Sustainability assessment of sanitation options in Vietnam: planning with the future in mind
J. Willetts, M. Paddon, Nguyen Dinh Giang Nam, Nguyen Hieu Trung and N. Carrard

ABSTRACT
This paper describes a participatory deliberative planning methodology employed in Can Tho, Vietnam to assess sanitation infrastructure options for a new peri-urban area with an expected population of 278,000 people. The study compared four options across a range of scales from centralised to decentralised treatment systems, and also included an innovative resource recovery option with urine collection and reuse in local agriculture. The study was undertaken in close collaboration with the local water utility, a local university, and several city government departments. In the sustainability assessment process key city stakeholders ranked the four options against criteria in five areas: (i) technical and risk, (ii) social and health, (iii) environmental, (iv) economic and financial, (v) city future. Stakeholders were provided with detailed information about each option, including quantitative data such as costs and energy use, and qualitative data against areas such as social acceptability. The assessment made evident the trade-offs between these five areas, and after their prioritisation, stakeholders agreed on the option that combined centralised treatment for the densely populated area to be inhabited earlier, and decentralised treatment for the remaining area. The methodology provided a robust way for stakeholders to engage in informed decision-making on this important planning issue.

Key words | planning, sanitation services, sustainability assessment

BACKGROUND AND CONTEXT

Introduction
Sanitation planning commonly involves pre-feasibility and feasibility studies for pre-determined technological options in a pre-determined configuration. Such processes are also often undertaken in relative isolation by those agencies responsible for public works or construction. A much broader planning process is required to ensure integrated urban development and to ensure the chosen technological option will deliver the most sustainable outcomes as compared with other options. Recent innovations in the field of wastewater technology means that there are a breadth of solutions available that work at different scales of treatment and including some that offer the potential for nutrient recovery. The most ‘fit-for-purpose’ solution will depend on the context and hence decision-making must be based in that context.

This paper describes a participatory stakeholder sustainability assessment used to determine the most appropriate wastewater option for a newly developed peri-urban area in Can Tho Vietnam. The Institute for Sustainable Futures (ISF), from the University of Technology Sydney, in collaboration with Can Tho University (CTU) and Can Tho Water Supply and Sewerage Company (WSSC) recently completed a 2-year collaborative research project assessing the wastewater infrastructure options for Can Tho City. The comparison of alternatives was made on the basis of cost-effectiveness and relative sustainability of the options, as...
determined through a participatory stakeholder sustainability assessment process with several government agencies in Can Tho.

The study described in this paper compared four wastewater management alternatives for a case study area in Can Tho, Vietnam. It included a detailed contextual analysis and cost-effectiveness study (described elsewhere in Willetts et al. (2010a, b) and Retamal et al. (2011)) and the participatory sustainability assessment that is the subject of this paper.

Case study area

Can Tho, a provincial city in the Mekong Delta, like many Asian cities is facing rapid urbanisation. This study focused on South Can Tho and specifically on four wards in Cái Rằng District covering 2,080 hectares. This area of South Can Tho is a newly urbanising part of the city, mainly comprising new developments on green field sites without established infrastructure such as wastewater management systems. Construction master plans for this area indicate a total population of 150,000 people by 2030, representing an increase from the current population of around 47,000. However, if developments go ahead as currently planned by investors, then the analysis conducted for this research suggest that the total population could reach as many as 278,000 (Willetts et al. 2010a).

According to local stakeholders and the WSSC, there are several challenges that need to be addressed when considering wastewater solutions for South Can Tho. These include the highly uncertain rate of urbanisation, the need to ensure affordability of tariffs and the challenges faced by WSSC to access to funding to manage sewage. In addition, technical challenges are presented by the flat terrain, high water table and low lying land that make use of gravity sewer systems difficult without the use of pumping. Susceptibility to the impacts of climate change represents a further challenge with increases in salinity and flooding expected for this area.

Throughout Can Tho, as for elsewhere in Vietnam, septic tanks are included as part of the construction on every building. However there is little in the way of further treatment. The first wastewater treatment plant (WWTP) in Can Tho is currently being constructed with support from German development agencies and is located at Cai Sau in South Can Tho, but under current plans the WWTP will only treat wastewater from the existing urban centre in Ninh Kieu as it was not designed to accommodate wastewater from the new South Can Tho urban area. A capacity upgrade of this treatment plant is a potential option under consideration for treating wastewater from South Can Tho, and is one of the options analysed in this study.

Technical options considered

The technical options considered in the study were defined through a collaborative process involving input from WSSC, CTU as well as other city authorities including the Department of Planning and Investment, Department of Construction, Department of Natural Resources and Environment, Can Tho Urban Administrative Authority. Criteria underpinning the choices included proven ability to operate at full-scale, land area requirements and amenity, ability to cope with the water table and topography, resilience to climate change impacts, energy requirements, skills requirement, ability to meet effluent regulatory requirements (QCVN 14), preference for locally available materials and technologies (in line with Government of Vietnam’s Decision 1930) and functionality and reliability to cope with the required wastewater volume and the expected variability in wastewater flow and quality. The four options considered are described in Table 1, and Option 3 is shown in Figure 1.

PARTICIPATORY SUSTAINABILITY ASSESSMENT METHODOLOGY

The three sections below describe the methodology employed to compare the four options. A deliberative decision-making approach was adopted rather than a numerically-focused multi-criteria analysis as is commonly adopted for such decisions (Lundie et al. 2005). We purposefully chose a deliberative process to provide the opportunity for different government agencies to engage with the relevant issues and to gain an appreciation of the complexity and the trade-offs required in such decision-making.
Development of criteria to enable comparison

Criteria were developed collaboratively for five broad areas of concern: (i) technical and risk, (ii) social, (iii) environmental, (iv) economic and financial, and (v) city future. These criteria are shown in Table 2. The criteria reflect relevant national legal requirements (for example requirements for Strategic Environmental Assessment in Vietnam), local issues that had been raised in the development of the project and the planned development orientations for the city. In addition, the criteria were informed by international frameworks for sustainability, particularly for urban water systems (for example Lundie et al. 2005; Sahely et al. 2005; Lennartsson et al. 2009). CTU partners were consulted on the development of the criteria and the relevant city level stakeholders were given the opportunity to comment on and contribute to criteria proposed for their areas of jurisdiction prior to the workshop. This input ensured the criteria held relevance for all stakeholders and also served to stimulate the interest of each stakeholder in the subsequent participatory process.

**Background research to provide information against criteria**

The criteria described above span a broad range of issues, and for stakeholders to make an informed judgement against these criteria, it was important to ensure information was made available on how each option performed against each criterion. The research team therefore prepared a detailed ‘information sheet’ concerning each option. On
these information sheets the technical design for each option was presented, and notes provided covering qualitative statements of ‘benefits’ and ‘concerns’ against each area in the sustainability assessment as well as important quantitative data. For instance, information such as the land area required, the annual energy consumption, net present value, operation and maintenance costs were all provided.

Since cost is obviously a key criterion, detailed research was undertaken to provide information against this criterion (described in more detail in Willetts et al. (2010a, b), and Retamal et al. (2011)). A cost-effectiveness analysis of four options was conducted that took into account the staging of developments in the new urban area following a well considered methodology in use in Australia and elsewhere (Mitchell et al. 2007).

### Participatory deliberative process

A participatory sustainability assessment process was conducted with project partners from WSSC and CTU, and five government departments (including the areas of construction, environment, investment and planning, health,

<table>
<thead>
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<th>Table 2</th>
<th>Sustainability criteria</th>
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<tr>
<td>Technical and risk</td>
<td>Social and health</td>
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<tr>
<td>System robustness: Ability of technology to work well in the context, including variations in influent quality, high water table, rainfall events, intermittent electricity</td>
<td>Public acceptability: People’s responses about visual amenity, potential for odour, familiarity, landscape, cultural identity etc.</td>
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<td>System complexity: Complexity in construction, in operation and maintenance, in management requirements and in institutional arrangements</td>
<td>Equity between socioeconomic groups: Equity in how different socioeconomic groups would be impacted</td>
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<td>Proven technology at full-scale: Existence of successful full-scale application of this technology in other places</td>
<td>Contribution to public health: Ability to ensure no direct human exposure to untreated wastewater</td>
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<td>Risk of the plan not being completed: Realistic feasibility in terms of the availability of required financial resources and skills</td>
<td>Employment generation: Quantity and type of employment opportunity likely to be generated</td>
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<td>Land-use investment: Amount and type of land required for wastewater treatment</td>
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urban administrative authority) and the Institute of Architecture and Planning to consider the wider implications of each option. Stakeholders engaged with relevant information about the options and made judgements of performance against the various criteria. Each participant was provided a fact sheet about each option covering background information against the five areas of concern to assist them in their judgements. Small group discussions were held to identify and clarify any questions and to ensure that there was a common understanding of the criteria and the options. Following this, each individual made an assessment of each option against each sustainability criterion on a scale from 1 to 5 (worst to best). Average scores were then calculated for each area of concern with an equal weighting given to each criterion.

RESULTS OF THE ASSESSMENT

The conclusion from the sustainability assessment was that the most beneficial option would be a combination of centralised and decentralised treatment for different areas (Option 3). The centralised treatment would service 105,000 people in the area closest to currently planned sanitation infrastructure with the densest concentration of population and likely to be inhabited soonest. The decentralised systems would service 173,000 people in other areas, providing flexibility to adapt to the actual pace of development and urbanisation.

The results of the process of individual assessment are shown below in Figure 2. Participants ranked each option against each criterion and the average of all participant scores was calculated. A higher score indicates better performance against criteria in that area of concern.

Participants felt that the spider diagram did not provide conclusive evidence for a clear choice of preferred option, and hence small groups then took into consideration which areas of concern they wished to give priority, that is, which of the five areas of technical and risk, social and health, environmental, economic and financial and city future they prioritised. They ranked the four options from 1 to 4 based on their priority concerns. This led to a preference by all four small groups for Option 3. Option 4 (resource recovery option) was given second preference, followed by Option 2 (fully decentralised) and finally Option 1 (fully centralised) was ranked last and least preferable. The performance of Option 3 against the sustainability criteria is summarised below.

**Technical and risk**

Technically, this option involves a small-scale capacity upgrade to the centralised treatment plant currently under construction, and use of a proven decentralised technology for less dense areas likely to be developed in the future.

**Social and health**

Socially, public health would be protected and affordability is ensured through relatively low operation and maintenance costs (which are the basis for setting wastewater tariffs in Vietnam).

**Environmental**

Environmentally, the energy requirement for pumping wastewater within the networks (and hence greenhouse gas emissions) is significantly less for Option 3 (10,800,000 kWh/annum) than for a fully centralised system (16,900,000 kWh/annum) although much higher than for Option 2 (whose energy usage is minimal). The proposed treatment would contribute markedly to improved...
surface and groundwater quality by meeting QCVN standards.

**Economic and financial**

Financially, this option has the lowest net present value (−13 m USD as compared with −27 m USD for Option 1, for example) and lowest levelised unit cost per household (500 USD as compared with 1,000 USD for Option 1, and 600 and 700 USD for Options 2 and 4, respectively). In terms of on-going operation and maintenance costs, Option 3 had a present value of 2,200 USD (as compared with 4,000 USD for Option 1) though this operation and maintenance cost was slightly higher than for the fully decentralised Option 2 (at present value of 1,900 USD).

**City future**

For Can Tho’s future, Option 3 was considered to contribute to innovation and demonstration of a new, tailored approach to wastewater planning that provides flexibility and adaptability to uncertainties such as the rate of urbanisation and potential climate change impacts.

The second preference was for Option 4 (combination of centralised and decentralised with urine diversion and use as fertiliser), with strong interest in this option for future wastewater planning. The costs of this resource recovery option demonstrated that the revenue stream from fertiliser sales (present value of 6.2 million USD) was significantly larger than the operational costs of the wastewater system (present value of 1.3 million USD). Option 1 (fully centralised) was the least favoured option as it had the highest overall cost and although it scored well on social and health criteria, it had lowest performance against Environmental and City future criteria.

**WIDER IMPLICATIONS FOR SANITATION PLANNING PROCESSES**

There are strong implications of the informed deliberative planning process demonstrated in this study for both local stakeholders, and for the broader water and sanitation sector. Overall, city stakeholders in Can Tho demonstrated strong interest in the study and its findings. For a rapidly growing urban area such as South Can Tho, understanding the cost and sustainability implications of alternative sanitation infrastructure scenarios provides a much needed evidence base to assist government agencies in determining how best to invest and provide services. Can Tho city leaders have indicated that the results of the study will be taken into account in the next stages of infrastructure planning in South Can Tho.

Dr Tran Tuan Anh, Vice Chairman of the Can Tho Peoples’ Committee, instructed all the relevant City departments to review the findings of this research project and to report back how these can be taken into account in development of South Can Tho. City stakeholders involved throughout the research process such as the WSSC and CTU commented on how the approach provided a sound analytical basis for decision-making, and shone new light on the previously unclear answer as to whether ‘centralised’ or ‘decentralised’ systems were best and made clear the contextual nature of the answer to this question. The preferred option would require new institutional arrangements for centralised management of the decentralised infrastructure to be developed, and also for investment to be secured for upgrade to the treatment plant currently under construction, which do present areas requiring work and resolution. In addition piloting of the decentralised technology within Can Tho is likely to be an important step in ensuring confidence in the use of this technology given there are not yet working examples in southern Vietnam.

Implications for the wider water and sanitation sector are many. The cost-effectiveness study and sustainability assessment process were supported by an AusAID research grant of approximately 130,000 USD, which included 9 researcher trips to Vietnam. The cost-effectiveness study accounted for 70% of this sum, with the broader contextual research, development of options and the sustainability assessment process described in this paper responsible for the remainder. This means that there is possibility to replicate the sustainability assessment methodology in other circumstances and for a fraction of this overall cost. Important factors in such replication include ensuring adequate information is collected and made available for a meaningful deliberative assessment process with local stakeholders. This kind of broad assessment process is most meaningful.
if there is substantial information made available for each of the proposed criteria to allow an informed judgement to be made. Such information may not be easily at hand unless specifically researched. In this case, significant research effort was invested in analysing the technical, cost and some environmental factors. Ideally, further research and analysis could have informed the social criteria, particularly public acceptability, public health implications and equity across different socio-economic groups. Equally, the sustainability assessment methodology could also be applied in a more broad-brush, less detailed fashion and used as a tool to engage stakeholders in the multiple dimensions of sanitation planning decisions.

More generally, another implication of the study is that it throws into question the assumed technological solution for wastewater in urban areas in developing countries which is large-scale, centralised systems. The findings of this study challenge that premise. The study shows decentralised systems to be a valuable component in developing cost-effective, sustainable wastewater solutions, particularly in the face of uncertain rates of urbanisation and the context of climate change mitigation and adaptation, and the need to proactively consider a breadth of options before arriving at a decision for a particular context.

CONCLUSION

Selecting the most fit-for-purpose, sustainable sanitation solution for rapidly urbanising cities in developing countries presents an enormous challenge. It is critical that the choices that are made are done with the future in mind. This paper has demonstrated a sound participatory methodology that involves stakeholders in deliberating on the pros and cons of four different sanitation infrastructure options against 21 sustainability criteria covering a range of areas including technical, social, environmental, economic and conceptions of the city’s future. Involvement of the water authority (WSSC) and other government agencies in both the development and assessment of options means that the results are locally grounded and accepted. Given that 80–90% of all wastewater generated in developing countries is currently discharged directly to surface water bodies (Corcoran et al. 2010), there is critical need for cost-effective and sustainable sanitation solutions to be ascertained and adopted, and this paper is a timely and important contribution towards that end.

REFERENCES


