Cost Recovery for Urban Sanitation in Asian Countries: Insurmountable Barrier or Opportunity for Sustainability?

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ABSTRACT

Urban sanitation and waste management services are in crisis in many Asian countries, attributed to a number of factors. In this paper we argue that the crisis is exacerbated by the application of inappropriate economic and technological models for urban sanitation. We examine why the dominant models, including full-cost pricing driven by neoclassical economics, are inappropriate in the context of Asian countries. On the basis of Ecological Economics and Buddhist Economics, we identify a set of principles for arriving at more sustainable solutions. Sanitation's role as a service for waste removal and disposal is expanded to a synergistic group of economically feasible services provided through cooperation between service providers, community and government. The STEEP framework is shown to be a useful way to tailor the sanitation options on the basis of contextual factors.

Eutrophied and malodorous bodies of water and wayside mounds of uncollected waste are common sights in many cities of Asian countries, symptomatic of a crisis in urban sanitation and waste management. Many reasons are given for this critical state, such as inadequate funding, institutional failure, and weak capacity to provide services (Evans 2005; Gutierrez et al. 2003). In this paper we identify three additional contributing factors: inadequate attention to contextual factors of particular locations, the application of an inappropriate economic model for cost recovery, and an inappropriate technological model. We look to alternative models and a way to systematically take account of contextual factors that can influence sustainable sanitation in particular locations. Our analysis is illustrative and focuses on sanitation in this paper; the arguments may be extended along very similar lines to be applicable to waste management.

Overview of the dominant paradigm for urban sanitation

The models for the economic management, technology choice, and administration of urban sanitation that are currently applied around the world, resulted from the particular historical transition of European cities through the industrial revolution to modern cities of today. In this section we provide a brief overview of the progression of urban sanitation practice in the developed North to the present time.

As large populations moved into newly industrialising cities of the 19th century, unsafe disposal of human and household waste led to squalid urban environments and deterioration in public health. Governments responded by investing in service infrastructures with centralised control and management systems reflecting the prevailing approaches of centralised, autocratic systems of government. The governmental priority was for increasing the coverage of services to facilitate economic development. As a result, urban demand was, and still is, met through large centralized infrastructures that bring energy and water to cities from distant places, and transfer wastewater and household waste out of cities to distant places.

Water supply, sanitation and waste collection services were developed under a public service ethos in Europe, and later in European colonies (Guy, Marvin & Moss 2001). The underlying philosophy was that such services were the right of citizens, so that charges were designed to be equitable and affordable to the public, rather than reflective of the cost of supplying the services. Charges for reticulated treated water, piped sewerage and waste collection were usually included in the municipal rates based on the value of a property, imperfectly assumed as a proxy for its owner's ability to pay (Bakker 2001). Government took on the responsibility for financing operations and maintenance of services.

A shift in priority has occurred over the last three decades, which manifests the dominance of neoclassical economics in shaping public policy. With the goal for widespread service coverage largely accomplished by this time, economic efficiency in the delivery of services became the new performance goal. Neoclassical economics shows that under certain conditions, the market provides an efficient mechanism for allocating goods and services for the welfare of individuals, and sees the role of government ideally as one that facilitates a free market, provides oversight, and intervenes to correct malfunctionings of the market mechanism (Edwards-Jones, Davies & Hussain 2000). The recipe for introducing a market model consists of decreasing government responsibility for welfare provision; corporatisation and privatisation of state enterprises; and financing through user charges reflecting 'full cost pricing' rather than through general tax revenues (Bakker 2001; Schwartz 2005).

The 'user pays' principle consistent with 'full cost pricing' is progressively being applied to urban water supply and sanitation around the industrialised world, as the potential first step towards a market model in this sector. After initial resistance from a public unaccustomed to paying for water, arguments such as Serageldin's below, have facilitated acceptance of more cost reflective water tariffs:

> The provision of water supply to the households carries several benefits. Households themselves value a convenient, reliable, and abundant water supply because of the time savings, amenity benefits, and to a varying degree, health benefits. Because these "private" benefits constitute the bulk of the overall benefits of a household water supply, ...[i.e.,] because this is principally a "private good", most of the financing for the provision of water supply services should be generated from user charges sufficient to cover the economic costs of inputs ... (Serageldin 1994 as quoted by McGranahan et al. 2001, p. 99)

That water supply and sanitation are generally treated together, as a single service sector, follows naturally from the technology model where they are parts of a single linear flow path, where urban use transforms reticulated water inputs to sewered wastewater, and both systems are administered by a single service provider. The progressive move to a 'user pays' economic model for sanitation in industrialised countries has seen the introduction of sewerage tariffs with a variable component based on volumetric water use in some jurisdictions (WSAA 2003).

The dominant technology paradigm for urban sanitation around the world today is similarly the result of innovations to serve European cities through the industrial revolution. Prior to this time, human waste was valued by farmers as a source of soil nutrients, and collected for this purpose. The introduction of flush toilets and water-borne sanitation, resulting in nutrients being diluted in large volumes of water, made agricultural re-use very difficult (Goddard 1996). Artificial fertilizers became available around the same time, which resulted in a changed attitude towards human waste that has become entrenched over the last century – that it is a nuisance produce to be got rid of. Out-of-sight sewers allow individuals to 'flush and forget', leaving it to

professional engineers to operate the sewer infrastructure and efficiently transport wastewater to central points for treatment and release. The staged wastewater treatment technologies reflect the progressive discovery of the consequences for health and the environment (Schertenleib 2004). The model continues to be promoted by consultants to developing countries (CESMA 2003), despite acknowledgement that:

> These [European and North American sewage collection and treatment] practices are not especially clever, nor logical, nor completely effective – and not necessarily what would be done today if these same countries had the chance to start again. (Feacham et al. 1983)

The urban water supply and sanitation models of the industrialised world have at each stage been imported to Asian developing countries – consistent with the general assumption that the 'developed' world should show the way to the 'developing' (McGranahan et al. 2001). Thus many larger Asian cities, particularly during British colonisation, were partially sewered in the early 20th century under a public service model, with costs subsidised by government and with customer contributions through municipal property rates. Recent examples show the currently dominant model from the industrialised world again being imported into Asian countries. The ADB-funded study into wastewater management for the People's Republic of China promotes "internationally accepted policies", such as financing services "through user charges, not from general tax revenues"; full cost pricing, and the distancing of government from service provision (Walker 2003). Bangkok has begun a program to rectify the sanitation crisis by introducing centralised sewerage and wastewater treatment prior to release, and is investigating cost recovery through user charges (Roomratanapun 2001).

Relevance of the dominant paradigm for developing countries in Asia

We argue that the urban sanitation models from industrialised countries do not lead to solutions that are sustainable for developing countries. The technology model of centralised piped sewerage is too costly for these societies to operate without external assistance. And a market model based on the 'user pays' principle for cost recovery is not easily defensible for conventional sanitation, as an extension of arguments made for water supply, when water supply and sanitation are not a part of the same linear flow path, i.e., when the existing technology is not piped sewerage, as is the case in the majority of urban areas in developing cities. The 'user pays' principle articulates the premise that the full cost of the service should be recovered from users through the prices they are charged – that is, through the mechanism of 'full cost pricing'. As argued by Serageldin earlier, this model is defensible when the service provides largely 'private' benefits – and by extension, is less defensible when significant public benefits are provided.

Adequately performing sanitation provides significant public benefits in supporting public health and urban amenity, and protecting the environment. Strict application of the 'user pays' principle would imply that the beneficiaries should each pay for a proportion of the full cost that is reflective of their proportion of total benefit. Thus household 'users' should not have to pay the full cost; the public, represented by government, should finance the public's share of the benefits provided. Full cost pricing, and distancing government from all responsibility for financing sanitation, are therefore inappropriate.

The low valuation of the private benefits from sanitation further compounds the prospects of recovering the very high cost of providing conventional sanitation. Water supply and sanitation are valued very differently. The alternatives for drinking water supplies are generally poor or dangerous, so that even the poorest households are willing to pay for it if required, sometimes at the cost of foregoing other necessities such as education and health (Gutierrez et al. 2003; WSP

1999). In contrast, there are many alternatives (even if not entirely appropriate) to having access to well functioning sanitary facilities, and a correspondingly low willingness among individuals and households to pay for sanitation (Mulenga & Fawcett 2003).

The difficulty with transferring the dominant paradigm to Asian cities is illustrated by the example of Colombo, Sri Lanka. Interviews held during 2003 with a number of institutional officials with responsibility for sanitation highlighted the intractability of the sanitation problem, which the approaches of the North do not solve. Approximately 20% of the population of Colombo is served by a sewerage network installed by the British colonial government in the early1900s; the sewage collected is discharged without treatment to the Indian Ocean via deep sea outfalls. The remaining population is served mainly by septic tank systems, constructed under the supervision of local government but lacking institutional arrangements for proper maintenance. Poorly performing septic systems have led to ground water contamination. The existing sewerage network is seriously under funded and consequently fallen into disrepair. In a climate of water prices being raised towards full cost pricing, and of escalating costs of living, officials are reluctant to introduce sewerage charges. The result is minimal action and further degradation in the state of sanitation in Colombo.

The example of Colombo highlights the need for technological solutions that are affordable to the economic circumstances of societies in developing cities, and an economic model that allocates costs to beneficiaries in an appropriate way, with the consensus of the public. There is a clear disjunction between a costly centralised sanitation model that provides both public and private benefits, and an economic model that allocates all the cost to the private beneficiaries through 'full cost pricing'. The remainder of this paper considers ways to find alternatives that make cost recovery for sanitation more feasible, consistent with sustainability.

A framework for sustainable urban sanitation

The discourse on sustainable development emphasises the need for simultaneous performance at the economic, environmental and social levels. For urban sanitation to be sustainable, costs need to be recovered, ecosystems need to be protected, and solutions need to gain the consensus of society reflecting accommodations of diverse views and needs.

The recovery of the costs incurred in providing a service is an essential requirement to enable the continuation of the service into the long term future. By 'costs', we refer to all the resources used in providing the service, including monetary costs and environmental costs. The need for monetary cost recovery should not be confused with the *mechanisms for recovering costs*, which can include pricing (charging users of the service), government support through tax revenues, and associated income generating activities. The urban sanitation costs that should be recovered are often prioritised according to the time scale of the need to restore the resources, useful in programs for progressively increasing prices - ordered, for example, as:

- Operation and maintenance costs (immediate, continually recurring costs on daily time scale)
- Administration and overheads
- Capital repayments (debt servicing)
- Capital refurbishment
- Environmental costs (the need to preserve long term capacity of environment to provide ultimate resources and assimilate wastes and supply ecosystem services)
- Costs determined by policy and economic methodology – taxes, depreciation, return on capital, opportunity cost (ERA 2004; Rogers, Bhatia & Huber 1998)

The more completely and correctly the 'full cost' is identified, estimated and recovered, the greater the probability for achieving sustainability would be.

The importance of recovering environmental costs, or replenishing the environmental resources spent, has been emphasised in several recent reports (Millennium Ecosystem Assessment 2005; Postel 2005; WRI 2005). The environment is the ultimate source of resources extracted for human use, and the sink for the resultant waste produced – and the costs exacted by these roles on ecosystems, such as the long term impacts of reduced environmental water, loss of biodiversity, and nutrient pollution, are poorly understood. The above reports argue that healthy ecosystems are essential for human wellbeing; they provide valuable ecosystem services and an effective means for poor societies to create wealth for themselves. Significant changes in policies, institutions, and practices from the status quo are required to reverse the degradation of ecosystems that has resulted from human activity, and to enable ecosystems to meet the needs of increasing populations and increasing standards of living (Millennium Ecosystem Assessment 2005, p. 1).

The third requirement for sustainable development – performance in the social domain- is facilitated through the involvement of the public in decision-making processes. Although public participation is not a new concept in democracies, the customary practice of decision making through autocratic government processes means that public participation occurs to varying degrees; it is an area constantly evolving to increase the significance and usefulness of participation (Morrison 2003; Roberts undated). We return to this later on in the paper.

In order to articulate principles that could point to a sustainable model for urban sanitation in Asian countries, we turn to ecological economics and Buddhist economics for an alternative to the approach of neoclassical economics. The principles we identify are of equal relevance to the industrialised world; however, the opportunity to apply them in practical solutions is limited by the commitment to existing infrastructure and institutional arrangements, in which very significant investments have been made. Regions like developing Asia, which have not sunk as much capital in solutions of the dominant paradigm, have greater freedom to find fresh scientifically sound solutions for sustainability.

Ecological economics' objective is sustainable development that improves the quality of human life within the carrying capacity of the planet. It is transdisciplinary in its approach to finding solutions to environmental problems, interacting with and using tools from many academic disciplines in a process of cooperative learning (Daly & Farley 2003; Söderbaum 1999). Another defining characteristic of ecological economics is a commitment to democracy in decision making processes that goes beyond the act of merely voting. Consistent with its goal for sustainability, ecological economics views decisions that are reached through public participation entailing broad based dialogue, that reflect consensus or accommodations between stakeholders of opposing ideological orientations, as most likely to be fair, just, and resilient in the long term (Costanza et al. 1997).

'Buddhist economics' is a term coined by Schumacher (1973) to refer to the collective teachings on economics interspersed throughout the Buddha's teachings. Economic activity related to 'right livelihood' is presented as an integral component of the Buddhist way of life, rather than a specialised discipline in a separate economic domain of human experience (Payutto 1992). Buddhism emphasises the relational nature of individuals, society, business, government, and the natural world, and the capacity for them to interact cooperatively to achieve beneficial outcomes for all (Nelson 2004). A core concept of complex systems theory is that component subsystems in

the natural world interact with each other through complex physical processes, so "everything influences everything else; nothing can be done in isolation" (Peet 1992, p. 78); this concept is extended further in Buddhism through the inclusion of morality in the system. The complex system of human existence, according to Buddhism, includes the material, mental and spiritual domains; the ethical quality of motivations and actions influences the outcomes in all three domains (Payutto 1992).

Buddhist economics is highly compatible with principles of ecological economics and sustainability (Daniels 2003). It contributes to the investigation of solutions to urban sanitation problems in Asian countries on two counts. The discourses of ecological economics and sustainability identify the need for ethics and social justice; Buddhist economics brings a rationale for ethical conduct to the fore. And the compatibility of this ancient Eastern philosophy, originating in a period of advanced Asian civilisation, with the sustainability concepts coming out of wealthy Western nations, has the potential to make Asian societies more receptive to the critical need for sustainable practices. Environmental protection is often viewed as a luxury not available to the poorest societies (Larsen & Gujer 1997); but not protecting the environment and the ecosystem services they provide, on which the poor depend most (Millennium Ecosystem Assessment 2005), will only serve to keep them trapped in poverty.

General principles based on ecological economics and Buddhist economics

We next identify a set of principles indicated by ecological economics and Buddhist economics perspectives. These provide criteria for identifying or evaluating prospective sustainable urban sanitation options, intended to contribute to a cooperative and participatory process for selecting the particular technological, institutional and social arrangements necessary.

1. *Overall entropic degradation should be minimised.*
   Ecological economics is attentive to the entropic degradation that occurs in all processes as a result of the second law of thermodynamics (Costanza et al. 1997; Daly & Farley 2003). It is a universal phenomenon where the overall entropy of the total system increases, correspondingly decreasing the capacity for useful work to be extracted. A component of the system may increase its usefulness (decrease in entropy) through active energy inputs – such as refined mineral resources – but the system as a whole experiences an entropy increase, when the energy and resources used in lowering the entropy of the component are accounted for. As resources from the biophysical world move through human activity systems, the amount of entropic degradation that occurs is determined by the particular technology choices made. The implication of this principle is that sustainable solutions require processes that accomplish a cyclic flow of resources associated with sanitation – namely soil nutrients and water - through a minimum use of energy, chemicals and other resource inputs, so that the net entropic degradation is minimised. Such an operational principle for minimising livelihood-related material and energy throughputs is aligned with goals that are common to material flow analysis and Buddhism (Daniels 2003).

2. *The precautionary principle should be applied when science is uncertain.*
   The complexity of the environmental debate is compounded by scientific uncertainty and value-conflict in addressing threats that are potentially irreversible and dangerous (Ravetz & Funtowicz 1999). The precautionary principle calls for precautionary action to be taken to prevent harm instead of awaiting scientific certainty while continuing potentially harmful activity.

The practice of discharging sewage from cities into the ocean, adding soil-based nutrients into the waters at a rate many times greater than would naturally occur, impacts the ocean in ways that are not completely understood. The continued practice is justified by decision-makers as the most financially effective option that utilises the assimilative capacity of the ocean (World Bank 2000), without taking a precautionary approach to impacts such as algal blooms and fish kills (Glibert et al. 2002) that can harm ecosystem services provided by the ocean, potentially irreversibly. An imperative of this principle on sanitation is the discontinuation of ocean discharge of sewage.

No harm should be caused to individuals, society and the natural environment
In the Buddhist view, the interconnectedness of the spheres of human existence as individual self, within society, and within the natural environment, means that impacts on all these spheres determines the ethical quality of economic activity (Payutto 1992). The consequences of activity, if ethical, would not cause problems to any individuals, or give cause for social agitation, or lead to degradation of ecosystems, at the time and location where the activity takes place, and also at times and locations removed from the present – i.e., in the future or globally.

This implies utilising the capacity of humans to cooperate in harmony with other actors (including ecosystems) to protect the interests of all. It is not a denial of the competitive and self interested nature of humans, but a call for morality to provide a broader and more enlightened view of self interest being served through cooperation that accomplishes the wellbeing of all. It points to activity systems that foster social cohesion, human dignity and freedom (Schumacher 1973). An urban sanitation model comprising of synergistic services such as fertiliser production, waste removal and energy production through waste digestion, has potential to exemplify this principle. In such a 'product-oriented' model, useful goods and services and livelihood opportunities could be created for society; ecosystem degradation could be minimised through minimising water extraction, returning nutrients to agriculture and reducing greenhouse gas emissions(Otterpohl, Braun & Oldenburg 2002); and financial viability could be enabled through multiple revenue streams that include customer fees, government support and sale of output products.

Underlying motivations of actors should be ethical
This principle is based on the Buddhist 'karmic law', the extension of the natural law of cause and effect in the ethical domain, which states that the ethical qualities of the motivation behind action, which drives action, 'conditions' the results of those actions. This law rejects the notion that the ends can justify the means, instead stating that the ends are defined by the means, and have far reaching consequences in the interacting chain where the ends of one action becomes the means of another (Payutto 1992). Therefore the ethical or virtuous motivation behind human activity is necessary to produce results that are truly beneficial. A need to examine the motives of all actors in the process of deciding on the sanitation solution is implied by this principle. This includes individuals and groups participating in the decision making process, potential service providers and investors, government representatives and others. Ethical motivations include a desire for improving the quality of the human condition, development of human potential, poverty alleviation, creating opportunity for 'right livelihood' and wealth creation by rightful means; they exclude greed and self indulgence (Payutto 1992). This principle may be more difficult to apply than the others, as it calls for self examination. But by learning through practice, including it in the participatory process, it has the potential to unite those of different ideological persuasions but common ethical motivations, and lead to more productive

engagement and greater willingness to accommodate the needs of other actors in the participatory decision making process.

The sustainability and morality imperatives of ecological economics and Buddhist economics define an urban sanitation service that can produce a number of beneficial products and services, by valuing human waste as a precious resource; in contrast, the dominant paradigm for urban sanitation defines it as a service that removes unwanted waste and disposes it in a way that causes minimum immediate nuisance (Beder 1993), utilising infrastructures that are capital intensive and costly to operate. A product-oriented approach can be designed to minimise entropic degradation by the appropriate choice of technologies and organisational arrangements. Arrangements that minimise the mixing of qualitatively different wastes, dilution in water and need for transportation all assist to minimise entropic degradation. These suggest neighbourhood scale arrangements and intermediate technologies as advocated by Schumacher (1973), where tradeoffs are made against other constraints such as land availability in urban neighbourhoods. A framework for prioritising the scale of decentralised options from arrangements at levels of household, neighbourhood, local government area, district, state, country is proposed by the Household-Centred Environmental Sanitation approach (WSSCC 2005), which aligns with the Sarvodaya Shramadana model for development in Sri Lanka based on a Buddhist society (Ariyaratne 1999).

Using the STEEP framework to consider contextual factors

Thus far we have described general guiding principles that arise from the perspectives of ecological economics and Buddhist economics, for selecting solutions for sanitation. A large number of technological and organisational options can fit within the broad guiding principles, so that an evaluation and comparison of each becomes a very complex matter. A defensible means of limiting the choices would contribute to simplifying the decision making process.

A systematic process for drawing out and taking contextual factors into account would provide a useful and defensible way to limit the number of possible options to those that are tailored to suit the particular locality for which a solution is sought. We adapt the STEEP framework used by Futures planners to help elucidate and articulate these critical factors. Futures planners engage in 'environmental scanning' to identify drivers of changes in the external environment that have implications to their sectors of interest. The STEEP framework is a taxonomy used to break down the otherwise gigantic task of scanning, into **S**ocial, **T**echnical, **E**conomic, **E**nvironmental and **P**olitical categories (Morrison 1992). We adapt this framework to identify both existing conditions and constraints, i.e., strengths and weaknesses; and trends that have the potential to influence future directions, i.e., opportunities and threats.

We demonstrate the use of the STEEP framework for considering contextual factors in the particular case of Colombo, presented in Table 1. The STEEP factors we have identified are largely based on interviews held with government officials in Colombo, supplemented with publicly known facts. The separation of relevant contextual factors into STEEP categories is a thinking-aid: the factors interact and influence each other across the columns and rows of Table 1. We use the same categories to structure our analysis of Table 1 below. This application is illustrative: a more complete treatment would involve a greater array of factors identified through input from a larger number of stakeholders from diverse backgrounds, consistent with public involvement in decision processes. Nonetheless, it demonstrates the power of the STEEP framework as a defensible, systematic process for limiting choices.

The social factors in Table 1 indicate a disjunction. On the one hand, we see the potential for responsible social attitudes towards water and environmental resources that should arise from a rich culture of such practices in the past, adherence to Buddhist ethical frameworks and high levels of literacy. On the other hand, there is the reality of irresponsible attitudes that have led to degraded water resources and sanitation services. This highlights a potential 'pull' factor: an opportunity to use cultural and religious arguments to promote more positive attitudes and behaviours. There is also a potential 'push' factor: the observed increase in public vigilance of environmental violations, attributed to the increasing influence of Non Governmental Organisations (NGOs), can potentially reinforce such changes.

The tension between foreign aid commitments that promote conventional centralised solutions and popular enthusiasm for 'appropriate technologies' suited to the circumstance of Sri Lanka could be directed towards positive solutions. Since there are wide-ranging scales of existing technology (from on-site systems to centralised sewers), the opportunity for innovative solutions at several scales is indicated. New settlements present the opportunity to introduce sustainable best practice. Existing settlements can take up solutions utilising existing and refurbished septic tanks, like small networked systems for treatment and recycling of wastewater coupled with digestion of biosolids (Dietzmann & Gross 2003; Otterpohl, Grottker & Lange 1997).And the centralised sewer network could be modified and repaired where cost effective and used to the end of its useful life, incorporating solutions to phase out ocean discharge of sewage.

In the economic realm, the factors of low labour costs and the financial constraints of community and government, as well as decreasing foreign aid, indicate solutions that preference operational costs in terms of labour inputs over large capital costs. Arguments from both the global move towards socially responsible investment and Buddhism may be used to market business opportunities in sanitation to prosperous sectors of the business community, for management of technology models that reflect the shift from capital to operational intensity.

In environmental terms, the STEEP analysis shows Colombo to be highly constrained. The gap in Table 1 for environmental opportunities is an indication that opportunities here are dependent on opportunities elsewhere, rather than an indication of pessimism. For example, changed social attitudes can reduce environmental weaknesses, such as ceasing the practice of dumping wastes into waterways. Technological innovations can reduce wastewater volumes by concentrating it or using water efficiency, or even avoiding water use altogether, thereby reducing both the space requirements for treatment facilities and the likelihood of groundwater contamination. This outcome is also consistent with the principle of minimising entropic expansion identified earlier. The analysis highlights the need for the social, technological, economic and political opportunities to be developed in order to address the environmental constraints.

The existing political desire for keeping up with international environmental best practice is evident in the environmental standards and regulations, while the past record of poor implementation may in fact be a benefit in that investment in inappropriately large scale sanitation solutions has been limited. The opportunity to adopt leading edge policy and standards that are feasible within the existing constraints is consistent with existing political aspirations, and could be more implementable because it is better suited to Colombo.

By considering the range of contextual factors identified through a STEEP analysis, key directions emerge. For example, technology solutions that are intensive in terms of requirements for energy, space, water volumes, and capital expenditure are excluded. Instead, it suggests a high labour component and physically compact infrastructures requiring low capital inputs, utilising

vegetation and local treatments where possible. So, rather than one uniform solution for the entire area of Colombo, a range of options at different scales are suggested. These kinds of solutions provide opportunities for strengthening linkages between a proud history (advanced hydraulic and sanitation practices), Buddhist principles (e.g., innovative opportunities to create 'right livelihood'), and political aspirations for world best practice policies (environmental protection and sustainable development).

In summary, the STEEP framework analysis demonstrates how it may be used to identify specific weaknesses, constraints, tensions, and disjunctions, and then to address them through specific innovative strategies that build on existing opportunities to facilitate higher likelihood of actual implementation.

Conclusions

In this paper we have argued that three factors contribute to the critical state of sanitation in cities in developing Asian countries, in addition to those commonly discussed. Firstly, the cost recovery model, using full-cost pricing for facilitating a market model, is not appropriate in the case of sanitation because a large proportion of the benefits are public. Secondly, the centralised sewerage technology paradigm, dominant in industrialised countries, is too expensive for developing economies to sustain and inconsistent with sustainability. Finally, inadequate attention is paid to contextual factors that can crucially affect solutions.

To address all three of these factors, we turned to ecological economics and Buddhist economics to develop a set of four principles to guide a process to deliver sustainable sanitation choices. Ecological economics and Buddhist economics are compatible and complementary, yielding principles that require recognition of thermodynamic constraints, complexity and scientific uncertainty, cooperative problem solving and ethics. Applying the principles indicates an alternative system model, including taking a broader, product-oriented definition of sanitation as a group of services providing benefits to individuals, society and the environment. The resultant cost recovery model would consist of multiple employment and revenue streams.

To further refine the solution paths that arise from the application of ecological and Buddhist economics to sanitation, we took the case study of Colombo, and applied the STEEP framework. This analysis revealed that preferred solutions would require lower capital investment and higher labour inputs, and innovations to reduce the wastewater volumes processed within the spatial constraints of the city. Such approaches are consistent with and reinforce the validity of the guiding principles outlined above.

The failure of conventional sanitation systems, in technical, social, environmental and economic terms, to alleviate the sanitation crisis in developing Asian countries points to a need for a different approach. We have argued that the neoclassical economic approach to conventional urban sanitation effectively leads to market failure. We have demonstrated that a framework combining ecological and Buddhist economics could facilitate qualitatively different sanitation solutions with better potentials to deliver improved sustainability outcomes in technical, social, environmental, and economic terms. This approach may present greater scope for appropriate application of neoclassical economics to allocate the costs for the different services involved in providing the product-oriented sanitation service.

Table 10 Example of STEEP framework applied explore contextual factors relevant to urban sanitation in Colombo

	SOCIAL	TECHNOLOGICAL	ECONOMIC	ENVIRONMENTAL	POLITICAL
Strengths	• Majority professing Buddhism	• Enthusiasm for adapting 'appropriate technologies' to suit Sri Lanka	• Low labour cost	• Warm climate supporting vigorous vegetation	• Environmental Standards and regulations generally keep abreast of developments in industrialised countries
Weaknesses	• Lack of respect for water and environment • Low willingness to pay for sewerage • Rampant illegal dumping of waste	• Scarce energy – imported fossil fuels, insufficient hydro electricity • Inadequate transport infrastructure • Existing settlements (limiting potential for green fields development) • Existing septic tanks; poor performance of existing septic tanks, no monitoring or regular maintenance regime	• Low average income level of community • Government highly constrained for finances, at both national and local government levels	• High water table • Contaminated groundwater • Urban encroachment into wetlands • Small house lot size • Little physical space for sewage/organic waste treatment facilities. • Solid waste dumping into water ways • Polluted surface water bodies	• Little political commitment to the non-glamorous cause of sanitation and waste • No political champion • Demarcation of responsibilities not always clear between water agencies • Poor implementation of regulations • Mainly poor organisational arrangements for local government services
Opportunities	• Ancient history of advanced hydraulic civilisation and sanitation practices • High literacy rates • Increasing public vigilance on violations of environmental requirements	• Limited sewer network – little commitment needed for sunk investment • Increasing international interest in developing new decentralised technologies	• Some healthy business growth sectors • Wealthy class growing • Post-tsunami aid spin-off benefits • Potential influence of Socially Responsible Investment movement		• 'Sustainable development' rhetoric • Millennium Development Goals
Threats	• Increasing individualism	• Foreign aid commitments promote conventional piped sewerage	• Widening gap between wealthy and poor • Decreasing foreign aid	• Increasingly serious impacts from climate change, weather events, natural disasters	• Corruption at many levels throughout organisations • Ethnic conflict and terrorism

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