people in the lower acceptance of Juárez, Xochimilco and León, but it does suggest that future research should examine whether low-income populations would accept DTs more readily as a long-term option if they knew high-income people in their community also had them.

The second set of incentives—provision of collection and maintenance support systems—increased user acceptance at the three remaining sites (Juárez, Xochimilco and León). Since the provision of these services would also improve overall toilet operation, and consequently program success, it is highly recommended to create such services in DS programs, particularly in large-scale urban settings where a diverse population, motivated by different sets of issues, might be expected.

The third incentive we suggested—high water supply pricing to discourage flush toilets—also increased acceptance, most notably in León and Juárez. Some users said that if water supply was expensive, they could flush the toilet with graywater or rainwater that they would collect personally. This is a creative way to address the water supply pricing disincentive. If a city was committed to promoting DTs, it might have to charge high prices for water supply as well as for sewage discharges.† With high enough water pricing (likely even only the full cost of supply), combined with aesthetic, convenient DTs, and good maintenance/collection services, great strides in achieving the ultimate acceptance of DT might be made. The use of the pricing incentive should, however, be done with caution. In low-income areas, people are truly struggling to make ends meet, and it would be very unfair to 'entice' them to accept DTs through otherwise burdening them with having to pay the full cost of urban water supply, especially if other income-level groups are receiving subsidized prices. Thus, recommendations of cross-subsidies in water pricing (Habitat 2001a) would apply here.

These responses are based on users' thoughts of what they would do in hypothetical situations. Although their responses may not perfectly reflect their choices under real development scenarios, these results represent a good attempt at identifying how problematic various aspects of DS are to users (aesthetics and convenience, labor and maintenance, real costs of water supply and treatment). They also identify a range of incentives that would seem to make a difference in people's acceptance of DT and show that different proportions of people might need different incentive strategies.

*Some interviewees said explicitly that the fact that sewage treatment was not effective was 'problematic' to them, indicating that users can perceive issues *beyond* their household as problematic.

†This dual pricing already occurs in some countries (e.g. Germany).

4.4 *Applicability to other contexts and implications for future urban dry sanitation programs*

4.4.1 Population types. The current experiences, and thus the available data, on urban large-scale DS programs seem to focus mainly on two broadly defined population types: (a) mostly self-motivated individuals (from high, medium and low-income groups) and (b) mostly low-income, peri-urban dwellers under institutional programs. This apppears true for Mexico as well as other countries. In less developed countries, several large-scale urban DS programs have been implemented or are being considered for low-income urban and peri-urban settlements (e.g. El Salvador (Gough 1997) and South Africa (Bhagwan 2002)). Broad-scale DS efforts for middle class urban residents have not yet received sufficient support (e.g. Tanzania (Niemczynowicz 1999b)). In more developed countries, large scale DS initiatives have occurred or are considered in eco-friendly developments (in Sweden (Drangert 1997, Fittschen and Niemczynowicz 1997); Germany (Otterpohl *et al*. 1997); Australia (Del Porto and Steinfeld 1999); and the United States (Del Porto and Steinfeld 1999, Campi, 2001)). These types of developments generally attract environmentally oriented, self-motivated individuals.

From the self-motivated population type in Mexico, we can deduce that DS can be acceptable to all income levels. From the low-income, peri-urban population type in Mexico we can deduce that DS can be acceptable to people who were not ideologically motivated prior to program implementation. Although users in each of these groups fell in the broadly defined 'self-motivated' or 'low-income peri-urban' groups, not all individuals in the former group were die-hard environmentalists, nor all in the latter low-income residents. Thus, DS satisfaction, though generally 'limited' to these population types at this time, need not be considered acceptable only to them.*

4.4.2 Option of dry sanitation. All the Mexican sites studied shared a lack of generalized access to centralized waterborne sewage. One would expect to find large-scale DS programs in places where conventional sewage is not an option. However, without further research one cannot deduce automatically that where conventional sewage is an option, people would not be satisfied with DTs. German and Swedish ecodevelopment experiences within city limits (in Lübeck (Otterpohl *et al*. 1997) and in Stockholm (Jönsson *et al*. 1997, Ingvar-Nilsson 2001)) suggest that people with potential access to conventional sewage may very well prefer DS. The fact is that, currently, people in areas with access to conventional sewage do not usually think (or have to think) about alternative sanitation options, nor are they presented with alternative sanitation options. In our survey, 27–100% of users in the four satisfied sites said they would buy or build a DT if they moved to another place *even if there was sewage there* (table 6). In other words, once people have had a satisfactory experience with a DT, many would choose to use it permanently. Thus, the low demand for DS in urban settings among broader populations groups may reflect the fact that few people in areas with conventional sewage have the real option (awareness, knowledge and access) of DS. Until DS is an option for broad populations of urban residents, we will not know how satisfied other population groups may or may not be with the technology, and further research on this topic is necessary.

4.4.3 Increasing mainstream acceptance. The incentives questions we asked provide an idea (and working hypotheses) of what urban residents would like in an ideal world. The preferences of low-income peri-urban dwellers, who aspire for 'urban' conveniences and yet are not a population defined** by environmental motivations could give an indication of what the 'broader', mainstream urban population might prefer.† From their responses, we know that a properly functioning, aesthetic, indoor DT would greatly increase acceptance. The provision of support and maintenance services and economic disincentives for water use would increase acceptance still more. Even so, 13–24% of these peri-urban dwellers‡ would not readily accept a DT under these circumstances. It is at this point where other strategies, such as raising the 'status' of DTs by publicizing their use among higher-income level households, and stronger awareness-raising campaigns may have a noticeable effect in increasing mainstream user acceptance. This would seem to be warranted by our results and the recommendations of other DS researchers and practitioners (Del Porto and Steinfeld 1999, Niemczynowicz 1999b, Interviewees C-1 and D-1).

*For example, Hanaeus *et al*. (1997) report that only 2/17 families in a Swedish Ecovillage with urine-diverting toilets had moved there for environmental reasons. Others had been motivated by wanting to live in an 'attractive rural area within a reasonable distance from the city center' (p. 156).

**Though certainly some of these residents do have an environmental motivation, as our survey showed.

†This may be a conservative estimate. Peri-urban dwellers may be more reluctant than the general population to accept alternatives to flush toilets because their chronic lack of access to adequate services may increase what Tiberghien (2002) calls the 'lure of modernity', represented by conventional sanitation. Stoner (1977) reports that previous latrine owners were sometimes the most resistant to using DTs, because they were tired of the experience.

‡We are not counting León users at this moment, because we estimate that a great degree of León users' reluctance is due to the high malfunction rates and other problems specific to this site, and that would bias the responses for this particular discussion.

4.4.4 Intermediate adoption. Another incentive for DT use might be an intermediate adoption—the use of DTs as secondary and/or complementary toilets in homes, which have water-based sanitation options. Many users in our study expressed this interest in versatility—be it for periods when water is lacking, to use just for urinating (or just for defecating), to have an extra toilet when a house has many people, or to allow some household members to use one type of toilet while the others use another type. We believe this might also allow new users to become familiar with DS without feeling they have to risk an all or nothing situation. A dual sanitation system in a household would not eliminate the need to invest in water-borne sewage infrastructure, but it could become an element of a larger DS diffusion strategy, and in the process it would save water and keep nutrients out of the wastewater stream (Otterpohl *et al*. 1997).

4.4.5 Hardware and software. The complementary importance of sanitation hardware and software has been recognized widely (Black 1998). Essential for DS success and user satisfaction are adequate training, effective technical support and a supportive regulatory environment. Pollard *et al*. (1997) attribute a large part of the success of DTs in Lismore, Australia to a longstanding cultural ambience which has encouraged eco-friendly technologies, a supportive regulatory authority, and a well-organized informal information network. Our results showed that whether programs were promoted institutionally or not, effective technical support was associated with higher levels of user satisfaction (and lower levels of toilet problems). Fittschen and Niemczynowicz (1997) suggested that better user training in toilet operation would likely have led to fewer problems and higher satisfaction in their study site.

5. Conclusions

User satisfaction with dry toilets (DTs) was studied in five urban and peri-urban sites in Mexico. High satisfaction rates were found with different combinations of program style (institutional versus diffusion) and toilet models (desiccating versus composting, batch versus continuous flow process, pre-fabricated versus built on-site), as well as among populations with different motivations (pragmatic versus ideological), income-levels (high, medium and low) and previous sanitation history (waterborne sewage, latrines, septic holes). User choice in accepting DTs and awareness of the purported benefits of dry sanitation (DS) were important in user satisfaction. User dissatisfaction was associated with technical and programmatic factors such as poorly designed toilets, large number of malfunctioning toilets and poor follow-up and support systems for users.

Assuming functional DTs and lower costs than conventional sewage services, incentives that would increase user acceptance of DS include indoor, aesthetic toilets with a complementary graywater system for the household, maintenance and end-product collection services and high water supply costs (as a disincentive to the flush toilet). The use of DTs as complementary systems in households with access to waterborne sewage might be an intermediate phase in DS diffusion. Associating DTs with high social status and raising awareness of the existence and benefits of DS might be additional important elements in increasing user acceptance of this technology.

DS program implementation features (sanitation software) are complementary to sanitation hardware and have a strong influence on user satisfaction. The toilet must function well and there must be adequate support systems. Currently, urban DS has been promoted mostly among environmentally motivated and low-income populations. A better understanding of user satisfaction with DTs will be achieved when DS is promoted to, or at least made a viable option for, a broader urban population including residents who may have access to conventional sanitation. The relatively low demand for DS among a broader base of urban residents may be due more to lack of citizen *opportunity* to install DTs and inadequate incentive systems than to an inherent inability of DTs to perform well at a large scale in urban areas.

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