Sustainability assessment of onsite sanitation facilities in Ramallah-Albireh district with emphasis on technical, socio-cultural and financial aspects

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Abstract

Purpose – This paper seeks to evaluate the present onsite sanitation systems in Palestinian rural areas in Ramallah-Albireh district with special emphasis on technical, socio-cultural and financial aspects.

Design/methodology/approach – A specialized questionnaire was developed and distributed to 200 households in four randomly selected villages with less than 5,000 persons and having onsite sanitation facilities. WAWTTAR software package was used to evaluate 16 different treatment systems and to select a sustainable onsite treatment system for these rural areas based on technical, environmental, financial and socio-cultural considerations.

Findings – Major findings indicated that most of the respondents were in favor of using treated grey wastewater and equally rejected the use of mixed treated effluent for agricultural irrigation. More than 50 percent of the respondents were against having new onsite treatment systems and favored centralized wastewater treatment options, as only 18 percent showed willingness to participate partially in construction costs. The WAWTTAR data analysis on feasible onsite treatment alternatives revealed that the septic tank-subsurface wetland system offers a higher level of sustainability to rural communities in Ramallah-Albireh district. Finally, the social and economical aspects have an equal status in technical and financial issues.

Practical implications – The results obtained can be utilized by local and international experts seeking a carrier in the planning and design of sustainable sanitation facilities in developing countries or for those who have newly filled a post in governmental, non-governmental or academic institutions.

Originality/value – This paper highlights adequate tools for the selection of sustainable onsite sanitation systems in Palestinian rural communities. Methodology and dissemination of the obtained results can be applied to other rural communities in developing countries.

Keywords Palestine, Sewerage, Economic sustainability, Sanitary appliances

Paper type Research paper

Introduction

Wastewater management in Palestine has been a neglected issue over the past years. Due to financial constraints, inadequately equipped lab facilities and un-trained lab personnel no comprehensive data on wastewater characteristics and amounts discharged are yet available. Similarly, the effectiveness of the current urban treatment facilities is usually constrained by limited capacity, poor maintenance, process

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malfunction, poor maintenance practices, and lack of experienced or properly trained staff. In some districts of the West Bank (Nablus, Jenin and Hebron), where farmers have limited access to available water resources, raw or partially treated wastewater discharged into the wades (seasonal small streams) is used for irrigation purposes. The situation of the sewerage system is extremely critical. About 73 percent of the households in the West Bank have cesspit sanitation and almost 3 percent lack any sanitation facilities, where less than 2 percent of the households in small communities are connected to sewerage networks (Abu-Madi *et al.*, 2000). The 2000 Census indicated that 192,000 households used onsite systems or cesspools. Data on systems failure rate is lacking and no national estimate is available (PCBS, 2000).

Lack of financial national funds and inequitable political power placed domestic wastewater management in Palestinian rural communities at a second priority within the Palestinian water strategy. With donor financial aids, some local non-governmental organizations as the Palestinian Hydrology Group (PHG) and Palestinian Agricultural Relief Committees (PARC) have provided onsite sanitation facilities in some Palestinian small communities. Despite the huge efforts made by some local non-governmental organizations (NGOs), the initial decision to install a particular onsite treatment system was primarily made within the NGOs by non-experienced developers based on principles of low-cost treatment systems and NGOs profitability. In small communities, developers often chose onsite systems which could be easily installed for each dwelling. Once the onsite systems were installed, they were usually rarely examined again or maintained unless an emergency situation evoked. In some cases wastewater was either leaking or backing up into land; hence they were contributing to pollution of ground water and nearby surface waters bodies. In all Palestinian small communities, existing onsite sanitation facilities are inadequately designed, poorly sited, and rarely maintained over their service life cycle. Furthermore, the lack of experienced technical staff by the water related Palestinian institutions responsible for technical review and licensing as well as the outdated local municipal regulatory codes still facilitate and promote the continued use of such onsite systems (Al-Sa'ed, 2004).

The water quality of groundwater wells and some freshwater springs is experiencing signs of gradual nitrate pollution (Mukhallalati and Safi, 1995; Alawneh and Al-Sa'ed, 1997). Among the nitrogen pollution sources is untreated municipal sewage from urban areas, domestic discharges and septic tanks from Palestinian rural communities and Israeli colonies, excessive fertilizer usage, leachate from solid waste dumpsites (UNEP, 2004). The newly issued Palestinian Environmental Law aiming at the environment improvement imposes stringent penalties for polluters. However, regulations for effluent quality standards for sewage works, industrial discharges, and wastewater and biosolids reuses are still undefined (PNA, 1999).

Most of the rural sanitation facilities installed recently entail trickling filters, anaerobic and rapid filters as well as natural treatment systems (algal and duckweed pond systems) preceded by septic tanks (Theodory and Al-Sa'ed, 2002). Until now, all implemented small rural sewage treatment plants showed positive removal rates of organic matter and suspended solids but were poor in nitrogen removal (Al-Sa'ed and Zimmo, 2000). While selecting the treatment technology no attempts were made to assess the socio-economic aspects of the suggested treatment technology. The result is often system failure and an unsustainable solution in achieving safe and affordable wastewater treatment facilities. A recent study (Al-Sa'ed, 2005) conducted on the socio-economical aspects of decentralized sanitation in small Palestinian communities revealed that about 85 percent of the people accepted the idea while about 60 percent of them refused small onsite sanitation systems. The major reason behind these findings is that most (80 percent) of the respondents did not show willingness to pay or participate in construction costs.

According to Al-Sa'ed (2004), both PHG and PARC implemented onsite wastewater treatment systems of different types and sizes in the range between 5 and 1,000 inhabitants over the last five years. The established onsite sanitation systems are illustrated in Figure 1.

Sustainable development definitions vary according to which it is applied. Even in the evaluation of onsite wastewater treatment systems presented in this research, the relative weights for the sustainability criteria are affected by the values of the specific communities using the system. For example, environmental and climatic features, the neighborhood and other social factors, and the ability of the users to pay for the system and other economic factors affect the relative importance of each criterion. Key factors to success in formulating rural community wastewater management programs should include public acceptance and local political support, funding availability and reasonable costs, visibility and accountability of local leaders (USEPA, 1994).

Unfortunately, there are many examples of wastewater systems that do not relate to the local conditions; some of them are working despite their lack of suitability to the local environment, while other such systems fail altogether. Examples of the latter are some of the so-called ecological plants that work well in warmer climate, but without sufficient heat and sunlight they have no or very little effect or demand a lot of energy to work. Other examples are the projects where the users are not properly informed about the vulnerability of a plant to the contents of the wastewater. Van der Graaf *et al.* (1990) has conducted a study on small community wastewater treatment systems but did not investigate the socio-economical impact on the technology selection and comparison. Therefore, sustainability must be assessed in a local context. The main goal of this study was to evaluate rural onsite sanitation systems from the perspective of the community with special emphasis on technical, socio-cultural, environmental, and financial aspects.

Methodology

Social-cultural impacts on sustainability of rural sanitation facilities

Sustainable development must be environmentally friendly, socially acceptable and financially viable. It is widely agreed that progress towards sustainable services requires the integration of these three elements into the decision making process. For this purpose, a work plan has been prepared to identify the impact of socio-cultural issues on the existing rural onsite sanitation facilities of randomly selected four Palestinian rural communities in Ramallah-Albireh district (Figure 2). The selection of these rural communities was based on the population number (less than 5,000 persons); the existence of onsite treatment systems and incremental nitrate pollution signs in groundwater and surface water bodies (PWA, 2004).

A unified questionnaire format was developed and distributed during field technical site visits to the rural communities under study. Site visits were conducted in

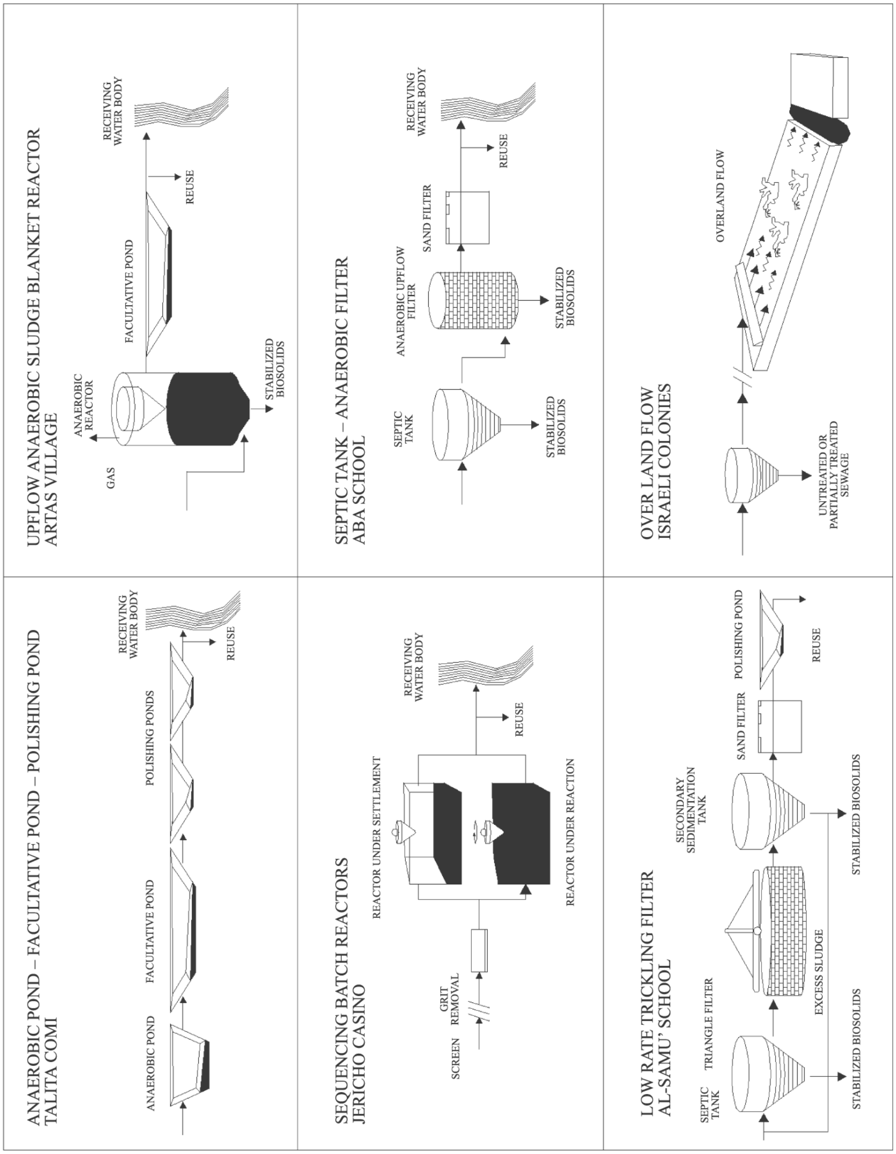

Figure 1.
Schematic diagram of onsite wastewater treatment systems in rural Palestine

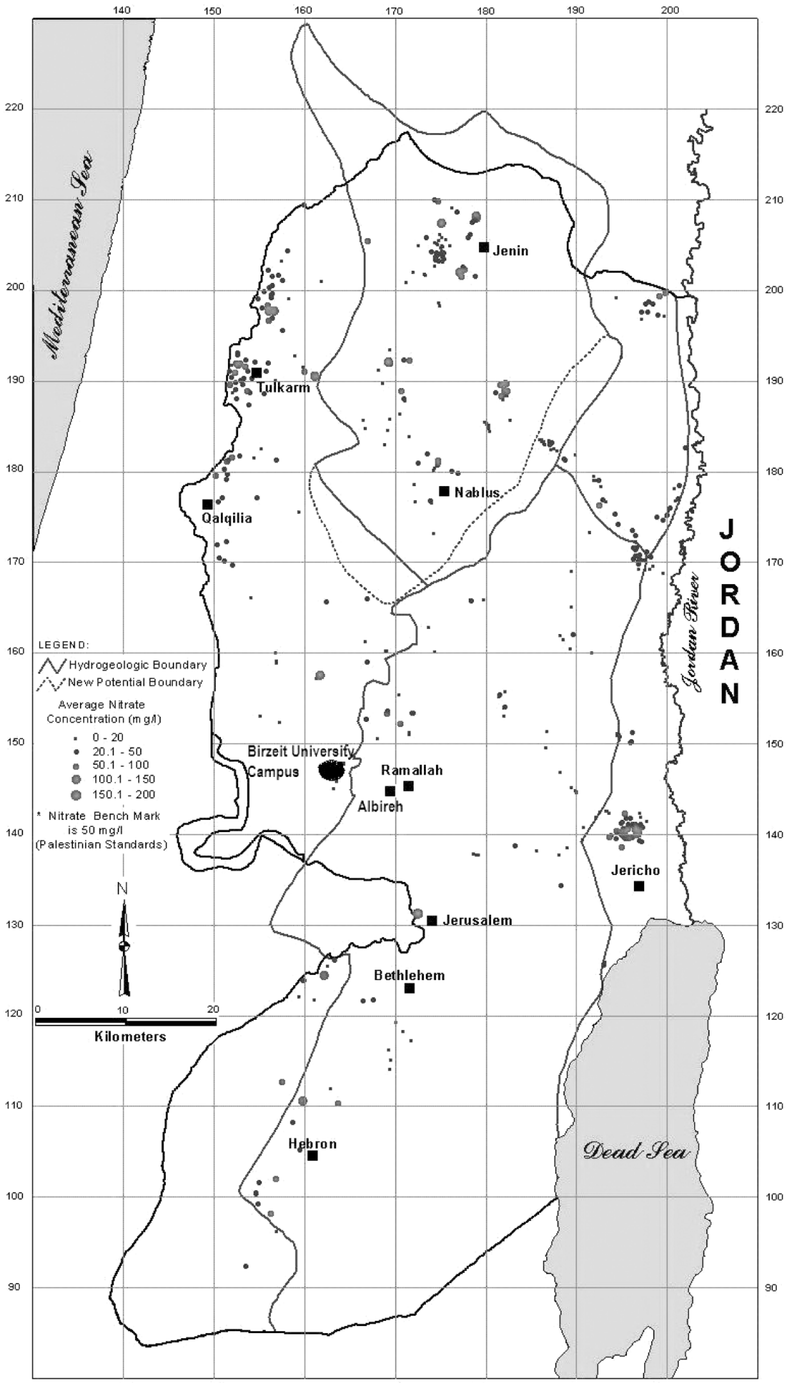

Figure 2.
West Bank districts-Ramallah-Albireh study area with nitrate pollution signs

November 2003 to the rural communities in Ramallah-Albireh district. Facilities were chosen in four villages: Billein, Rammun, Kober and Ni'llin, where only Billein village has an onsite treatment system, the rest have septic tanks. The questionnaire was distributed to rural areas inhabitants of all ages. The selection of a random sample (50 households for each village) was made; then, a one person from each household was chosen and interviewed.

The questionnaire focused on the following main issues:

- Is the sanitation system socially and culturally acceptable to the community?
- Is the system affordable with respect to capital and annual running costs?
- Which type of waste management is it preferable: centralized or decentralized?
- Do you have benefits of wastewater separation; grey and black wastewaters?
- Would you be willing to buy vegetables irrigated with treated effluent?
- Is it safe for you to have an onsite treatment system?

Selection of financially sustainable onsite treatment systems

The choice of an adequate solution should be based on an integrated assessment of the local technical, environmental and social aspects. The selection of existing onsite sanitation facilities in the study area was based solely on a financial basis. In this study, technology and environmental impacts and appropriateness, in the context of the availability of skilled personnel to operate and maintain it, as well as socio-cultural factors were taken into account (Figure 3).

Capital costs are an important item in the selection of an appropriate treatment technology. Decision makers need to be aware of the relative costs of technologies, so that a decision to select a particular technology can be based on sound financial and economic considerations. For this purpose, WAWTTAR software package was used to assist in technology selection and comparison based on environmental, social and economical aspects (Finney and Gearheart, 1998). The main use of WAWTTAR, as a tool for individuals with a technical background, is not to design but to screen and investigate possible wastewater treatment options. The user accomplishes this by examining the public health status, water resource requirements, material availability, cost structures and ecological conditions of a particular community. The program assesses these combined factors to generate a set of comparable and feasible technical sanitation solutions.

Results and discussions

Socio-cultural aspects and public participation

Figure 4 illustrates the distribution of rural population and households in all districts of the West Bank (PCBS, 2000). About 38.1 percent (609,203 capita) of the total population in the West Bank is concentrated in small rural communities, where the Ramallah-Albireh district has the most rural areas among the West Bank districts. Ramallah/Al Bireh rural areas occupy about 21.8 percent (133,084 capita) of small communities with around 8.3 percent of the total rural population in the whole West Bank.

In the study area, the average population for each village is shown in Table I, where the families have around 10 persons per household. Large family size may be related to

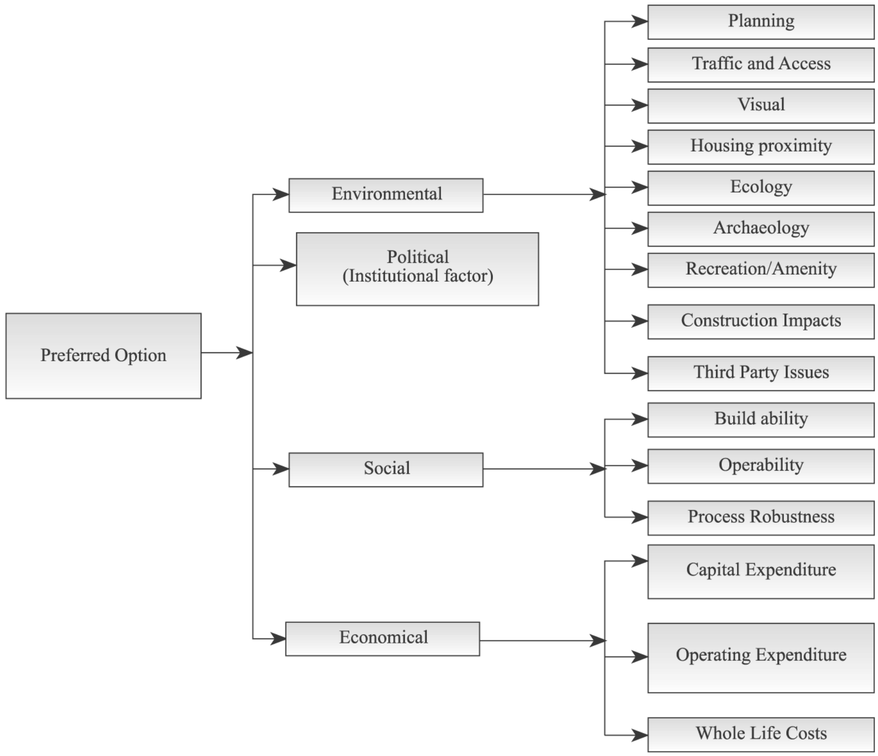

Figure 3.
Flow sheet for the selection of a preferable onsite treatment system

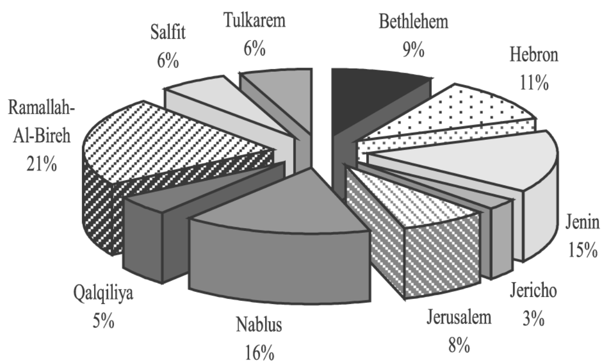

Figure 4.
Distribution of rural communities in the West Bank districts

general trends in poverty levels and fertility, and to proximity of the villages to one another.

The data gathered were analyzed qualitatively and quantitatively (Table II). Data analysis shows that the level of knowledge regarding hygiene is high in all the communities covered during the research. However, this knowledge is not practiced for a number of reasons:

- Lack of financial means to ensure a more hygienic life style.
- Most of the people in rural communities do not have enough water to bath daily or provide hand-washing facilities at the existing toilets available.
- Lack of knowledge on cause, transmission and prevention of waterborne diseases. The level of knowledge regarding the treatment of these diseases is high because the incidences of these diseases are high. The knowledge regarding the treatment of these diseases was obtained mostly from clinic and hospital personnel.

Name of village	Average population (capita)	Average family size (capita/household)
Billein	1,631	14.8
Rammun	2,983	9.2
Kober	3,411	10.1
Ni'lin	4,414	8.5

Table I. Population and family size distribution in the villages under study

No.	Item	Mean	Std Dev.	Percentage
I.	*Open-ended questions*			
1.	Age (year)	37.6	11.2	
2.	Gender [a] (%)	73.0	0.5	
3.	Education [b] (%)	62.5	1.3	
4.	Children (under 18 years age) (capita)	4.3	2.6	
5.	Rooms number per household (rooms)	3.9	0.9	
6.	Average income (US$/month)	400.0	75.0	
7.	Empty cost rate [c] (US$/each pumpage)	10.0	3.0	
II.	*Awareness (people concerned about the project)*			
1.	People agreed completely to use treated wastewater			25%
2.	People refused completely to use treated wastewater			75%
3.	Accepting decentralized system			75% accepted
4.	Accepted onsite sanitation with reservations			40% accepted
III.	*Social criteria*			
1.	Interference with customs			75% interfered
2.	Contradiction with cultural tradition			65% contradicted
3.	Participation in new onsite sanitation			55% refused
4.	Separation black and domestic			63% agreed
5.	Wastewater irrigation			75% with wastewater irrigation
IV.	*Economic criteria*			
1.	Readiness to pay the full construction costs			82% not ready
2.	Pay only the construction costs			75% refused
3.	Centralized sewerage network construction			85% agreed
4.	Safe disposal to valleys			65% agreed

Notes: [a] Gender: Male I, female O; [b] Education: consists of five classes, from illiterate to university graduate; [c] Cost of emptying the cesspool

Table II. Questionnaire data and results on socio-cultural and economical issues

Table II illustrates the results of the site visits and data analyzed from the questionnaire distributed in the study area. Initial results showed that household status (income, education and occupation) has an impact on water consumption rates. Households of higher status tended to use more water than those households of lower status. It was also clear that most (75 percent) of the respondents have rejected wastewater reuse for agricultural applications. This rejection stems from socio-cultural considerations, where 55 percent of the interviewed people were even against the establishment of new onsite facilities. Against our technical advice, 85 percent of the respondents agreed on having a centralized wastewater management facility, as their financial share will be minimal due to donor countries financial and technical support.

Financial and economic issues

The basic information obtained from the questionnaire (Figure 5) with regard to willingness to pay, revealed that the willingness to pay only extended to what users saw as a benefit or priority and were not willing to pay neither full investment costs (82 percent) nor partial construction cost (75 percent). Hence, complementary financing will always be necessary to ensure the sustainability of the services. This may be done through a variety of taxes. However, tax collection in many developing countries is not efficient or effective and, moreover, a large part of the population do not pay taxes that can be used for sewage management (Nisipeanu, 1998).

The costs of managing onsite wastewater treatment systems are mostly determined by the local conditions and the corresponding types of wastewater treatment technologies used. In areas with deep, permeable soils, septic tank-soil absorption systems can be used. In areas with shallow soils to a limiting condition, very slowly permeable soils, or very highly permeable soils, more complicated onsite systems will

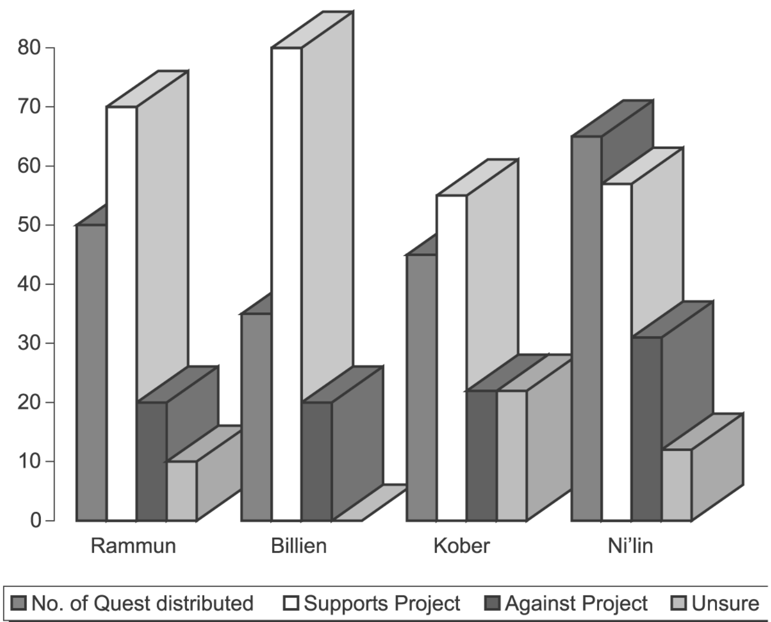

Figure 5.
Public opinion towards onsite treatment and agricultural wastewater reuse

be required. Most of the costs come from the salary and benefits needed for the services of the operator. All systems will require periodic septic tank pumping and for some systems, worn out pumps and other parts will have to be repaired or replaced.

Evaluation and selection of a cost-effective wastewater treatment technology

Decision makers in developing countries are challenged with the fact that poor urban residents cannot afford and reject costly conventional sewage treatment systems. Fortunately, a broad range of cost-effective technological options are available to respond to the demands of urban consumers beyond the urban centre, with the potential to reduce costs to the order of US$ 100 per household. The UNDP/World Bank Water and Sanitation Program has worked with many countries over the past decade to develop, demonstrate, document and replicate many of these low-cost sanitation options. In Palestine, there is a need for such programs in the smaller communities, where recently a study funded by the World Bank revealed that subsurface wetland system was identified as a low-cost treatment option for small communities (PWA, 2004).

In this study, a septic tank system serving as a pre-treatment stage followed by various post-treatment alternatives were investigated based on the relative cost values and analyzed to choose the best alternative. Table III shows the different types of wastewater treatment systems that can be used in small communities. Capital investment costs for each option were estimated and the preferable treatment option was identified using the WAWTTAR software package.

Information on capital cost and the cost for operation and maintenance for a wide range of technologies that are not available in Palestine can be derived from experience in a limited number of countries. Extrapolation of the data to other locations is fraught with difficulty. Relative costs may be sufficient to narrow the choice of technology, although it should be borne in mind that the relative values may change from location to location, dependent of specific local conditions. Cost of land and labor in particular

Number	Code	Treatment system option
1	A	Septic tank
2	B	Blackwater-holding tank and greywater-septic tank
3	C	Blackwater-composting toilet and greywater-septic tank
4	D	Blackwater-incinerating toilet and greywater-septic tank
5	E	Aerated tanks (aerobic units)
6	F	Septic tank-intermittent sand filter
7	G	Septic tank-recirculating intermittent sand filter
8	H	Septic tank-subsurface wetland system
9	I	Septic tank-anaerobic filter-intermittent sand filter with recirculation
10	J	Septic tank-trickling filter with recirculation
11	K	Septic tank-rotating biological contactor with recirculation
12	L	Septic tank-anaerobic filter to trickling filter with recirculation
13	M	Separated gray and blackwater denitrification systems
14	N	Textile filter pressure dosed dispersal system
15	O	Septic tank-sequencing batch reactor (SBR)
16	P	Septic tank-wetland/trickling filter
17	Q	Septic tank-wetland/mound system

Table III. Onsite systems evaluated using WAWTTAR software package can vary considerably. The information provided here should therefore be used only as a guide of the relative costs needed. Actual costs for a particular location and community should be ascertained from suppliers of equipment, materials and labor. Detailed calculations and assumptions made on capital costs of onsite wastewater treatment systems can be found elsewhere (Mubarak, 2004).

Figure 6 shows clearly that the preferable option is the Septic tank–subsurface wetland (Number 8, code H; Table III) compared with all other 16 researched alternatives. Using the WAWTTAR software package revealed that this option was financially feasible (US$ 4000) and had the most economical benefits (US$ 6000) determined as the net present value (NPV) over a 20 years life cycle period.

The performance of the least expensive systems was compared for every criterion. Each system was assigned a score, with five being the most desirable and one the least desirable. For this analysis, experience and judgment were used to establish the performance score. The final score per asset was normalized by dividing the score per asset by the number of assets. The individual performance and related scores are provided in Table IV. The sum of the overall sustainability scores for the conventional septic systems was 11.42 and 13.55 for the septic tank-subsurface wetland system (most feasible option). These scores are relative to each other and are not meant to suggest an overall sustainability score for either of these systems as compared to some absolute score for sustainability (which does not exist), or as compared to other onsite systems or centralized collection and treatment systems.

A detailed comparison of the two options suggests that a principal trade-off between the two systems is that the wetland filter system increases initial installation as well as operations and maintenance costs, while producing a higher quality effluent that can be reused for landscape irrigation. Effluent reuse has environmental benefits of reducing the discharge of pollutants to surface water and using the nutrients for the growth of landscape plants.

For this particular example, the highest weighted social criteria are for protection of human health (weighted score of 10) and preservation of cultural traditions, ways of

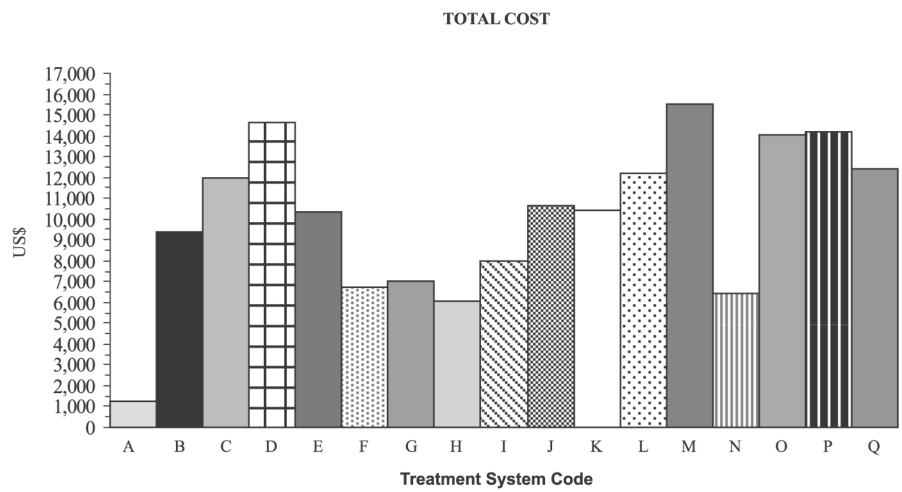

Figure 6.
Estimated capital cost of onsite wastewater treatment systems analysed

Table IV. Sustainability evaluation between septic tank and septic tank-wetland systems

Criteria	Criteria weight Value	Norm	Performance Septic system	Score	Performance Septic–subsurface wetland	Score
The treatment system protects public health	10	0.21	No pathogens enter groundwater and septic tank is operating well	3.5	Much higher effluent quality is achieved	4
Promotes societal virtues such as the public trust	6	0.13	Consumers little understand how system works and are not supported by health agencies	3	Consumers understand how but are not supported by health agencies	3
Preserves cultural traditions, ways of life, and physical heritage	9	0.19	Allows for dispersed human settlement and opportunities for rural lifestyles and livelihoods	5	Allows dispersed human settlement and smaller lot sizes may erode way of life	2.5
Community makes informed decisions and actions reflect local values	7	0.15	Costumer is the manager and has ownership sense; treatment capacity limits and reuse create limits to the sense of ownership	4	Costumer is the manager of the system and has ownership sense. Reuse potential promote ownership sense	5
Preserves aesthetically-valued environments (beauty, open space). No odors or audible impacts	8	0.17	Promotes large lots and open space. Unsuitable soils with high rainfall will produce odors. Environmental impacts may reduce aesthetic quality	4	Less area demand. Unsuitable soil with high rainfall to produce odors is unlikely. High housing density may reduce visual aesthetics	4
Community ability to attain highest potential as appropriate natural resource-based development	8	0.17	Septic system promotes low density and rural lifestyles and cannot support high density development	3	Wetland systems promote low rural lifestyles, but can support higher density development. Effluent reuse is possible	4.5
Social criteria			Overall weighted score	3.87	Overall weighted score	3.90
Ability of most community members to fund system implementation costs	8	0.19	Septic systems are widely used, widely available, and of modest cost. Most cost goes to trenching and equipment installation	5	Modest cost and the higher costs for design & equipment are balanced by lower trenching costs	4
Community financial capacity and necessary capital improvement, considering initial and final population	10	0.24	Septic systems are widely used at modest cost. As individual systems, no capital investment in advance is required	5	Wetland systems are not used widely and newly promoted at low cost. No capital investment in advance is required	5
Community capacity to finance the necessary system operation and maintenance	9	0.21	No resident's involvement. Maintenance septic tank, septage disposal is a challenge	4	Periodical filter rinsing and septage pumpage. Pump failure must be maintained. A challenge is septage disposal	3.5
Community capacity to finance the necessary long-term repair and replacement of the system	7	0.17	Home owner is responsible for long-term repair/replacement, and often has financial resources. The cost is usually associated with lining or leaking tank	3	Home owner is responsible for long-term repair/replacement; home owner often has the financial resources. Disposal field lining is less likely	4.5

(*continued*)

Table IV.

Criteria	Criteria weight Value	Norm	Performance Septic system	Score	Performance Septic–subsurface wetland	Score
The system supports the community economic development objectives	8	0.19	Septic systems are of modest cost, but produce no recreational or water resource benefits	2.5	Textile systems have many potential financial benefits if water reused; landscape improvements increased property value; economical gain from irrigated food crops	5
Economic criteria			Overall weighted score	3.98	Overall weighted score	4.41
Surface water quality and quantity	9	0.16	Assumed adequate distance from surface water to attenuate water quality impacts, and the septic system works well. The septic system does not promote conservation and the permit conditions eliminate reuse	3	When limited distance to attenuate water quality impacts, wetland works well as of added treatment provided by the soil filter. System promotes conservation through root-zone reuse in the shallow trenches	5
Groundwater quality and quantity	8	0.14	With adequate distance to groundwater to attenuate water quality impacts, the septic system works well. Septic systems promote groundwater recharge	4.5	Works well to attenuate water quality impacts. Promotes groundwater recharge, and water resource conservation through root-zone reuse	5
Aquatic ecosystems	10	0.18	With adequate distance from surface water, septic systems protect aquatic ecosystems. Septic systems do not promote conservation and permits do not allow reuse	3.5	With adequate distance from surface water, system provides significant protection of aquatic ecosystems. Wetland systems promote conservation and reuse. Subsurface reuse is feasible within most permits	4.5
Land-based ecosystems	10	0.18	Septic systems do not promote conservation; permits do not allow reuse, both of which would reduce impacts by water withdrawals. Systems may promote urban sprawl	1.5	Wetland systems promote conservation through reuse which will reduce impacts by water withdrawals. This system may promote urban sprawl	3
Soil quality	7	0.13	Septic systems may promote soil salt accumulation. Lining may clog with bioslimes over time but the problem is localized. The pH is normally not altered unless greywater only is dispersed in the leach lines	3.5	May promote accumulation of salts in soil, however minimized by drip lines usage; treated effluent is dispersed over larger area. Drip lines may clog with bioslimes but can be designed to have self-cleaning devices	3.5
Air quality	6	0.11	Under normal operating conditions, no odors are produced, but lack of ventilation might cause toxic air emissions	5	Usually wetlands systems do not cause odors. Some emissions of household toxics may be emitted intermittently but at low-risk levels	5
Energy use	6	0.11	Normally no energy use except gravity and septage pumpage	5	Recirculation of treated effluent might consume energy	4.5
Environmental criteria			Overall weighted score	3.57	Overall weighted score	5.24

life, and physical heritage (weighted score of 9). Based on the analysis summarized in Table IV, it is obvious that the application of the various criteria could result in tradeoffs when selecting a real system. However, that is a typical dilemma for treatment technologies and environmental infrastructure. The value of this type of decision making is that it is based on a balanced approach, providing equal importance to the three types of community capital. Given the long-lasting effects of environmental infrastructure, the sustainability analysis provides a basis for making credible tradeoffs. Overall, advanced onsite wastewater systems, such as the septic tank-subsurface wetland filter system, offer a higher level of sustainability to users, the community, and the environment. At the same time, reductions in sustainability may occur because such systems will allow for higher housing densities in rural communities.

Given the prevailing political and economic conditions in Palestine, a pragmatic and step by step approach is recommended to improve wastewater management and water reuse agenda in rural areas. Sustainable solutions for wastewater management building upon pollution prevention at the source, low cost alternatives as subsurface wetlands are essential. In addition, public-private partnerships should be investigated as an important management potential if the Palestinian governing regulatory system is strong enough (PWA, 2004).

Management options for onsite sanitation facilities

In the rural areas, village councils provide water and sanitation services. These institutions are weak for many reasons, but particularly due to their lack of autonomy, inadequate performance incentives, no access to capital, and human resource constraints. Several non-governmental organizations (NGOs) executed several water and sanitation projects and engaged in research and development. However, most the rural water and sanitation projects are on a small scale, where the main NGOs include the Palestinian Hydrology Croup (PHG), Palestinian Agricultural Relief Committees (PARC), Birzeit and Alquds universities.

Some municipal water departments and utilities prepared master plans several years ago. However, these plans have rarely been implemented. The staff involved with municipal services lack motivation and have little to no opportunity to improve their skills. The co-ordination among the municipal departments, and between the water utilities themselves, is poor. A possible unified administrative structure is suggested and illustrated in Figure 7. Policies of the wastewater authority will be determined by a board, composed of representatives from the Palestinian National Authority. Representatives of the municipalities and/or users will also be included in this board and, the authority will include planning, financial and technical units.

Although wastewater treatment regulations have been imposed by the different agencies and NGOs in the West Bank, it appears that in rural areas there has been little concern within the institutional and administrative structures to support the necessary changes. The traditional bureaucratic services have proven inadequate, both in terms of supervision effectiveness and the lack of experience of the existing personnel. The technical shortfalls are only one side of the problem. The willingness of the institutional structure to implement new nationwide policies is perhaps the major concern. Thus, for such policies to be effective and viable there must be concomitant changes at the institutional level. These changes should be continuously monitored

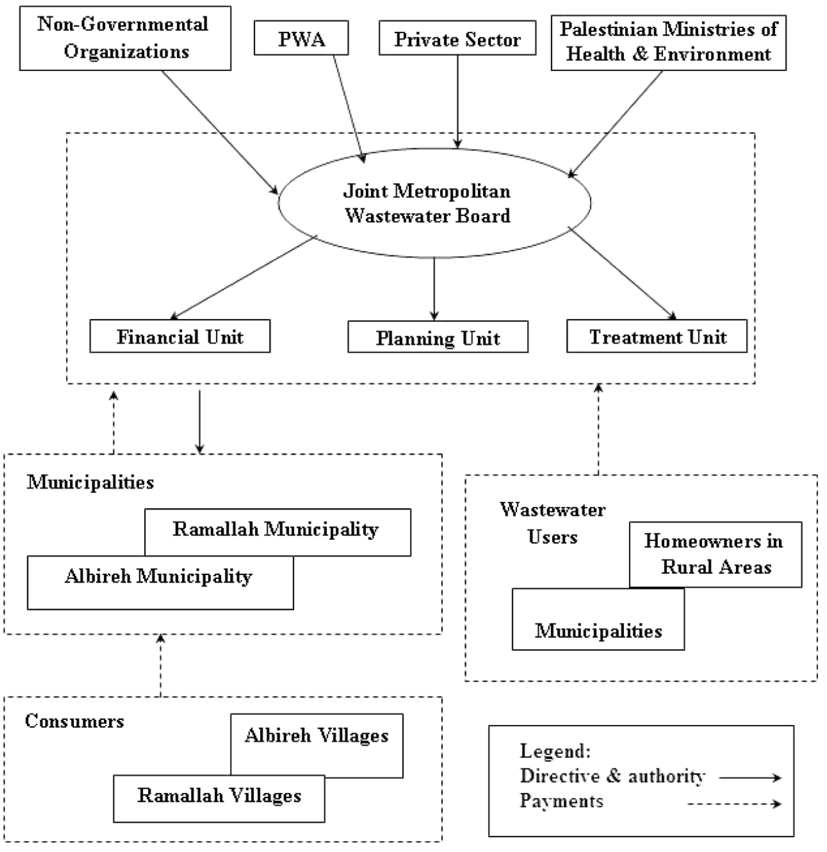

Figure 7.
Suggested management framework for onsite sanitation facilities

and evaluated. It is proposed that a single national authority should be in charge of the water sector to provide more effective control, to promote wastewater treatment and to avoid a conflict of roles and overlapping responsibilities (Figure 7). In addition, inter-municipal enterprises for sanitation should be established between municipalities within the watershed area.

Finally, certification of on-site system service providers should be considered. Site evaluations by geotechnical scientists are the foundation of subsequent on-site system design and installation. An inaccurate soil evaluation can negate all other attempts to construct and maintain an effective treatment system. Certification should also be considered for individuals who provide for the operation and maintenance of the on-site systems. Certification will not overcome all of Palestinian's problems, but it will provide evidence that on-site professionals meet a minimum level of expertise. It also serves as an avenue to inform and train personnel. Many donor countries have already recognized this need and suggested certification of onsite system contractors and operators. This may be done more effectively on a statewide basis.

Conclusions

Existing onsite wastewater systems in small Palestinian communities are unsustainable as they were mainly constructed based on the low-cost alternative, which was not necessarily the most appropriate solution. Respondents were aware of the impacts of poor sanitation services and had major fears as to pollution problems adversely affecting their health. In addition, they had doubts about projects liability and were not ready to pay for on-site sanitation facilities. Sustainable development incorporates social, economical and environmental factors into the evaluation and selection of wastewater management options. An assessment approach was developed and applied to evaluate in detail two systems using these factors. By considering various sanitation alternatives and their combinations, the WAWTTAR software package was an adequate tool to identify the most feasible and cost-effective sanitation system for a variety of site conditions and community goals. The septic tank-subsurface wetland system offers a higher level of sustainability to users in Ramallah-Albireh rural areas. As new and improved onsite wastewater treatment technologies are developed, decentralized management of domestic wastewater in rural communities offers greater sustainability, reliability and flexibility.

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