Urban Environmental Sanitation in Nepal

An assessment of community-scale, decentralised wastewater management in Nepal, and the potential for a community-led urban environmental sanitation approach in Tansen

Case studies from Sunga, Srikhandapur, Nala and Bhusal Danda

on behalf of

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Water and Sanitation in
Developing Countries

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Masters Thesis
by Laura Bright-Davies

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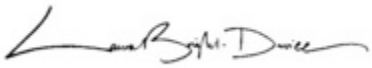
Cover Image: The sanitation situation in Tansen, the proximity of untreated wastewater to water supply and the urgent need for improvement (Bright-Davies 24.09.12)

Statement of authenticity of material

This thesis contains no material which has been accepted for the award of any other degree or diploma in any institution and to the best of my knowledge and belief, the research contains no material previously published or written by another person, except where due reference has been made in the text of the thesis.



Laura Bright-Davies
03 February 2013, Kathmandu, Nepal

Preface

Kathmandu is perhaps the perfect location to become 'immersed' in a topic such as urban sanitation. One cannot walk the streets without being aware of the severity of poor urban sanitation, and the monumental challenge for urban managers and experts in tackling this crisis. Even in the comfort of the GIZ guesthouse, where I have spent the last months, the unsavoury smells of untreated sewage wafting over from the Bagmati River – incidentally Nepal's holiest River – pervades my nostrils and leaves a long-lasting memory.

Figure 1: The Bagmati tributary / stream of untreated sewage running through central Kathmandu (Bright-Davies, 18.09.12)

As a graduate architect from a prestigious design university in Australia, I was often given the not-so-prestigious task of designing bathroom floor plans or detailing public toilet cubicles. At that time, I never imagined I would end up rejecting the world of conventional architecture, to instead work within the field of excreta or wastewater management in developing countries. Perhaps those menial tasks during my architecture beginnings, zooming in and out of toilets on AutoCAD, subconsciously shaped my current choice of academic/career direction. Or perhaps it was more of an awakening over time to the urgent need for architects to consider the whole urban framework, including the unsavoury aspects, as we find ourselves in the context of a rapidly urbanising world and a multitude of associated urban problems.

In following the footsteps of two great Architects (who are, coincidentally, my two Master Thesis supervisors), I have learnt that we have a much greater role to play than simply designing buildings and/or toilet blocks; particularly in the field of urban sanitation. And I hope that this research will play a small part in building the knowledge base and attention surrounding a much-deserving topic, and basic human right[1].

[1] On 28.07.2008, the UN General Assembly recognised the access to clean water and sanitation as a human right (UN 2008).

Acknowledgements

First and foremost, I would like to thank my two supervisors Dr. Alexander Jachnow and Dr. Christoph Lüthi, without whom this thesis would not have been possible.

Thanks to Alex, for convincing me to study the Urban Management Masters programme in the first place, and later for encouraging me write my master thesis in Nepal instead of my original ideas to write about first-world problems. Alex made my internship with MST possible and was consistently supportive throughout the months I spent writing my thesis, patiently answering the ceaseless barrage of questions coming from the neighbouring desk. I am also especially grateful to everyone at MST, for wholeheartedly welcoming me into the team, supporting me whenever necessary and for all the extracurricular inductions into Nepali culture – pujas, weddings and Tihar rituals. Additional thanks to Harish Bhusal, for accompanying me on site visits to Tansen and various wastewater treatment plants, assisting with Nepali (and German) translations, managing affairs while I was immobilised with food-poisoning and generally proving himself indispensible.

Thanks to Christoph, firstly for introducing me to the world of toilets and sanitation – such a vital element in the realm of sustainable urban development, I only wish I'd been introduced into this field earlier. I am incredibly grateful for the invitation to spend two weeks at EAWAG/SANDEC in Switzerland, where I conducted preliminary research and was provided with innumerable resources and contacts. Christoph and the team at SANDEC went out of their way to help me both during my visit to Switzerland and throughout my time Nepal. It was a great pleasure to meet such a motivated group of people who are dedicated to such important work, and not afraid to roll-up their sleeves and get their hands (or feet) dirty.

Additionally, thanks to the generous invitation and support from EAWAG, I was lucky enough to attend the *IWA Conference on Decentralised Wastewater Management* in India, during my research period in Nepal. This opportunity opened my eyes to cutting-edge expert knowledge surrounding decentralised wastewater treatment systems (DEWATS[2]) and management, provided me invaluable contacts and allowed the chance to visit exemplary wastewater treatment sites in India.

Special thanks must also be extended to all the Nepalese sanitation experts from UN-HABITAT, ENPHO, SVN, WaterAid, DWSS and RWSSP, for giving their time for interviews and site-visits. Mingma Sherpa, in particular, was an unfailing source of advice and assistance, and key facilitator for most of the abovementioned interviews.

I am especially grateful to the Deutscher Akademischer Austausch Dienst (DAAD) for granting me the Postgraduate Study Scholarship, which allowed me to attend the Masters programme. With this generous support I was able to wholeheartedly dedicate my time and attention to the coursework in Berlin, thesis production in Nepal and additional research in India.

Also, I am forever indebted to Elspeth Muir, for taking the time to proofread and edit over 150 pages. Els, I will design you a house one day in return – complete with a decentralised wastewater treatment system, of course.

Last but not least, I would like to thank my dearest friends in the Urban Management programme, for bringing so much life and colour to the course, while giving continuous encouragement and moral support from their various corners of the globe.

[2] 'DEWATS' (Decentralised Wastewater Treatment Systems) is a technical approach for simple, proven, affordable and low-maintenance treatment of organic wastewater, promoted by a worldwide network of sanitation organisations and experts (Gutterer *et al* 2009).

Abstract

Nepal is experiencing the fastest rate of urbanisation in the South Asian region, with sanitation and wastewater management emerging as some of the biggest challenges in urban areas. A huge percentage of the population still remain un-served in terms of toilet coverage, and virtually all wastewater and septage is discharged into rivers and water bodies without any form of treatment. As a result, urban environments are highly polluted, public health is jeopardized, and economic growth and development prospects are hindered.

There is an urgent need for alternative approaches to the conventional, centralised wastewater treatment systems, which have largely failed to address the problems of poor sanitation in urban areas of Nepal. The concept of environmental sanitation, using technologies such as DEWATS is emerging as an appropriate response in the context of Nepal.

The first part of this thesis provides an assessment of the sustainability aspects of community-scale DEWATS, based on current practices in Nepal. Case studies from three urban and peri-urban locations are presented, in order to highlight the extent of the associated benefits, identify the main drivers for long-term operation and maintenance (O&M) and unveil the barriers hindering larger scale implementation and promotion of such systems.

The second part will investigate the urgent need for improved sanitation and wastewater treatment in the hillside town of Tansen. Tansen was selected due to the current challenge faced by the municipality in providing its steadily increasing urban population with adequate sanitation services. In particular, the community of Bhusal Danda, within Tansen, will provide a grounded project site, in which to apply the Community-led Urban Environmental Sanitation (CLUES [3]) planning approach for sustainable sanitation and decentralised wastewater management. By combining the CLUES approach with lessons learnt from the three case studies,

[3] 'CLUES' (Community-led Urban Environmental Sanitation) is a set of planning guidelines developed in 2011 by EAWAG-SANDEC, WWSCC and UN-HABITAT. These guiding principles intend to assist disenfranchised urban and peri-urban communities to plan and achieve improved Environmental Sanitation and associated infrastructure (Lüthi *et al* 2011a).

the feasibility for a similar concept in Tansen will be assessed and a range of customised sanitation service options put forward.

Keywords: Environmental Sanitation, Ecological Sanitation, DEWATS, CLUES, O&M, Nepal, WATSAN, WASH.

List of Abbreviations

ABR	Anaerobic Baffle Reactor
ADB	Asian Development Bank
BMGF	Bill and Melinda Gates Foundation
BOD	Biochemical Oxygen Demand
BORDA	Bremen Overseas Research and Development Association
BSP	Biogas Support Programme Nepal
CBO	Community-based Organisation
CBD	Community-based Development
CDD	Community Driven Development
CIUD	Centre for Integrated Urban Development
COD	Chemical Oxygen Demand
CSP	City Sanitation Planning
CLUES	Community Led Urban Environmental Sanitation
DDC	District Development Committee
DAAD	Deutscher Akademischer Austausch Dienst
DED	Deutscher Entwicklungsdienst
DEWATS	Decentralised Wastewater Treatment Systems
DISWATS	Decentralised Integrated Solid Waste and Wastewater Treatment System
DUDBC	Department of Urban Development and Building Construction (GoN)
DWSS	Department of Water Supply and Sewerage (GoN)
EAWAG	Eidgenössische Anstalt für Wasserversorgung, Abwasserreinigung und Gewässerschutz (Swiss Federal Institute of Aquatic Science and Technology)
ECOSAN	Ecological Sanitation
ENPHO	Environment and Public Health Organisation
ETP	Emerging Towns Project
GDP	Gross Domestic Product
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
GoN	Government of Nepal
HH	Households
ICIMOD	International Centre for Integrated Mountain Development
ICLEI	Local Governments for Sustainability (International Association)

INGO	International Non-governmental Organisation
ISSDP	Indonesia Sanitation Sector Development Programme
IWA	International Water Association
LDC	Least Developed Country
MuAN	Municipal Association of Nepal
MDGs	Millennium Development Goals
MoF	Ministry of Finances
MoFALD	Ministry of Federal Affairs and Local Development
MPPW	Ministry of Physical Works and Planning
MST	GFA - Municipal Support Team
NGO	Non-governmental Organisation
NPC	National Planning Commission
NRP	Nepalese Rupees
NWSC	Nepal Water Supply and Sewerage Corporation
O&M	Operation and Maintenance
PPP	Purchasing Power Parity
RBTS	Reed-Bed Treatment Systems
RWSSP	Rural Water Supply and Sanitation Project
SANDEC	EAWAG - Department of Water and Sanitation in Developing Countries
SDB	Sludge Drying Bed
SNV	Stichting Nederlandse Vrijwilligers (Netherlands Development Organisation)
SUNAG	Sub-National Governance Programme
SWM	Solid Waste Management
TLO	Tole-Lane organisations
UDDT	Urine Diverting Dry Toilet
UGDP	Urban Governance and Development Programme
UMN	United Mission to Nepal
UN	United Nations
UNDP	United Nations Development Programme
UNFPA	United Nations Population Fund
UN-HABITAT	United Nations Human Settlements Programme
UNICEF	United Nations Children's Fund
VDC	Village Development Committee
VIP	Ventilated Improved Pits
WASH	Water and Sanitation Hygiene
WATSAN	Water and Sanitation

WESI	Water and Environmental Sanitation Improvement
WHO	World Health Organization
WSP	Water and Sanitation Programme
WSS	Water Supply and Sanitation
WSSCC	Water Supply and Sanitation Collaborative Council
WWTP	Wastewater Treatment Plant

At the time of writing, the value of the Nepalese Rupee (NPR.) was as follows:

US $1 = NPR. 87.35

NPR. 100 = US $1.15

(Monthly average during December 2012; XE 2012)

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I. Introduction

i. The Global Sanitation Crisis

We are frequently reminded of the multitude of global crises – the global financial crisis, peak oil, climate-change – currently afflicting the planet. But one crisis that has received only a fraction of the attention it deserves is the global sanitation crisis. This is an issue, which is rarely acknowledged nor eagerly discussed, despite the fact that over 2.6 billion people – 40% of the global population – are currently living without access to improved sanitation[4] [5] (WHO/UNICEF 2010).

Inadequate sanitation, however, does not just mean having limited access to a toilet or latrine, which is only one component of the 'sanitation value chain' (See Figure 5). Systems for treating excreta and wastewater are equally important as, if not more than, the provision of latrines. The lack of adequate wastewater treatment has widespread repercussions such as environmental degradation, contamination of drinking water, and a multitude of related health and livelihood impacts.

Rapid population growth combined with increasing urbanisation naturally exacerbates this phenomenon. Experts claim that more than 50% of the global population already reside in towns and cities (UN 2012; UNFPA 2007), with most of this growth occurring in the Asian

4 Sanitation can be defined as *"… access to, and use of, excreta and wastewater facilities and services that ensure privacy and dignity, ensuring a clean and healthy living environment for all"* (COHRE et al 2008, 2).
5 Improved sanitation is defined as a *"sanitation facility… that hygienically separates human excreta from human contact"* (WHO/UNICEF 2010, 24).

regions. However, if the Swedish definition of 'urban' were applied to China or India, this region would be considered almost entirely urbanised already (Satterthwaite 2002). In lieu of an exact figure, current trends in Asia suggest that the rate of urban growth is occurring faster than can be quantified. These rapidly growing urban settlements present the greatest need for improved sanitation. In South Asia alone, almost 1 billion people lack access to adequate sanitation and hygiene services (World Bank 2012a).

The mounting problems of poor sanitation are particularly prevalent amongst the urban poor. Although poverty rates are generally lower in urban areas than rural areas, urbanisation is causing concentrated poverty in cities and a rapid increase in the number of urban poor (UNFPA 2007). Today, over one billion people live in overcrowded, polluted and dangerous urban conditions (ibid), which typically lack basic services such as clean water and sanitation. The majority of wastewater and septage is discharged into rivers and water-bodies without any form of treatment. This not only pollutes urban water resources, but also has detrimental impacts on economic growth and human development prospects.

Most notable is the correlation between inadequate sanitation and poverty, chronic illness and infant mortality due to waterborne illnesses such as diarrhoea or cholera. Diarrhoea causes more than 2.5 million deaths annually (WHO 2011) – approximately 5000 deaths per day of children under five years of age (Lüthi *et al* 2011b) – making it one of the highest causes of death in developing countries.

In addition to the health impacts, poor sanitation has further socio-economic impacts, especially for girls and women in developing countries, who suffer from "*diminished productivity and missed opportunities for education"* (Rosemarin *et al* 2008, 3). The lack of access to safe, clean, hygienic and private sanitation facilities causes a large number of woman and girls – particularly in adolescence and during menstruation – to drop out of school and instead stay at home managing household affairs (ibid). These girls are inhibited from reaching their education potential and consequent employment opportunities. Whether it be through associated illness and premature death, or blocked access to education and labour markets; the combination of these factors consequently weaken national economies and attribute to an inescapable cycle of poverty (COHRE *et al* 2008).

Perhaps due to the lack of prestige associated with discussing topics surrounding human excreta, investment in water, sanitation and hygiene (WASH) is considerably low, as is the global commitment to prioritising this crisis. Diarrhoea kills more people each year than HIV/AIDS or Malaria (WHO 2011), yet has received only a portion of the financial aid allocation (See Figure 2). On the other hand, investment in WASH can produce significant economic benefits; with WaterAid Nepal estimating that every US$1 invested in water and sanitation improvement can yield an economic return of US$2.5, or 150% (2006).

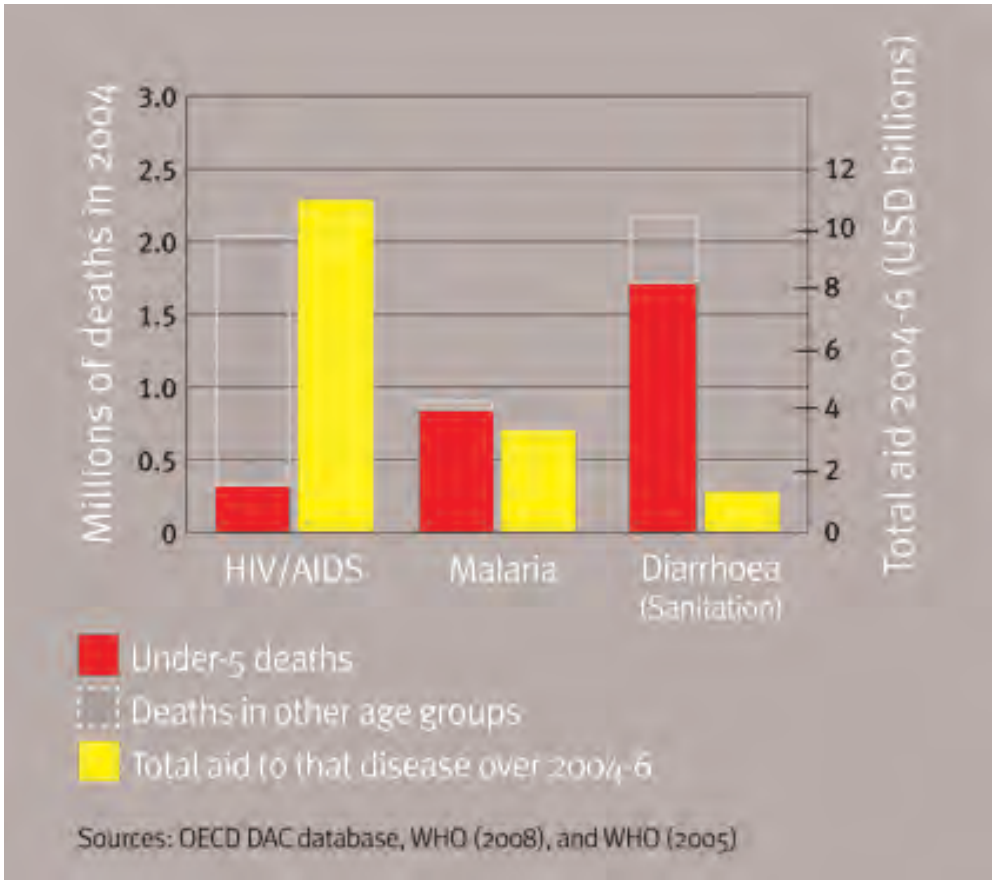


Figure 2: The main causes of death and the respective aid allocation (WaterAid 2009, 7).

Despite diarrhoea having the highest death rate, this chart (above) shows the disproportionately low financial contribution from aid agencies to sanitation compared to the contribution for HIV/AIDS and Malaria. It clearly demonstrates the global tendency to overlook the severity of the sanitation crisis.

Sanitation was an afterthought when it came to the United Nations (UN) Millennium Development Goals (MDGs), despite being linked to the success of at least three, if not all, of the eight main goals. Remedied two years later and included as a sub-category of *Goal 7: Environmental Sustainability*, Target 7.C aims to halve the proportion of the population without sustainable access to safe drinking water and basic sanitation by 2015. In recent years there has been an increased political awareness and allocation of funds in WASH, especially since the UN declared 2008 the *International Year of Sanitation*. However, according to a number of agencies such as WHO and UNICEF, it is now clear that Target 7.C will not be met by 2015 (WHO/UNICEF 2012).

As a result, millions of urban dwellers continue to live without the provision of basic sanitation and associated wastewater treatment. It is therefore widely accepted by water, sanitation and health experts alike that this crisis is one of the biggest challenges related to sustainable urban development. With urban populations continuing to grow, as does the need for affordable, effective and sustainable methods of sanitation management. Sustainable sanitation approaches and attitudes, such as Ecological Sanitation and environmental sanitation, are evolving as appropriate alternatives to conventional sanitation in both developed and developing countries. This study will focus on the context of Nepal, where this situation is no exception.

II. Contextualisation

i. Introduction to Nepal

The landlocked Federal Democratic Republic of Nepal is a developing country in South Asia, between China and India. Nepal has a population of 26.5 million – of which, approximately 2 million live abroad – and is experiencing both rapid urbanisation coupled with high levels of poverty (GoN CBS 2012).

Figure 3: Map of Nepal (Own design, adapted from UN 2007)

The World Bank estimates that more than 20% of the country's population currently live in urban areas (Muzzini & Aparicio 2013). This rate is steadily increasing by 5% per year; making it the highest rate of urbanisation in the South Asian Sub-continent (ibid). The increase in urban

population is due to a couple of factors: rural-urban migration intensified by a 10-year civil war, and the re-classification of growing towns from villages to municipalities (UNFPA 2007). People are moving to municipalities from surrounding villages drawn by the prospect of a better quality of life, access to health and education facilities, and improved employment opportunities. Current trends suggest that half the country's population will be living in urban areas by 2035 (Nycander et al 2011, 7). This rapid growth, combined with the Nepalese Government's inability to provide sufficient infrastructure and services, means the country's urban environments are already struggling to cope.

Nepal falls within the world's poorest regions, based on Gross Domestic Product (GDP) at purchasing power parity [6](PPP), with the GDP per capita PPP estimated at US$1,260 for 2011 (World Bank 2012b). This per capita GDP, when adjusted by PPP, is equivalent to just 6% of the world's average, placing Nepal at position 108th within the world GDP rankings (ibid; IMF 2011).

Nepal is also recognised by the UN as amongst the world's 48 least developed countries (LDCs) in terms of socio-economic indicators (UN 2011). Poverty estimates, which form part of the LDC criterion, suggest that Nepal experiences high levels of poverty with approximately 25% of the population – or 7.5 million people – living below the poverty line (The World Bank 2011). This occurrence is manifested in urban areas, with UN-HABITAT[7] reporting that 59.4% of urban dwellers were living in slum conditions in 2007 (UN-HABITAT 2008a, 178). These dense urban areas, with an increasing number of people living within ever shrinking spatial limits, face a multitude of challenges in terms of urban sanitation.

[6] GDP per capita PPP is calculated by dividing the country's gross domestic product, adjusted by purchasing power parity, by the total population.
[7] The United Nations Human Settlements Programme (UN–HABITAT) is the United Nations agency for human settlements.

ii. Political Situation and Government Commitment to WASH

Nepal has only recently emerged from almost a decade of civil unrest and political instability. Between 1996 and 2006, weakened institutions and poor governance brought the country to the verge of a failed state. In 2006, at the end of the civil war, Nepal was ranked 20th within the Foreign Policy *Failed States Index*, falling into the 'critical' classification category[8] (Foreign Policy 2012, online). The ranking has only slightly improved – it is now 27, within the 'in danger' category (ibid).

In November 2007 a peace treaty was signed, and since then the country has been in a state of political limbo as the process to rewrite the constitution is perpetually prolonged. As a result of on-going political instability, budget allocations in the WASH sector have been low, although this situation has gradually recovered in recent years (WaterAid 2011, 37). While the outcome of this reform is still unknown, the process is expected to involve the creation of a federal state, and a considerable reallocation of resources to local authorities (Nycander *et al* 2011, 6). Due to the shortcomings of government leadership, a number of international donor agencies (e.g. UN-HABITAT's *Water for Asian Cities Programme*, the Asian Development Bank's (ADB) *Small Towns Water Supply and Sanitation Sector Project)* are actively engaged in the formation of water supply and sanitation (WSS) policies and implementation programs (Lüthi 2012).

iii. The State of Urban Sanitation in Nepal

The state of sanitation in Nepal has reached crisis level, especially in urban areas. The economic impact of inadequate sanitation is an annual loss of up NPR. 6.0 billion (US$8.4 million) (WaterAid Nepal 2006).

[8] Foreign Policy *Failed States Index* rates countries according to their level of stability and/or risk or collapse or violence, using *Fund for Peace's* software to place them into one of the following categories: 'most stable,' 'stable,' 'borderline,' 'in-danger,' or 'critical' (Foreign Policy 2012).

Like many LDC's, the major sanitation challenges faced by small-towns and municipalities in Nepal are the supply of safe drinking water, provision and use of latrines, treatment of wastewater and management of solid waste. Delivery of these services to remote urban locations is often hindered by Nepal's rugged topography and landlocked location, making access both problematic and expensive. Poor planning and inadequate funding tend to worsen this situation.

It is difficult to establish exact figures for water supply and toilet coverage in Nepal, especially if you take into account the functionality or safety of these facilities. In terms of toilet coverage, official sources state that 43% of the population have access to toilets (GoN 2011a). However, WaterAid Nepal estimate the number of improved and hygienic latrines actually being used is closer to 27%, suggesting that neither the MDG target of 53% coverage by 2015, nor the national target of universal sanitation by 2017 will be achieved (2011a, 17). To some degree, these over-ambitious targets tend to further exacerbate the problem. Government agencies and other organisations are hastily constructing latrines simply to increase toilet coverage without considering their functionality, ensuring their sustained use or improving hygiene awareness (WaterAid 2008).

The percentage of sanitation coverage in Nepal is considerably higher in urban areas (48%) than rural areas (27%) (WHO 2012). However, the negative impacts of poor sanitation are more pronounced in dense urban areas. Public health is jeopardised by low standards of sanitation and hygiene awareness, particularly in regards to the inadequate management of various waste streams (e.g. Human and/or solid waste).

iv. Turning Crises into Opportunities: The Potential for Sustainable Solutions

In 2013 Nepal will host the next *South Asian Conference on Sanitation* (SACOSAN). With this international event on the horizon, the country is eagerly trying to establish some models of sustainable sanitation, to show international visitors and the local population, that sustainable sanitation is possible in Nepal.

The upcoming conference, and the exposure of unattainable MDG deadlines, means that this moment presents a vital opportunity to redirect much-needed attention towards the sanitation sector. The momentum is occurring at the same time as the global fixation on 'sustainability,' which suggests an increasing worldwide awareness about the necessity for ecologically sensitive and responsible solutions. New investments in sanitation have the potential to transform the whole sanitation chain – from latrine design, through to waste removal and treatment, and eventual re-use or disposal – essentially providing sustainable sanitation options for everyone.

Sustainable alternatives for dealing with the sanitation challenges in Nepal will form the basis of this thesis. Sustainable sanitation refers to the notion of:

> *"[protecting and promoting] human health by providing a clean environment and breaking the cycle of disease. In order to be sustainable a sanitation system has to be not only economically viable, socially acceptable, and technically and institutionally appropriate, it should also protect the environment and the natural resources."*
>
> (Lüthi et al 2011b, 50)

Sustainable systems are simple, cost-effective, safe and user-friendly; provide improved health and environmental conditions; and present opportunities for re-use and resource recovery. These systems can be easily operated and maintain, long after the initial implementation and construction.

III. Research Objectives and Structure

The overall objective of this study is to investigate and validate the benefits of community-based and community-led sanitation, which have already been piloted in a handful of locations around Nepal. The community-centred approach is considered to be both a cost-effective and sustainable solution to the challenges of urban environmental sanitation. As such, this research intends to substantiate these claims, while providing a knowledge base for decision makers regarding the further implementation of these approaches. It is therefore important to identify the driving factors behind initial implementation and long-term sustainability, as well as the various barriers hindering success and widespread scaling-up of this approach.

This thesis consists of two parts:

The first part is a comparative analysis of the sustainability aspects of three case studies from Nepal: Sunga, Srikhandapur and Nala. These urban and peri-urban communities present alternative methods for the decentralised management of environmental sanitation, as opposed to conventional, centralised approaches. These examples were selected in order to highlight the extent of the associated benefits, identify the main drivers for long-term O&M and unveil the barriers hindering larger scale implementation and promotion of DEWATS. They also reveal various stages along the timeline between initial implementation and on-going operation, having being constructed in 2006, 2008 and 2012 respectively.

The second part will present an investigation into the case study of Bhusal Danda – Tansen (See Figure 3); surveying the current situation and responding to the urgent need for improved sanitation and wastewater treatment. This hillside town was selected due to the current challenge faced by the municipality in providing its steadily increasing urban population with adequate sanitation services. In particular, the community of Bhusal Danda will provide a grounded project site, in which to apply the *Community-led Urban Environmental Sanitation* (CLUES) planning approach for sustainable sanitation and decentralised wastewater management.

i. Expected Outcomes

The outcome of this study is to show the benefits of existing models of community-based DEWATS in Nepal, and identify the factors influencing their success and/or failure. The intention is also to highlight the main incentives for communities to invest in and implement such decentralised systems. By combining the CLUES planning approach with lessons learnt from the three case studies, the feasibility for a similar concept in Tansen will be assessed and a range of customised technical options proposed for the selected community of Bhusal Danda. This research will provide the preparatory steps for the feasibility study of Tansen's *Sewerage and Drainage Improvement Project*, undertaken by GFA / MST on behalf of GIZ, for improved urban environmental sanitation.

ii. Research Questions

Part One – Comparative Analysis of Current Practices in Nepal

The exemplary settlements of Sunga, Srikhandapur and Nala will be assessed in terms of their financial and social sustainability, within the following categories:

- Planning and Implementation
- Operation and Maintenance: Management and Financing
- Stakeholder Engagement
- Technological Aspects

Financial assessment will be based upon the costs for planning, construction and on-going O&M, as well as the financial implications of various technological aspects. The social aspects are based on the level of community participation during the planning and implementation stages, stakeholder engagement in ensuring O&M, levels of 'ownership' and the tangible benefits received by the users as a result of the project. The intention is to establish the strengths and weaknesses of these sanitation interventions in their respective contexts, ascertain whether the associated costs are acceptable, and to clarify the main incentives for other communities to invest in such systems. The empirical study intends to answer the following research questions:

1. **Benefits:** To what extent have the financial and social benefits of environmental sanitation been realised?
2. **Drivers:** What are the main driving factors, which promote the implementation of environmental sanitation in an urban context and ensure its longevity?
3. **Barriers:** If the benefits of environmental sanitation are so commonly heralded, then why has it not naturally taken off in other areas?

Part Two – Community-Led Urban Environmental Sanitation in Nepal

Taking the project site of Bhusal Danda, Tansen, as a case study, the feasibility of improved environmental sanitation will be investigated through the strategic application of CLUES planning steps. The extent of the CLUES steps will incorporate Steps 1 – 5, in as much detail as the context-specific requirements and time limitations of the research period permit.

The following research questions will be studied through empirical methods:

1. What do the residents of Bhusal Danda identify as their priority concerns, in terms of environmental sanitation?
2. What would be an appropriate response for the improvement of environmental sanitation within this urban settlement?

iii. Research Methodology

This thesis adopts the social research strategy known as 'Action Research.' The defining characteristic of action research lies in its practical orientation for addressing 'real world' *"issues and problems, concerns and needs"* within an organisational setting, and is most commonly associated with *"hands-on, small-scale research projects"* (Denscombe 2010, 125). The purpose of action research is intended so solve an immediate, practical problem, while producing guidelines for improving best practices. In this sense, the *"two processes of 'research' and 'action' are integrated"* (Somekh 1995, 34). Action research involves a cyclical process, where "*initial findings generate possibilities for change, which are then implemented and evaluated"* as the basis for continual investigation (Denscombe 2010, 126). This strategy is sometimes also referred to as 'Participatory Action Research' or 'Practitioner Research' due to the active participation of the researcher (or practitioner) within an organisation change situation, while concurrently conducting research.

Preliminary research for this thesis was conducted during a two-week study period and review of secondary literature, undertaken at the Swiss Federal Institute of Aquatic Science and Technology (EAWAG) within the Department of Sanitation in Developing Countries (SANDEC) in Zurich. This was followed by several months of fieldwork and data collection in Nepal, during my internship with GFA Consulting Group / Municipal Support Team (GFA/MST), on behalf of the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ).

The field research undertaken in Nepal employed empirical methods for both qualitative and quantitative data collection and assessment, although this dissertation incorporates predominantly the qualitative rather than quantitative results. Qualitative research describes the process of collecting narrative, descriptive data – in the form of spoken or written words, or visual images (Hoepft 1997; Denscombe 2010). This methodology is commonly associated with research strategies such as *"case studies, grounded theory and phenomenology"* while utilising methods such as *"interviews, documents and observation"* (Denscombe 2010, 273). As such, the findings of this research were obtained through the following instruments: user interviews, site visits, focus group discussions and expert interviews (See Appendix IV – ***List of Interviewees***).

User Interviews and Site Visits

Interviews with nine users were conducted in Nepal during site visits to the case study communities of Sunga (2), Srikhandapur (5) and Nala (2). The intention of these interviews was to assess the level of user-involvement in the planning process and 'ownership' of the sanitation intervention, as well the extent of the associated benefits and user-satisfaction levels.

Interviews were administered through both structured questionnaires and semi-structured discussions, where respondents could respond freely to the subject (See Appendix III – ***Household Questionnaires***). Interviewees included members from the respective DEWATS users' committees, DEWATS caretakers and households connected to the DEWATS and/or biogas.

In the case of Bhusal Danda, semi-structured interviews were conducted with two local community leaders, two employees from the UMN Hospital, and one engineer from Tansen Municipality. In addition, structured questionnaire surveys were performed with a select group of five households.

Site visits to exemplary models of DEWATS in both Nepal and India were also necessary to assess the technical performance beyond what was available in secondary literature.

Focus Group Discussion

In addition to the ten individual interviews performed in Bhusal Danda, a half-day focus group discussion was facilitated with approximately 20 members from the local *Sewage Management Committee*. The purpose of the data collection in Bhusal Danda was to establish an understanding about existing sanitation conditions and problems, identify user preferences and priorities and to ascertain existing awareness levels of WASH. This discussion was facilitated in English, with Nepali translations.

Expert Interviews

A series of interviews were performed with twelve sanitation experts in Nepal, to gauge their perspectives on environmental, Ecological Sanitation and DEWATS. The experts were asked why they thought these alternative – and commonly heralded – concepts of sanitation hadn't naturally taken off across other parts of the country. The interviews helped to ascertain the main factors hindering the scaling-up of environmental sanitation, Ecological Sanitation and/or decentralised sanitation approaches.

Interviews were conducted with experts from relevant donor agencies and local non-governmental organisations (NGOs) as well as government representatives and other local stakeholders. Meetings were administered as semi-structured interviews, with open-ended questions. Respondents were interviewed in English and the sessions digitally recorded, wherever consent was given.

iv. Scope and Limitations of Research

The primary focus of this research project is on the feasibility of DEWATS as an urban sanitation solution for Nepal. However, it does not attempt to profess DEWATS as the only solution. There are a number of alternative sanitation systems and service options – such as ECOSAN toilets and UDDTs – which are potentially suitable, depending on the specific contextual conditions and requirements. DEWATS were chosen as a specialised technical solution, due to the practicability of implementation at a community or even municipal level.

It is important to note, however, that DEWATS are a relatively new intervention in Nepal. As such, the only examples so far have been constructed with financial and technical support from NGOs and international donor agencies. Although DEWATS technology is continuously being improved and made more affordable, initial construction costs for DEWATS are still high. For this reason, the feasibility of building DEWATS on a large scale across Nepal is unrealistic without some form of external support – i.e. infrastructure grants or soft loans. To improve citywide sanitation through the expansion of decentralised treatment services, *"municipalities will need funding over and above routine municipal resources - especially when sanitation investments do not generate financial returns"* (WSP 2011).

The CLUES planning guidelines outlined in part 2 are intended to provide a starting point for the pre-feasibility assessment of a sanitation intervention in Bhusal Danda, Tansen. However, as stipulated in the guidelines, the 7-steps are intended to be a thorough and comprehensive process, which take place over the course of ten months. Due to the time constraints of this research project, the CLUES steps will not be followed methodically, but instead incorporated simply as a guideline for preliminary research. By covering the first few CLUES steps, it is expected that the feasibility of further involvement in Tansen can be assessed and continued accordingly.

IV. Research Foundations

This section will review and summarise the various sources of literature, which represent the current state of research on sustainable sanitation in the context of Nepal.

i. A Brief Introduction to Sustainable Urban Development

In the 1987 United Nations report *Our Common Future*, the concept of sustainable development[9] - essentially that we should aim to meet our present needs without compromising future generations – was proposed as the driving force behind global economic policy. Although there are several other variations of this definition the broader objectives of sustainable development can be summarised with the *"three E's:"* environmental, economic and equity values (Berke and Manta-Conroy, 2000).

While there is also no clear-cut definition of sustainable *urban* development, the three elements of sustainability – ecological, financial and social – are considered to be interdependent and inseparable within the dimensions of the urban system (Campbell 1996). In our increasingly urbanising world, nowhere else is the implementation of these objectives more imperative, and once implemented more effective, than in cities. Urban areas consume a disproportionate amount of global resources, yet their dense civic nature has the potential to be developed in such a way that is more environmentally sustainable than scattered rural areas. Architects and urban planners throughout the world argue that the benefits associated with adopting sustainable approaches are potentially so great, *that "environmental sustainability should become the guiding principle of modern urban design"* (Rogers 1997, 5).

[9] The United Nations Bruntland Report provides the most widely used definition of Sustainable development: "*…development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs*" (UN 1987, 37).

In recent decades, this widespread concept of sustainable development has been promoted as both a new urban planning agenda (Beatley and Manning 1998) and one of the competing rationales for contemporary planning (Campbell 1996). Grave global concerns surrounding the environment, such as greenhouse gas emissions and loss of biodiversity, have led to increased advocacy of more sustainable land use practices (Vitousek et al. 1997). Many planners and urban experts now consider the most pressing challenges facing the profession are to replace the current resource consuming and environmentally straining activities with sustainable alternatives. Within this mindset, the WASH sector has a significant role to play in providing innovative solutions, which can guide cities in a more sustainable direction (Varis & Somlyódy 1997).

In terms of defining sustainability with particular reference to sanitation, the review of literature within the following section will introduce the more specific concepts of 'environmental' and 'ecological' sanitation.

ii. Conventional Sanitation

a) Systems and Technologies

Nepal's urban and peri-urban settlements currently employ a mix of sanitation technologies in terms of waste collection, storage, conveyance, treatment or disposal. The majority of these systems encourage either the conventional *"hide and forget"* or *"flush and forget"* mentality at the user-interface, implying that human excreta is considered to be waste, and waste should therefore be disposed of (Rosemarin *et al* 2008; Rüd & von Münch 2008, 2). This approach results in a *"linear flow"* sanitation system (See Figure 4), which is believed to have a direct correlation to environmental degradation, public health risks as well as short and long-term consequences on natural resources (Rosemarin *et al* 2008).

The on-site collection and storage facilities in Nepal are predominantly pit-latrines, flush and pour flush toilets, and septic tanks. It is not uncommon for these collection and storage facilities to release harmful pathogens into the soil, posing a high risk of groundwater contamination (Rajbhandari 2008). In addition to on-site facilities, underground conveyance systems can be found in many urban areas. With both the on-site and conveyance sanitation systems, capacity

for appropriate treatment or disposal of sewage is virtually non-existent in Nepal (Tuladhar *et al* 2008). It is not uncommon for sludge from pits or septic tanks to be released into rivers during the Monsoon months, flushing the wastewater downstream – out of sight and out of mind. Similarly, the majority of sewage is simply discharged into nearby rivers and water-bodies, without any form of treatment (ibid). Combined with the insufficient coverage of latrines in dense urban environments, this results in unsanitary conditions and an increased exposure to contaminated food and drinking water. The ingestion or inhalation of harmful pathogens are the primary causes for gastroenteritis and other diarrhoeal diseases, which kill over 40,000 people each year in Nepal, the majority of which are children under five (Pokhrel and Viraraghavan 2004). In overcrowded urban areas in Nepal, children are exposed to an even higher rate of diarrhoeal diseases (17.9%), compared to 12.6% in rural areas (UN-HABITAT 2008a, 108).

Water quality is further deteriorated by the lack of solid waste management in urban centres. Non-organic solid waste is often disposed indiscriminately on the side of roads or directly onto riverbeds, due to limited space for alternative dumping (ICIMOD *et al* 2007). Solid waste blocks sewerage and drainage systems, or ends up polluting the rivers and severely disturbing the waterway ecology. Ground and surface-water pollution from both untreated wastewater and the dumping of solid waste contributes to the problem of water scarcity, which is prevalent in almost all urban areas. Water scarcity and contamination inevitably threatens agriculture and local food security.

In response to this scenario, there has been a tendency in recent decades towards conventional, centralised approaches to wastewater management. Since the 1980s, a number of sewer systems and treatment plants based on Western models have been constructed in Nepal, with limited success (Tuladhar *et al* 2008). Of the four centralised sewerage treatment systems constructed in Kathmandu, not one is effectively operating today (ibid). Citizens and municipalities are simply unable to afford the high capital investment, associated connection rates, and the operation and maintenance provision for these high-tech systems. Frequent power shortages cause on-going technical failure and Nepal lacks both the skilled expertise required for continuous maintenance and repairs, as well as spare-parts, which often need to be imported.

The above problems are prevalent throughout the developing world, where the ability to maintain sophisticated wastewater treatment plants is lacking (Rosemarin *et al* 2008). In these contexts, it is necessary to break the trend of conventional planning approaches and adopt appropriate alternatives, which adhere to the objectives of sustainability such as: environmental safety; energy and resource efficiency; ease-of-use; low maintenance; affordability; and ideally, the potential for nutrient reuse in energy production or agriculture (ibid):

> *"In addition to maintaining a sanitary environment to live, sustainable sanitation systems will need to promote water, nutrient and energy reuse, as the shortage of finite resources becomes more apparent and the prices for water, fertiliser and energy continue to rise."*
>
> (Lüthi et al 2011b, 11)

While this research focuses on sustainable alternatives for developing countries, it is worth noting that there also needs be a concerted effort to improve sanitation systems in developed countries. Firstly, conventional, centralised sewerage systems are fundamentally flawed. They are costly to maintain and inefficient in terms of water wastage and nutrient recovery, failing in both the economic and environmental categories of 'sustainability'. Secondly, developed countries are in a prime position when it comes to the marketability and promotion of innovative and desirable technologies. There is great potential for developed countries to set an example of sustainable sanitation alternatives, which are then more likely to be adopted in other parts of the world. How can we expect citizens in South Asia or Africa to use a toilet that is not used in Europe?

b) Institutional Aspects, Sanitation Policy and Planning Approaches

WASH and urban development services in Nepal are managed by a number of different agencies. The *National Planning Commission* (NPC) is the apex body responsible for formulating national level development goals, while the *Ministry of Finance* (MoF) is responsible for the allocation of public sector finance to the various sectoral ministries (Communication with Mr. Arjun Koirala, 01.02.13). The NPC, together with the MoF, facilitate the implementation of development plans and programmes. Meanwhile, the *Ministry of Federal Affairs and Local Development* (MoFALD) works in cooperation with the MoF – coordinating, facilitating, monitoring and evaluating

activities undertaken by local bodies at the grass-roots level. Their scope of responsibility encompasses 75 *District Development Committees* (DDC), 58 Municipalities, 3915 *Village Development Committees* (VDC), and their respective user committees (GoN 2013, online).

Under the direction of the NPC, the *Ministry of Physical Works and Planning* (MPPW) and the *Ministry of Urban Development* (MoUD) are the principal agencies responsible for the formulation of policies and strategies related to infrastructure for physical planning and urban development (ibid).

Under the umbrella of both the MPPW and MoUD, the *Department of Water Supply and Sewerage* (DWSS) and the *Department of Urban Development and Building Construction* (DUDBC) are the implementing agencies for WSS within the urban sector. DWSS is responsible for water supply and sewerage operation and construction in small towns, peri-urban areas and municipalities outside Kathmandu Valley (GoN 2011b; UNDP 2010). Under the DWSS, the *Nepal Water Supply and Sewerage Corporation* (NWSC) work as the main utility operator. Working in parallel to the DWSS, the DUDBC works together with local municipalities to implement water supply and wastewater management systems (GoN 2011b).

In addition to the government agencies, major stakeholders in the WSS sector include the World Bank and the ADB who have been active in urban and rural water and sanitation projects in Nepal since the early 1990s and 1984 respectively (UNDP 2010); UN agencies such as UNICEF, UN-HABITAT, UNDP and WHO are also supporting the sector; as well as many NGOs (including WaterAid, Plan and Helvetas) (ibid).

There are a handful of national policies and programs that cover WASH issues in Nepal, however their translation into practice is somewhat questionable. While there are comprehensive guidelines for rural areas in the 2004 *Rural Water Supply and Sanitation National Policy* (GoN-MPPW 2004), completed guidelines for urban areas currently do not exist. The most recent *National Urban Water Supply and Sanitation Sector Policy* conceived in 2009, is still being drafted (GoN-MPPW 2009) and is therefore problematic to implement. Both policies aim for the provision of safe and potable water, and basic sanitation services. In addition, the *National Hygiene and Sanitation Master Plan* (GoN 2011a), supports both policies by identifying target areas and key approaches for the various sectors to follow.

All of these documents are ambitious in their targets for 100% water supply and sanitation coverage by 2017 (WaterAid 2011a). However, it is simply unrealistic to expect these goals to be achieved with the current levels of investment and political will at both the government and sector level.

iii. Non-conventional Sanitation

In recent decades, a variety of alternative approaches, actions, technologies and management processes for achieving environmentally sustainable sanitation have been adopted in Nepal. Ecological Sanitation is one such concept, as well as the set of activities defined as environmental sanitation, both of which fall under the umbrella of sustainable sanitation and apply the systems approach to the 'Sanitation Value Chain'. This section will provide a brief definition of each of these terms to clarify their subtle yet notable differences. Also, the technical approach of decentralised sanitation systems will be introduced as a sustainable system for treating wastewater at the local level.

a) Environmental Sanitation

Environmental sanitation is based on the Bellagio Principles for Sustainable Sanitation. It was developed by a team of WASH experts in 2000 in response to the shortfalls of conventional sanitation policies and practices in meeting the needs of the developing world (WSSCC 2000; See Appendix I – ***Bellagio Principles***). The Bellagio Principles call for drastic global reform of sanitation policies and practices, to achieve: *"…universal access to safe environmental sanitation, within a framework of water and environmental security and respect for the economic value of wastes"* (ibid, 1). These principles prioritise the following values:

1. Human dignity, environmental security and demand responsiveness;
2. Good governance and stakeholder participation;
3. Waste as a resource and integrated waste management processes; and
4. Managing waste as close as possible to its source and with minimal dilution.

Environmental sanitation takes a new view on a subject, which is often limited to the immediate aspects surrounding human excreta and/or the provision of toilets. It acknowledges that a hygienic environment is only achieved when the entire physical environment – including various sanitation services and waste-streams – is considered as a whole; particularly those aspects directly related to human health and quality of life (Tilley et al 2008). The typical components of environmental sanitation include drainage and storm-water management, solid waste management, sanitation (excreta and wastewater management) and to some extent the provision of potable water (EAWAG 2005). In this sense, environmental sanitation requires renewed collaboration between multiple actors and sectors, which often operate independently from one another (Lüthi *et al* 2011a).

Environmental sanitation also forms the basis of the sanitation systems approach, stipulating which *"sanitation devices and technologies should always be considered as parts of an entire system"* (Tilley *et al* 2008, 3). This approach is inherent to the *Compendium of Sanitation Systems*, which is a comprehensive guide recently developed by EAWAG and WSCC to guide planners and sanitation experts through all available sanitation technologies and processes. The Compendium defines sanitation as a *"multi-step process in which wastes are managed from the point of generation to the point of use or ultimate disposal"* (ibid, 9). This can also be understood as the 'Sanitation Value Chain,' (described further on Page 31).

b) Ecological Sanitation

In the same vein as environmental sanitation, Ecological Sanitation presents an alternative approach to conventional sanitation thinking, by considering the problems of sanitation within the greater realm of the natural ecosystem (Rüd & von Münch 2008). Ecological Sanitation can be considered both a *"systematic approach as well as an attitude"* (Langergraber & Muellegger 2005). While environmental sanitation provides an integrated understanding of inter-related 'waste' streams and services that should be addressed as a whole, Ecological Sanitation deals specifically with the treatment of excreta and organic waste; while doing so in an entirely holistic manner. Treatment is achieved by mimicking natural ecosystems, otherwise known as the *"ecosystems approach",* where water and nutrients are not considered as simply 'waste' products, but as potentially valuable resources such as water, energy, urea (fertiliser), salts and minerals (BMGF 2012; Rüd & von Münch 2008; Esrey *et al* 2001).

Expanding upon the Bellagio Principles three and four, the key objectives of Ecological Sanitation are to promote a new philosophy for embracing what has previously been regarded as waste, while at the same time minimising the domain of waste itself. This is translated into practice, firstly, through the Ecological Sanitation ideology of re-use, which allows no option for *"disposal"* at the end of the sanitation chain. The Ecological Sanitation paradigm therefore presents a movement away from the linear flow, *"broken"* chain of conventional sanitation, which is notoriously inefficient and wasteful. Ecological Sanitation adopts a circular, *"closed-loop"* approach instead (See Figure 4), which aims to close the gap between sanitation and agriculture (Langergraber & Muellegger 2005). This method is deemed to be more appropriate in terms of achieving sustainable sanitation and food security (Winblad & Simpson-Herbert 2004), compared to linear systems require vast quantities of water in the transportation of solid matter from the point of *"capture"* to end-of-pipe *"disposal"* (See Figure 4).

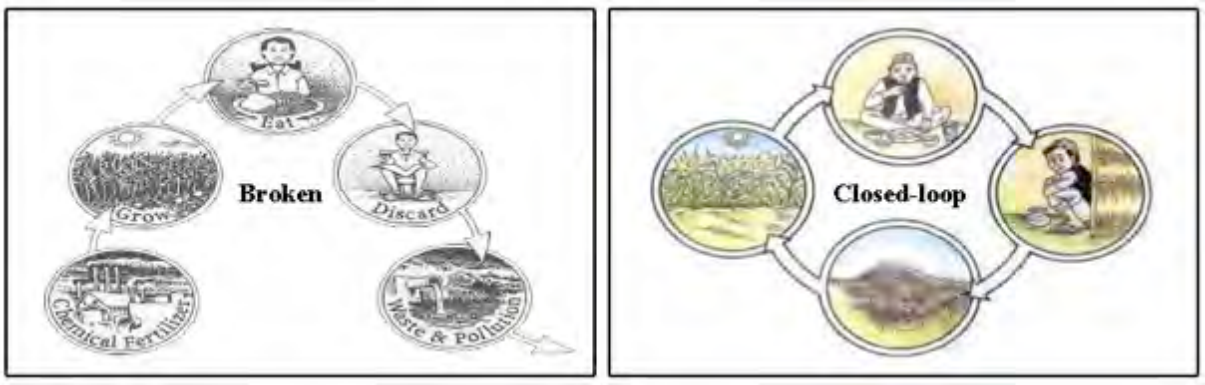


Figure 4: The *"Broken"* chain of conventional sanitation practices, compared to the *"Closed-loop"* cycle of Ecological Sanitation (WaterAid Nepal 2008a, 3).

Ecological Sanitation also counteracts the conventional sanitation chain and its inherent dependency on synthetic fertilisers and pesticides for food production; consuming finite resources such as phosphorus, while valuable nutrients found in faeces and urine are simply flushed down the drain (Cordell *et al* 2009).

The Ecological Sanitation approach explores many possibilities for waste re-use, be it in agriculture, aquaculture, horticulture, energy generation, or industrial uses. For example, sanitised faecal matter can be used in as a soil conditioner or in the production of biogas, and experts estimate that urine has the potential to provide more than half the phosphorus required to fertilise global cereal crops (WHO 2006; Esrey *et al* 2001). The objective of closing the sanitation-loop is:

> *"to protect human health and the environment while reducing the use of water in sanitation systems and recycling nutrients to help enable sustainable production of food"*
>
> *(Rockström et al 2005, 45).*

In addition to re-use, the main priorities for Ecological Sanitation are to *"contain and sanitise"* waste before it is recovered or recycled (Winblad & Simpson-Herbert 2004, 4). Human excreta contains harmful bacteria, parasites and viruses, hence the necessity to contain such pathogens within the sanitation process, and to break the viscous cycle of disease (Rockström *et al* 2005). This element of Ecological Sanitation can be compared to the principles of environmental sanitation, which are to destroy any harmful pathogens as close as possible to where they are disposed or excreted (WSSCC 2000). It also enables the safe and easy re-use of waste, localised treatment of wastewater and the extraction of valuable nutrients, which are otherwise washed downstream (Esrey *el at* 2001). In this sense, the ideology and technologies of Ecological Sanitation can be applied in order to achieve the objectives of environmental sanitation.

The concepts of Ecological Sanitation can be promoted through various physical forms and applied technologies such as ecological compost toilets, natural wastewater treatment techniques and biogas generators, which aim to prevent harm while simultaneously providing benefits (Tilley *et at* 2008). These systems not only reduce the spread of infectious disease, environmental degradation and pollution, but also enable the recovery and re-use of nutrients; generating sustainable livelihoods, improving the quality of water, food sources and essentially, the quality of human life (ibid, Esrey *et al* 2001).

Ecological Sanitation can be implemented at every scale from simple household installations through to complex, predominantly decentralised systems (Otterpohl 2004). Likewise,

environmental sanitation – particularly at community and urban scale – tends to deviate from centralised, conventional sewerage towards decentralised alternatives for unplanned urban areas (Lüthi *et al* 2011a). The implementation of urban-scale, decentralised systems for wastewater treatment will be explored in further detail throughout this thesis.

c) The Sanitation Systems Approach and Sanitation Value Chain

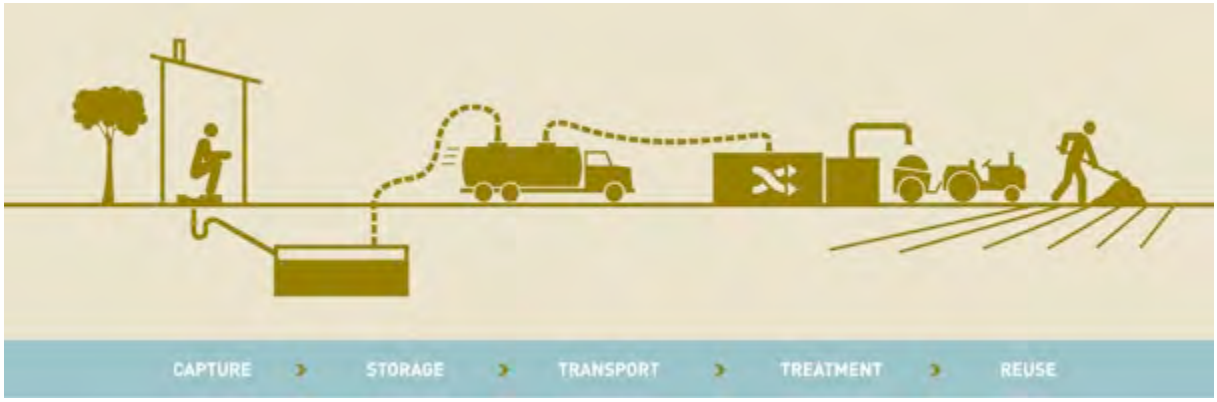


Figure 5: The Sanitation Value Chain (BMGF 2012)

Both Ecological Sanitation and environmental sanitation consider the entire sanitation value chain, which spans from the user interface (capture) > collection and storage / pre-treatment > conveyance (transport) > treatment > re-use and/or disposal (See Figure 5) (BMGF 2012; Tilley *et al* 2008). The main difference is that environmental sanitation combines the human-waste sanitation inputs chain with other elements such as storm-water drainage and/or solid-waste management; all the essential pieces of the environmental sanitation puzzle.

For the purpose of distinguishing the distinct sanitation systems along the value chain, the following matrix (Figure 6) will be used throughout this thesis. The vertical columns represent the various groups of technologies or functions utilised to process the horizontal rows of 'input products' or 'resources', which are otherwise considered to be 'wastes':

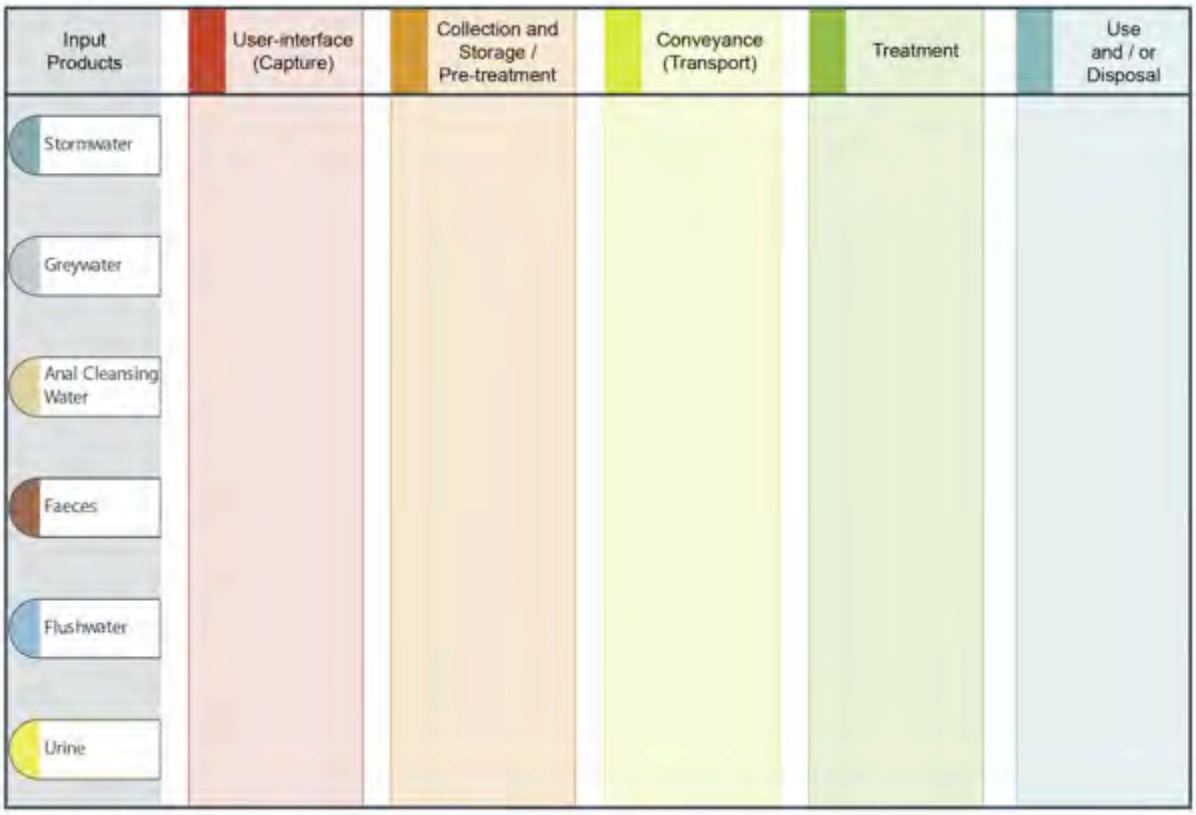


Figure 6: Sanitation Value Chain Matrix (adapted from Tilley *et al* 2008, 14)

d) Decentralised Wastewater Treatment Systems (DEWATS)

Similar to both environmental sanitation and Ecological Sanitation, the technical approach of DEWATS evolved in response to the deficiencies of conventional, centralised, wastewater treatment infrastructure (Gutterer *et al* 2009). Such centralised networks have largely failed to address wastewater disposal needs in the developing world, due to high capital investments, difficult O&M, and low connection rates (ibid).

DEWATS, on the other hand, present an opportunity to manage and treat wastewater at the local level, as per the principles of both environmental sanitation and Ecological Sanitation. This is considered to be a more democratic, sustainable and viable alternative for sewage collection, wastewater treatment and solid waste management in poor urban areas (UN-HABITAT 2008c). The recent shift towards decentralised approaches and increased attention within the global development discourse help to validate this assertion (Taylor *et al* 2003). DEWATS can also be

considered as an Ecological Sanitation solution in cases where the primary and secondary treatment technology is configured towards re-use. Typical re-use options for DEWATS are in the production of biogas as an alternative energy source, or faecal sludge management for the re-use of enhanced end-products in agriculture.

Decentralised wastewater management is defined as "*the collection, treatment and disposal/reuse of wastewater from individual homes, clusters of homes, isolated communities as well as from portions of existing communities at or near the point of waste generation*" (Tchobanoglous 1995, cited in Lüthi et al 2011a, 11), and is therefore in accordance with the 4th Bellagio Principle for Sustainable Sanitation: to reduce the domain of sanitation management to the smallest practicable size (WSSCC 2000).

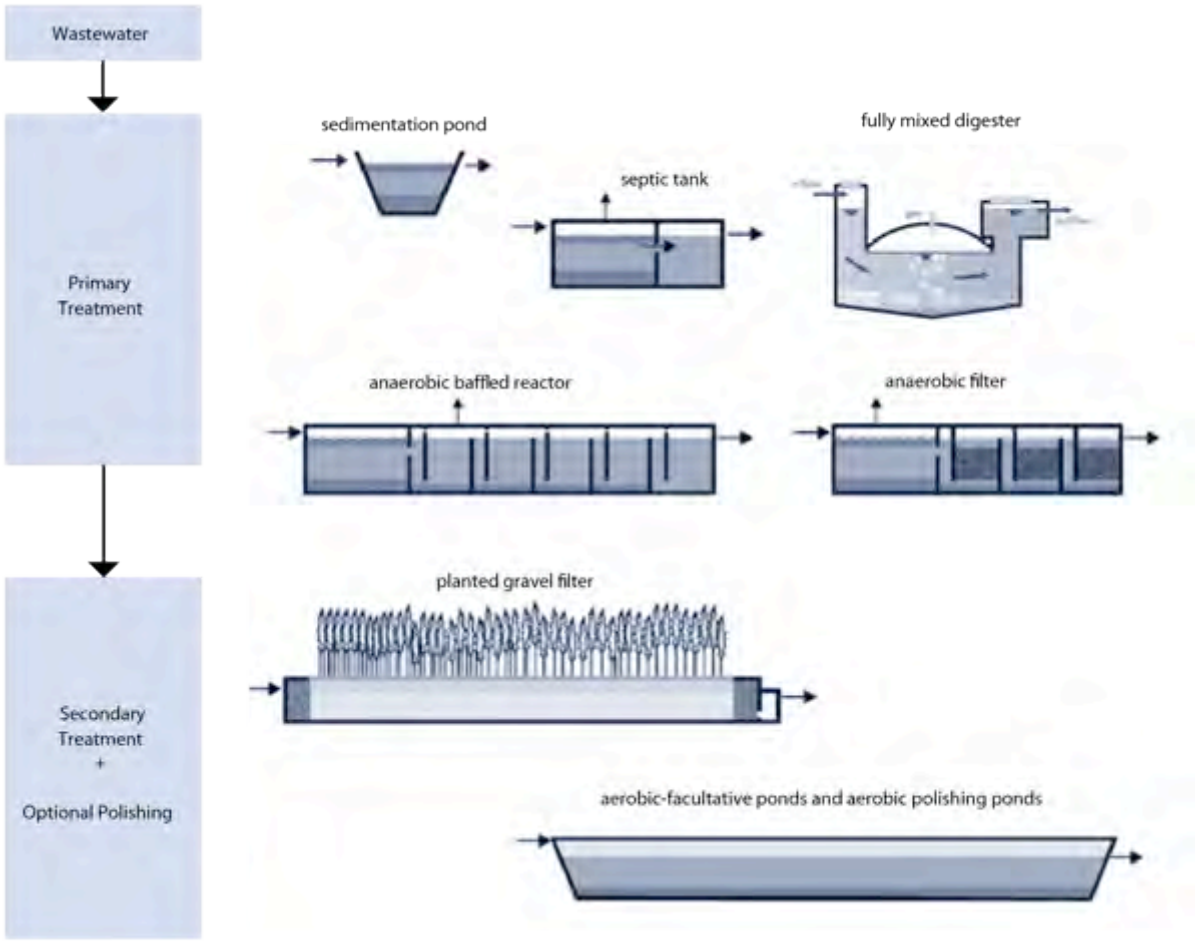


Figure 7: DEWATS configuration scheme (Own Design, adapted from Gutterer *et al* 2009, 35)

The configuration of DEWATS can vary considerably depending on size, location and a number of other determining factors. In Nepal, the most commonly adopted components incorporate anaerobic processes (e.g. Anaerobic Baffle Reactors; ABRs) for primary treatment, combined with Constructed Wetlands (CW) for secondary treatment or polishing (See Figure 7). Some systems also combine ABRs with biogas digesters, as a primary treatment step.

Anaerobic processes refer to absence of oxygen and the subsequent *"degradation of concentrated wastewater solids during which anaerobic bacteria break down organic material into inert solids, water, carbon dioxide and methane"* (IWA 2012, 12). Effluent solids are then trapped and consumed by microbes, treating the wastewater using natural processes. An ABR consists of a series of baffles, under which the wastewater is directed to flow through the layers of settled sludge. Solids are then trapped and consumed through the anaerobic digestion process mentioned above (See Figure 8).

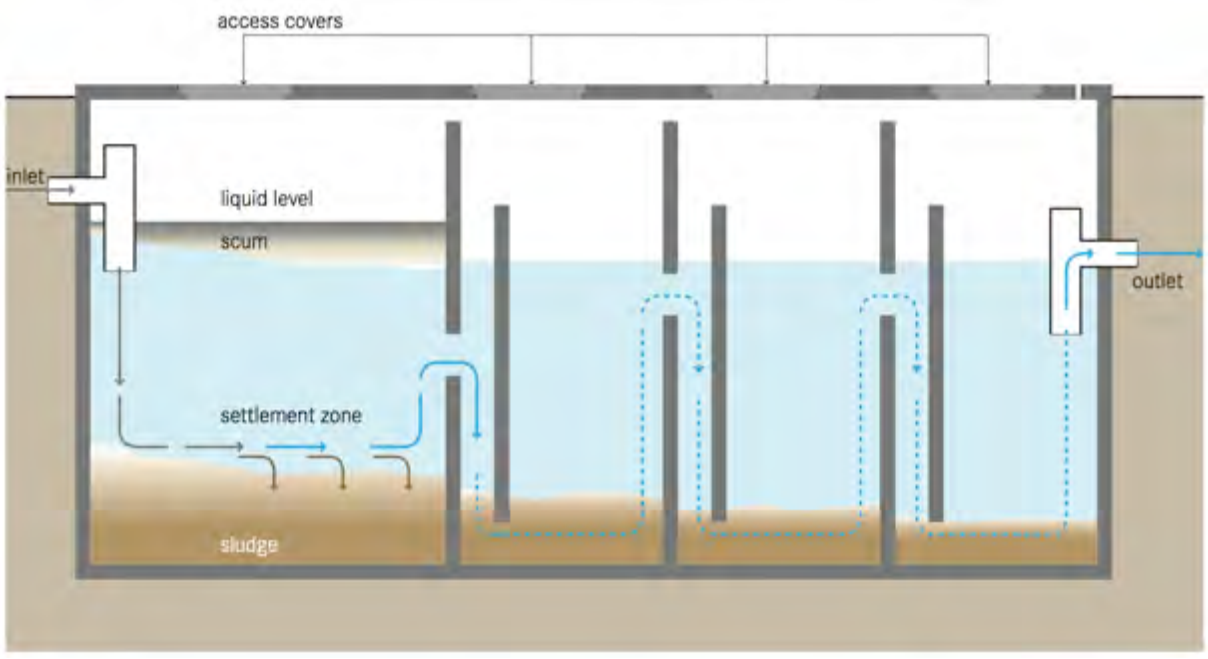


Figure 8: Typical ABR configuration (Tilley *et al* 2008, 69)

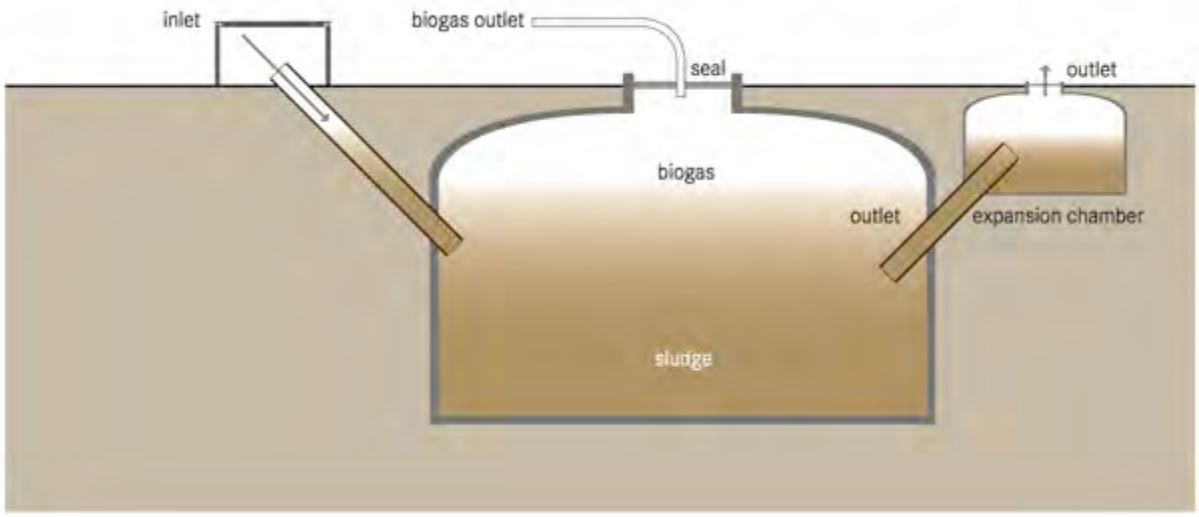


Figure 9: Typical configuration of an Anaerobic Biogas Reactor (Tilley et al 2008, 123)

Other anaerobic methods for primary wastewater treatment include methane collecting bio-digester technology (Tilley *et al* 2008; See Figure 9). These systems use similar microbial degradation treatment processes as mentioned above, while producing a digested slurry that can be used as a soil amendment, or biogas that can be used for energy (e.g. electricity, light, heating or cooking). The advantage of such systems lies in the added potential to treat livestock faeces and organic waste, in addition to human waste.

The primary outputs from ABR treatment systems (faecal sludge and effluent) outputs can be further treated through the natural processes inherent to Constructed Wetlands, which is referred to as secondary treatment or polishing. CWs apply biological wastewater treatment technologies, configured in such a way to mimic wetland ecosystems found in nature: *"these systems use wetland plants, soils and their associated micro-organisms to remove contaminants from wastewater"* (WaterAid Nepal 2008a, 4). CW in the form of sub-surface flow systems, also known as Reed-Bed Treatment Systems (RBTS), use sloped sand or gravel beds combined with planted reeds to filter out the wastewater pollutants. Water flows through either vertically or horizontally and is "*treated through natural processes like mechanical filtering, chemical transformations and biological consumption of pollutants in wastewater"* (ibid, 5; See Figure 10 & Figure 11).

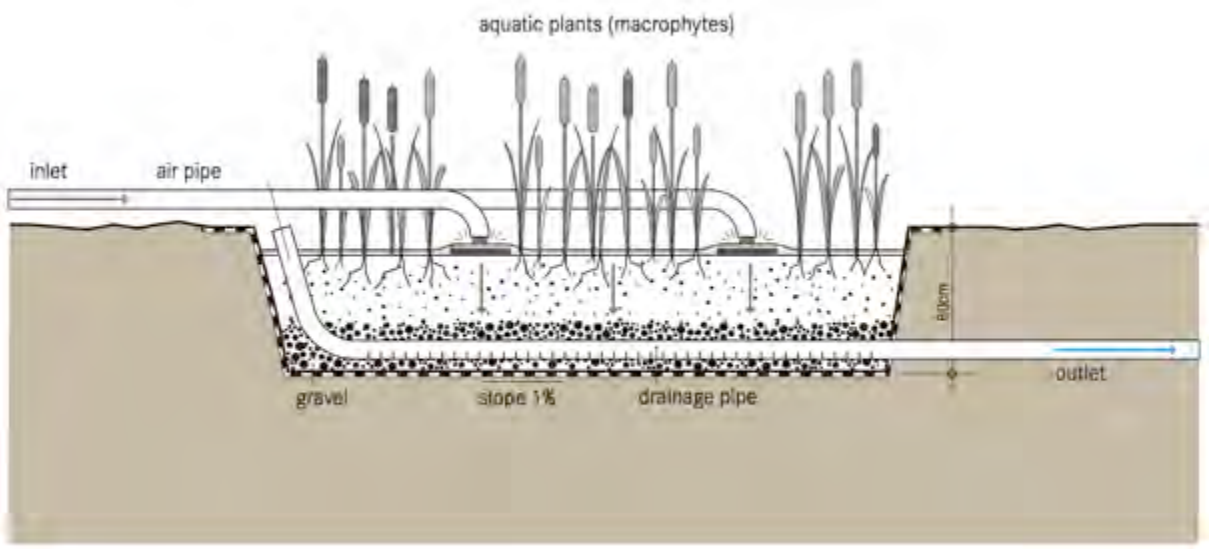


Figure 10: Vertical Flow Constructed Wetland (Tilley et al 2008, 107)

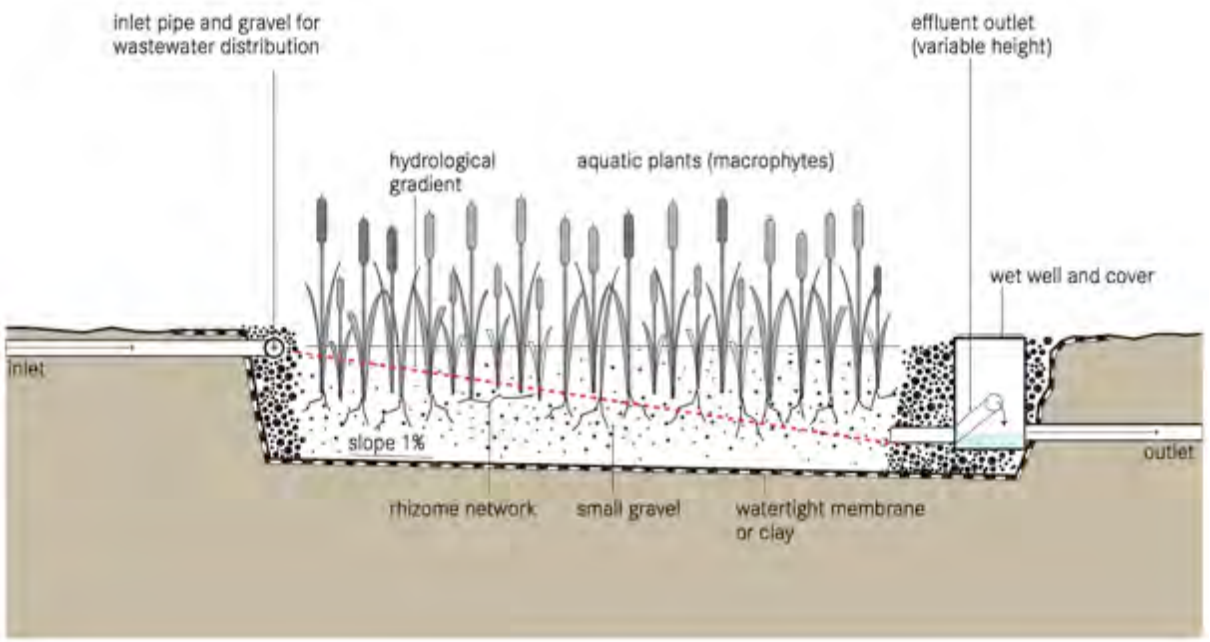


Figure 11: Horizontal Subsurface Flow Constructed Wetland (Tilley et al 2008, 105)

Due to their simplicity and adoption of natural systems, both ABRs and CWs are affordable to construct – requiring low primary investment costs and utilising locally available materials and labour – and can be maintained without skilled expertise (Gutterer *et al* 2009; BORDA undated). The implementation of decentralised wastewater solutions are predominantly in the form of low-tech and low-maintenance solutions. In addition, DEWATS can be operated without energy

inputs and have a lower risk of malfunction associated with the unavailability of spare parts (Bauchrowitz 2010). Compact treatment systems, possibilities for nutrient recycling, efficient use of water and water re-use are the inherent aspects, which position DEWATS within the criterion of both environmental and ecological sanitation.

e) Decentralised Integrated Solid Waste and Wastewater Treatment Systems (DISWATS)

Decentralised Integrated Solid Waste and Wastewater Treatment Systems (DISWATS) take DEWATS one step further, with the inclusion of solid waste within the treatment equation. DISWATS presents a relatively new approach currently being tested in Nepal (Interview with Mr. Rajendra Shrestha 05.10.12). The objective of combining solid organic waste with DEWATS is to generate energy in the form of biogas (ibid; interview with Mr. Bhushan Tuladhar 18.09.12). It is expected that any profit associated with the production of biogas can potentially offset O&M costs – making the DEWATS more sustainable.

By combining the sectors of sanitation and wastewater treatment, solid waste management and re-use (in the form of biogas), DISWATS adheres to the principles of both Ecological Sanitation and Ecological Sanitation.

iv. Current Trends in Sanitation Planning

In Nepal, the abovementioned concepts surrounding sustainable sanitation have been complemented by various citywide and community-level planning approaches, such as *CLUES Planning*, *Water and Environmental Sanitation Improvement (WESI) Plan, Citywide Sanitation Strategy* and *Community-driven Development*.

There is a strong need for innovative approaches when it comes to sanitation planning in developing countries. Past experiences have proven that the longevity of water and sanitation projects in these contexts do not have the best track-record (Rosemarin *et al* 2008). In 2001, the

World Bank evaluation of water supply and sanitation projects deemed only 50-66% to be of a satisfactory standard, and less than half were considered to be sustainable (World Bank 2003). On-going operation is hindered by various constraints such as low community demand or user-acceptance, prohibitive costs, lack of political will and limited management capacity.

These constraints have been acknowledged and addressed accordingly in the following planning approaches of CLUES and WESI, which have been specifically developed for implementing sustainable sanitation solutions on a large scale.

a) Community-Led Urban Environmental Sanitation (CLUES) Planning

CLUES planning is a complete set of guidelines developed by experts from EAWAG/SANDEC in partnership with UN-HABITAT and WSSCC (Lüthi *et al* 2011a). CLUES is the most up-to-date planning framework for facilitating the delivery of environmental sanitation services, in specific reference to urban- or community-scale contexts. The aforementioned 'Systems Approach' (Page 31) to sanitation is an inherent part of CLUES, where all the various stream of wastes are considered as a whole. In this sense, the main characteristics include:

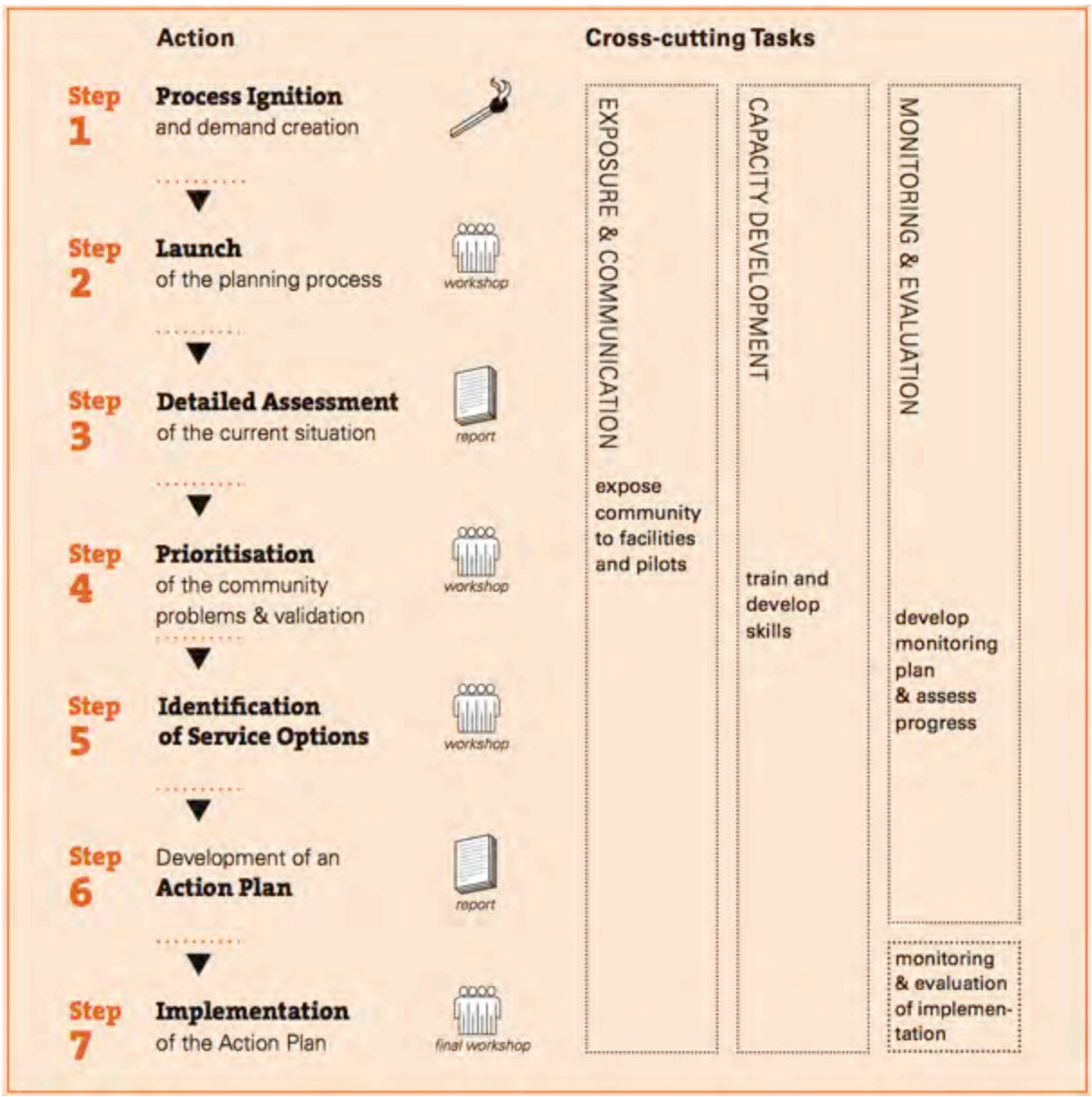
> *"a multi-sector and multi-actor approach accounting for water supply, sanitation, solid waste management and storm drainage and emphasizing the participation of all stakeholders from an early stage in the planning process."*
>
> *(ibid, 5)*

These elements are all considered to be vital in achieving clean and healthy urban environments.

The CLUES planning process is divided into seven easy-to-follow steps, which are intended to be undertaken in sequential order (See Table 1 & Appendix II – ***Overview of CLUES Planning***). In reality, these steps occur concurrently and may also be repeated whenever necessary to arrive at the most suitable solution. In addition to the 7-steps, there are three relevant *"cross-cutting tasks"* which need to occur throughout the planning process: *"Awareness Raising and Communication; Capacity Development; and Process, Monitoring and Evaluation"* (ibid, 17). These

cross-cutting tasks can be visualised in the following table – as well as the expected outputs and workshops – at their respective stages throughout the 7-step planning process:

Table 1: Overview of the CLUES planning approach (Lüthi *et al* 2011a, back-cover)



CLUES highlights the importance of broad community-level involvement throughout the entire planning, decision-making and implementation processes:

> *"the process should be 'owned' by the stakeholders who are directly affected: even though experts may be providing advice and taking a lead role on certain activities, the local community should take responsibility for the overall planning process."*
>
> (Lüthi et al 2011a, 15)

By placing the community at the centre and involving all relevant stakeholders from the outset, this approach attempts to address varying perspectives and expectations, reach a common consensus and essentially achieve an appropriate solution for sustainable sanitation. CLUES also emphasises the necessity of good urban governance or an 'enabling environment' in achieving successful, sustainable and replicable solutions: *"Political will is perhaps the single most important factor in achieving sustainable improvements in un-served urban areas"* (Lüthi 2012, 45). CLUES planning therefore outlines the critical elements for achieving an *"enabling environment… [within a] political, legal, institutional, financial, socio-cultural and knowledge framework"* (Lüthi *et al* 2011a, back cover).

This planning approach has recently been piloted in Nala – Nepal, with support from EAWAG/SANDEC, UN-HABITAT's *Water for Asian Cities Programme*, WaterAid-Nepal and a local NGO: *Centre for Integrated Urban Development* (CIUD) (Sherpa *et al* 2012). This project in Nala will be explained in further detail in the Part 1 case study assessment (Page 61). In addition, CLUES is currently being validated within the ADB-funded *Small Towns Programme* in selected small towns in Nepal.

b) Water and Environmental Sanitation Improvement Plan

The CLUES approach is compatible with similar Nepali planning approaches such as the WESI Plan. Introduced by CIUD, the WESI Plan adopts an integrated and comprehensive approach for managing both urban water and sanitation (CIUD 2010). This methodology has been tried and tested in several peri-urban locations around Nepal, with the implementation of ECOSAN toilets

and DEWATS. The WESI Plan considers water and sanitation one element, instead of two individual elements. When treated as separate elements problems like untreated wastewater, or ground and surface water contamination, inevitably occur (ibid).

c) Citywide Sanitation Strategy / City Sanitation Plan

The planning guidelines outlined by CLUES are intended to complement a citywide sanitation strategy, where citywide decisions by local authorities are based upon active engagement and support from the community level. Citywide sanitation strategy is a comprehensive planning process for sanitation sector development, which thereby optimises both a 'top-down meets bottom-up' approach to planning (WSP 2010). The objective of this approach is to develop the urban sanitation sector into *"one that is all-inclusive and sustainable"* (ibid, i).

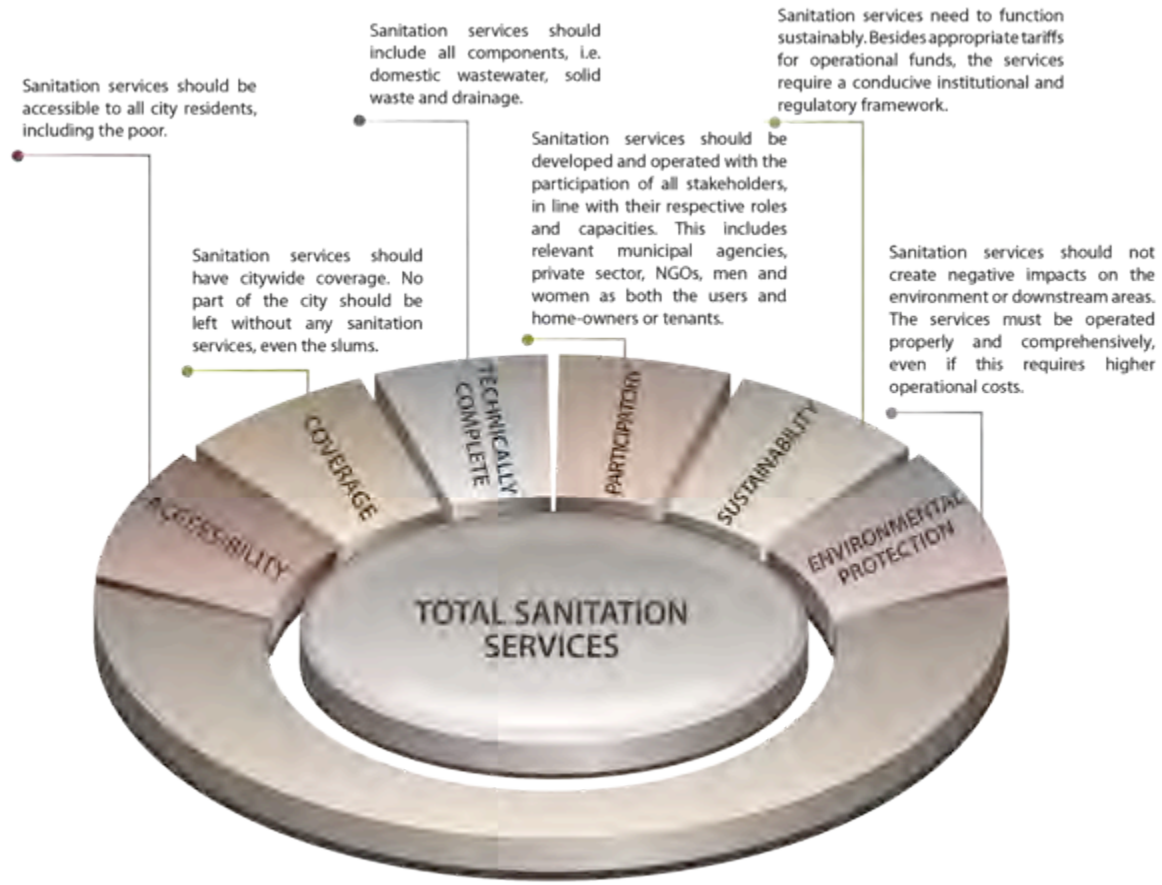


Figure 12: CSP Guiding Principles (WSP 2010, 5)

The guiding principles of a citywide sanitation strategy, or City Sanitation Plan (CSP), should incorporate *"mainstream thinking, planning and implementing measures related to sanitation sector with a balanced mix of centralised and decentralised approaches"* (Walther 2012). Figure 12 (above) shows each of the principles that would be referenced within a CSP (WSP 2010, 5).

Citywide sanitation also acknowledges all the waste streams of environmental sanitation – such as garbage, blackwater, greywater and rainwater run-off – in the design of sanitation services for 100% sanitised cities. In the explanation of citywide sanitation, WSP have intentionally chosen to use the term 'service' to *"emphasise the need for on-going processes not just 'one-off' investments in construction"* (2010). For this reason, sanitation solutions will be referred to as 'service options' within the second part of this thesis (See ***Identification of Service Options (CLUES Step 5)***, Page 107).

The widespread adoption of citywide sanitation strategies has already been successful in Indonesia[10] and India[11]. One such example is the CSP for the Indian city of Shimla, which was recently developed through GIZ *Support to the National Urban Sanitation Policy* and its *Indo-German Environment Partnership Programme*. The objective of this partnership was to assist *Shimla Municipal Cooperation* to improve local conditions in regards to sanitation and solid waste. At the time of writing, this strategy was concurrently being implemented.

The Shimla CSP includes decentralised wastewater treatment combined with the upgrading and rehabilitation of Shimla's existing sewerage system. In addition to sanitation service options, municipal solid waste management is an integral part of the CSP, hence the construction of a solid waste treatment plant combined with a door-to-door collection system.

[10] The *Indonesia Sanitation Sector Development Programme* (ISSDP) is a sub-programme of the *Water and Sanitation Programme* Trust Fund, co-funded by the Government of the Netherlands. ISSDP is assisting six cities in Indonesia to develop citywide sanitation strategies.
[11] The *Jawaharlal Nehru National Urban Renewal Mission* is a large scale scheme launched in 2005, by the Government of India under the Ministry of Urban Development (Walther 2012). Under this programme, Shimla is one of the 63 urban centres eligible for fast-track infrastructure development (GIZ ASSEM 2011).

Although citywide sanitation strategy is not yet practiced in Nepal, there is significant scope for Nepal to learn from previous CSP examples, in terms of refining and optimising the sanitation development planning process. The case of Shimla provides a particularly suitable precedent, due to its proximity to Nepal, hilly topography and location within the same geo-climatic region. Shimla also presents a similar case to Tansen, as a recipient of GIZ technical support for capacity development, as well as urban infrastructure and service delivery. Both municipalities are therefore enabled to invest in water supply, sanitation and solid waste management.

d) Community-driven Development

In a similar mind-set to the CLUES Planning, ADB and the World Bank have been promoting the value of community participation in WSS projects in developing countries, either in the form of what they define as *Community-based development* (CBD) or *Community-driven development* (CDD) approaches. The CDD approach intends to empower communities to take responsibility for their own development, harnessing their inherent potential and social capital, and essentially improving livelihoods. CDD projects encourage higher levels of participation and allow communities to take control over their own resources and decisions (Hill 2009). This approach can be distinguished from CBD and other *"more general"* participatory approaches where *"less control over decisions and resources are given but are nevertheless participatory"* (Hill 2009). CDD is also deemed to be an effective approach to poverty alleviation.

In the context of Nepal, ADB is currently involved with the DWSS and MPPW in national sector development, supporting the implementation of a *Community-based Water Supply and Sanitation Project* (CBWSSP). This project started in 2003 and is now operating in more than twenty districts (GoN 2011a). At the same time, ADB is supporting the DUDBC with the *Secondary Towns Integrated Urban Environmental Improvement Project* (Nycander *et al* 2011). The intention of these two projects is to improve services in small towns and urban communities, such as improving WSS facilities to underserved populations (Chow & Pradhan 2010).

The objective is also to assist the DWSS to carry out further reforms, while strengthening the capacity of communities to plan, implement, manage, operate and maintain their own improved WSS facilities (ibid).

The World Bank–funded *Rural Water Supply and Sanitation Project* (RWSSP) provides a prime example for CDD project planning within the WSS sector. The objective of the RWSSP was to assist the Government of Nepal to implement a strategy, which promotes *"decentralisation and involvement of both beneficiaries and the private sector for the effective provision of rural WSS"* (Hill 2009, 61). Due to its success, the World Bank has extended its funding of the initial project and continues to support the further implementation of additional projects. Although this model is focussed on rural areas and is therefore not directly applicable to the urban focus of this study, its fundamental extraction of the CDD principles provides the template for which the aforementioned ADB-CBWSSP was replicated (ibid).

1 An Assessment of Current Practices in Nepal

In recent decades, the concepts of sustainable sanitation have been adopted and implemented in various forms in Nepal, albeit still on a relatively small scale. DEWATS were introduced towards the end of the 1990s, in the form of constructed wetlands with sedimentation tanks or anaerobic baffle reactors (ENPHO 2010b). Interest in DEWATS and technologies has increased since then, with more than 13 DEWATS constructed across the country and a handful currently under construction (WaterAid Nepal 2008b). Similarly, urine-diverting Ecological Sanitation toilets were introduced around 2002 with more than 1000 such toilets constructed across the country (ENPHO 2010b). Other technologies include the production of biogas from household organic waste, with more than 200,000 such units constructed since the 1950s (ibid). There is significant potential for scaling-up the application of these alternative technologies, as existing examples are generally well accepted with high levels of user-satisfaction.

In order to move forward with the promotion and further application of urban environmental sanitation practices in Nepal, it is important to evaluate and compare existing models and their respective technological and management attributes; particularly in terms of planning, funding, implementation and O&M. The following three case studies have been selected for a comparative assessment (See Figure 13): (1) Sunga, Madhyapur Thimi Municipality; (2) Srikhandapur, Dhulikhel Municipality; and (3) Nala, Peri-Urban Community.

Figure 13: Satellite Photo of Kathmandu Valley showing the case study locations of Sunga, Srikhandapur and Nala (adapted from Google Maps 2012)

These examples were selected according to the following characteristics:

- Their urban or peri-urban nature
- Consisting of between 200-400 households, which is considered to be a manageable scale for sustainable DEWATS (Interview with Mrs. Luna Kansakar 05.11.12)
- Representing various alternatives for decentralised wastewater management at the community scale.
- To follow the progression of DEWATS in Nepal, and show the various stages between initial implementation, and on-going operation and maintenance (they were constructed in 2006, 2008 and 2012 respectively, and will be presented chronologically).

1.1 Sunga

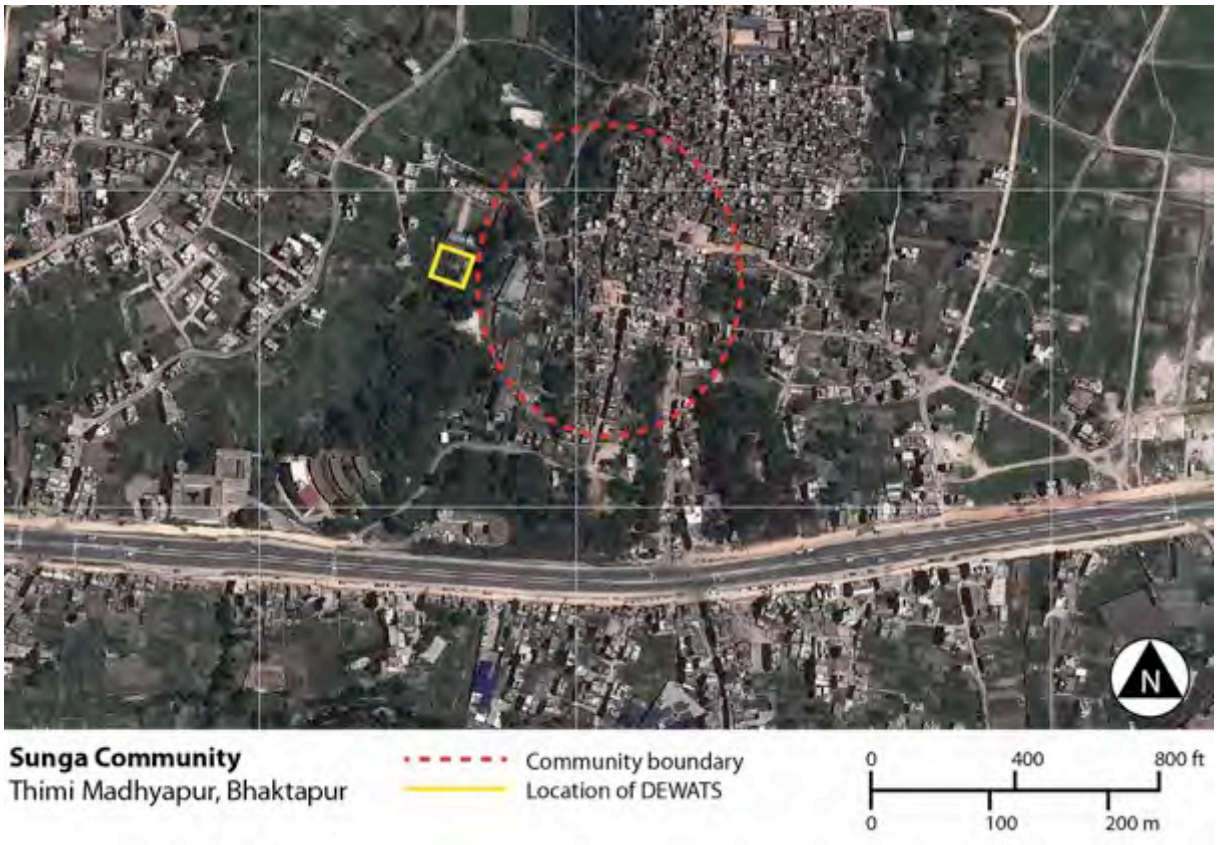


Figure 14: Satellite Photo of Thimi Madhyapur showing Sunga Community (adapted from Google Maps 2012a)

1.1.1 Background and Rationale for DEWATS

The community of Sunga represents a low-income and socially marginalised urban cluster within the Madhyapur Thimi Municipality of Bhaktapur District, approximately 10 kilometres from Kathmandu (See Figure 14). Between 2005 and 2006, the community-based wastewater treatment project was implemented; the first of its kind in Nepal (WaterAid Nepal 2008b). This DEWATS was designed to treat the sewage of 200 households, which was previously discharged directly into the neighbouring Siddhikali River (ENPHO 2010a). At the same time, this project intended to set a precedent for larger-scale wastewater treatment systems in other areas of Nepal (WaterAid Nepal 2008b): *"to demonstrate appropriate technology for decentralised wastewater management at the community level"* (UN-HABITAT undated).

1.1.2 Planning and Implementation

The Sunga sanitation improvement project was conceived through requests from local community members and the Madhyapur Thimi Municipality. Interestingly, the project was first attempted in the neighbouring community of Siddhikali, where a large sewage outlet was turning a natural stream and surrounding environment into wasteland (WaterAid Nepal 2008b). However, after more than 1.5 years of community involvement and efforts to promote the merits of a WWTP, UN-HABITAT was unsuccessful in convincing the local people (Interview with Mr. Rajendra Shrestha 27.11.12). Community objections were centred around suspicion of the new and foreign technology, as well as concerns about treatment efficiency and foul odours. As a result, the project was cancelled.

The municipality were therefore delighted when the residents of Sunga invited construction of the WWTP to proceed in their neighbourhood instead (WaterAid Nepal 2008b). With strong local support, UN-HABITAT worked with the local community, forming the *Sunga Wastewater Treatment Plant Management Committee* and discussing the various treatment options available to them (Interview with Mr. Rajendra Shrestha 27.11.12). During the pre-construction community planning consultation sessions, the number of attendees increased from 70, to 95, to 125 at each consecutive meeting (Interview with Mr. Krishna Lal 27.11.12). This localised approach was in accordance with other national urban development projects, such as the *Urban Environment Improvement Project* being implemented through the ADB (ibid).

1.1.3 Construction Costs

The total construction cost of the Sunga WWTP amounted to NPR. 2.2 million was co-financed by ADB, UN-HABITAT and WaterAid Nepal as a demonstration project for Community-based Wastewater treatment (UN-HABITAT 2008b). Design of the WWTP was performed by the local NGO – ENPHO, and the later addition of the Biogas unit was implemented through *Biogas Support Programme Nepal* (BSP).

1.1.4 Technical Components

The technical solution chosen by UN-HABITAT, with support of the Sunga community, was a wastewater treatment facility in the form of a constructed wetland. This DEWATS was designed specifically for the site provided by the municipality – public land on steep terrain, which had previously been used as a waste dumping site (WaterAid Nepal 2008b). The technical components include the following (UN-HABITAT 2008c):

- **Preliminary treatment:** 1 course bar screen & grit chamber
- **Primary treatment:** 1 settler + ABR, 1 biogas digester (currently not in operation)
- **Secondary treatment:** 2 parallel horizontal flow constructed wetlands (RBTS), 2 parallel vertical flow constructed wetlands (RBTS)
- **Sludge treatment:** 1 planted gravel sludge drying bed (SDB)

Figure 15: Photos of the constructed wetlands at Sunga DEWATS, with project engineer Rajendra Shrestha and on-site caretaker (Bright-Davies 27.11.12)

The various waste streams can be visualised through the following diagram:

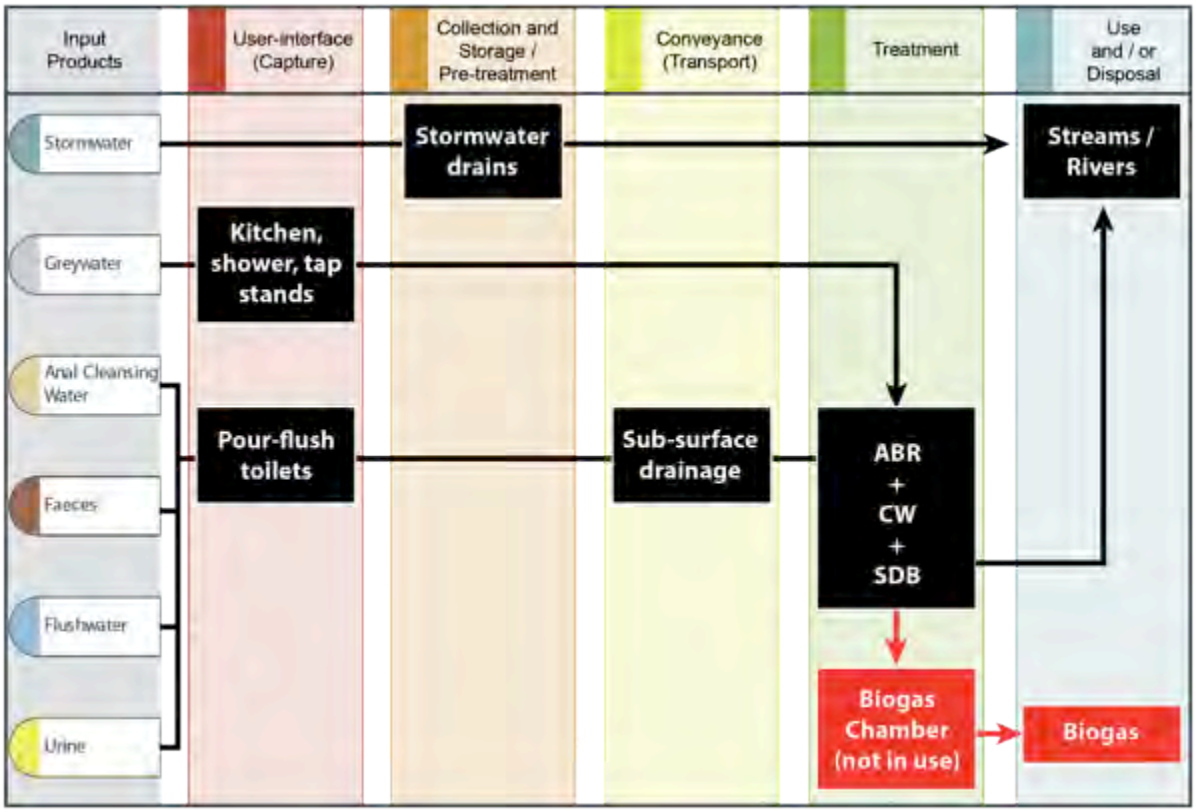


Figure 16: Sanitation Chain in Sunga (Own design, adapted from Tilley *et al* 2008, 14)

1.1.5 Operation and Maintenance

Operation and maintenance of the Sunga DEWATS is undertaken by a full-time, on-site caretaker, who is paid by the Madhyapur Thimi Municipality (Interview with Mr. Rajendra Shrestha 27.11.12). This caretaker received a one-day training session from UN-HABITAT in post-construction maintenance, and is capable of managing basic O&M activities on a daily basis. These activities include clearing blockages on the bar screen, cleaning the gravel beds, de-sludging the ABR, harvesting the plants and generally ensuring that the whole system is functioning properly (ibid). The Municipality manages larger maintenance and repair work, such as damage caused by heavy rainfall or landslides.

Two years into operation of the DEWATS, the annual O&M costs were reported to be NPR. 20,000 (UN-HABITAT 2008c). However, according to the project engineer Mr. Rajendra Shrestha,

current O&M costs are estimated to be between NPR. 36,000 – 50,000 annually (Interview 27.11.12). The Madhyapur Thimi Municipality has been solely responsible for funding during the last six years of operation O&M. The Municipality presently provides the NPR. 36,000 salary for the caretaker and up to NPR. 14,000 is allocated from the annual budget for major maintenance and repair work, when required.

1.1.6 Performance, Observations and Findings

After more than six years of operation, the Sunga DEWATS is still performing its original purpose of treating municipal wastewater, although it currently serves only 82 of the 200 households for which it was designed (ENPHO 2010a).

Initially, there were technical issues such as clogging, which caused the reed bed to entirely dry up. These reed beds have since been rehabilitated, but still require on-going attention (Interview with Mr. Sarbagya Shrestha 09.11.12). Regular monitoring has shown positive results for overall performance and plant removal, however the treated water does not meet national discharge standards in terms of biochemical oxygen demand (BOD) and chemical oxygen demand (COD) (ENPHO 2010a). This means that treated wastewater cannot safely be re-used for irrigation at this stage, and is instead discharged into the nearby river.

After completing construction of the WWTP, a Biogas unit was incorporated into the DEWATS configuration with the intention to provide biogas to the neighbouring school (Interview with Mr. Rajendra Shrestha 27.11.12). However, the integration of the biogas digester was unsuccessful, and due to a large crack at the bottom of the biogas chamber, the system stopped producing gas after 3-4 months of operation (ibid). Repair costs are deemed too high to justify, so the biogas chamber remains inoperative (ibid).

Positive outcomes / benefits:

According to the Sunga community, the main benefits experienced since the construction of the DEWATS are as follows (Interview with Mr. Krishna Lal 27.11.12):

+ 100% toilet coverage - construction of toilets for households that were previously defecating outdoors
+ Reduced risk of destruction caused by landslides, as the construction of the DEWATS now stabilises the previously steep and precarious site
+ Cleaner and more hygienic physical environment, without odours, raw sewage or solid waste dumping in public spaces

Negative outcomes / challenges:

An observation of this project reveals some uncertainty regarding the financial sustainability of on-going O&M. As the municipality has financed the majority of O&M since 2006, it appears that community 'ownership' of the system is almost non-existent. Despite claims from implementing agency, UN-HABITAT, that *"Sunga, needs no extra funding or external energy – it is self-sustaining"* (Interview with Mr. Rajendra Shrestha 05.10.12), in actual fact the Municipality has voiced reluctance to continue financing future O&M costs, due to increasing budget constraints and the need for maintenance work that exceeds the 14,000 allowance (Interview with Mr. Krishna Lal 27.11.12).

1.2 Srikhandapur

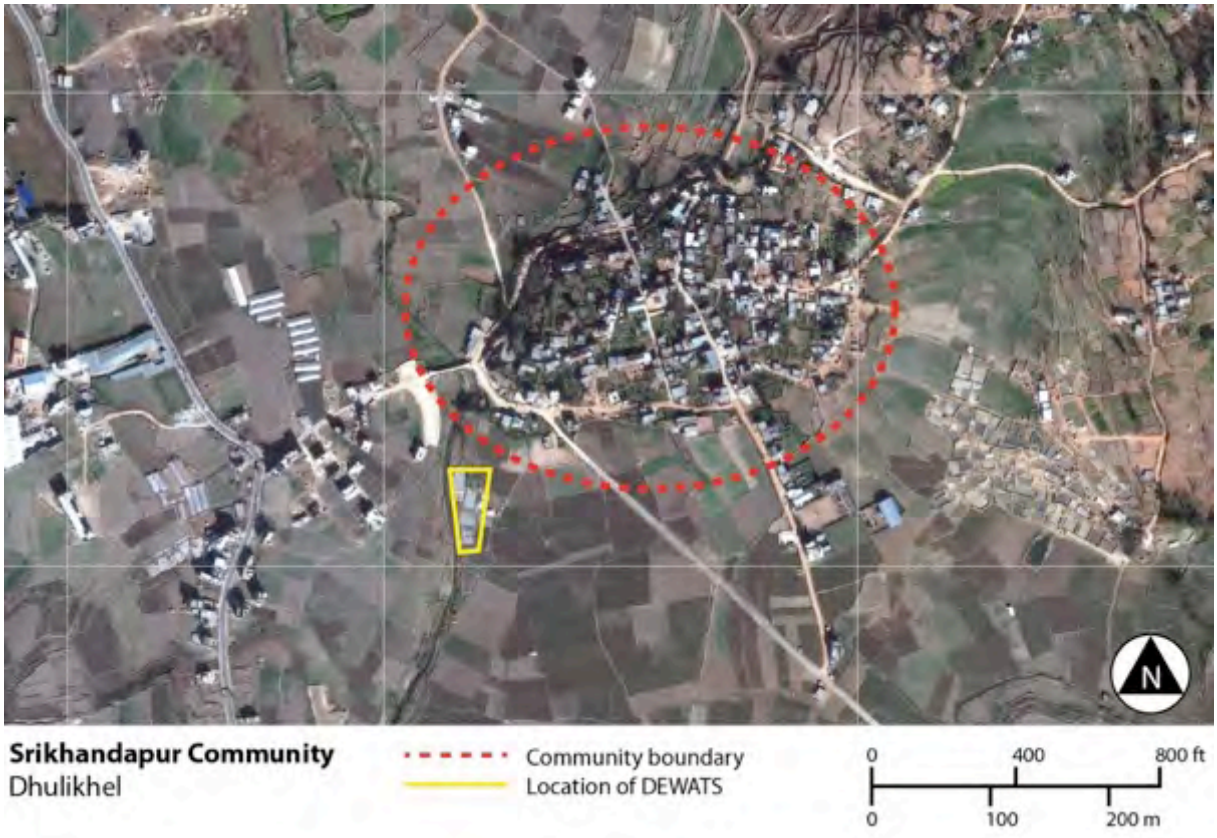


Figure 17: Satellite Photo of Dhulikhel showing Srikhandapur Community (adapted from Google Maps 2012b)

1.2.1 Background and Rationale for DEWATS

After the construction and initial success of Sunga DEWATS, this model was replicated in the peri-urban settlement of Srikhandapur (Interview with Mr. Sarbagya Shrestha 09.11.12), which is located 32 kilometres from Kathmandu within Dhulikhel Municipality (See Figure 17). The community-based wastewater treatment plant was constructed in 2008 and designed to serve approximately 200 households (ENPHO 2010c). Similarly to Sunga, the purpose of the Srikhandapur project was to improve the condition of urban environmental sanitation by treating the wastewater, which was previously being discharged into the nearby river (ibid). In addition to wastewater treatment, this system includes the production of biogas, for use by local residents as an alternative energy source for cooking. The intention of combining these

technologies was to demonstrate the economic feasibility of biogas to finance on-going O&M of the DEWATS.

1.2.2 Planning and Implementation

The Srikhandapur DEWATS was implemented through UN-HABITAT in cooperation with Dhulikhel Municipality. Technical support and design of the constructed wetlands was performed by ENPHO, and Biogas components designed by BSP Nepal (ENPHO 2010c). During the planning and implementation phase, the community-based organisation was formed – *Srikhandapur Sewage Treatment Users Committee* – in coordination with UN-HABITAT and the Municipality (Interview with Mr. Purna Bar Karmacharya 03.10.12). Apart from the formation of a Users' Committee, it appears that community involvement in the planning and decision-making process was minimal.

1.2.3 Construction Costs

The initial construction cost of NPR. 7.4 million was co-financed by UN-HABITAT, Dhulikhel Municipality and the Srikhandapur community as a demonstration project for Community-based Wastewater treatment and Biogas (ENPHO 2010c). UN-HABITAT paid the majority of the construction costs, NPR. 5.4 million, the Municipality provided NPR. 1.7 million and the community contributed the remaining NPR. 300,000 (Interview with Mr. Purna Bar Karmacharya 03.10.12).

The site was donated by the Municipality and construction work performed by the local community, in order to keep costs to a minimum.

1.2.4 Technical Components

The technical components of the Srikhandapur DEWATS include (ENPHO 2010c):

- **Preliminary treatment:** 1 course bar screen & grit chamber
- **Primary treatment:** 2 parallel biogas chambers
- **Secondary treatment:** 6 horizontal flow constructed wetlands (RBTS) +
- **Sludge treatment:** 1 horizontal planted SDB


Figure 18: Photos of the constructed wetlands and biogas chambers at Srikhandapur, with on-site caretaker (Bright-Davies 03.10.12)

The various waste streams and associated outputs can be understood as follows (See Figure 19):

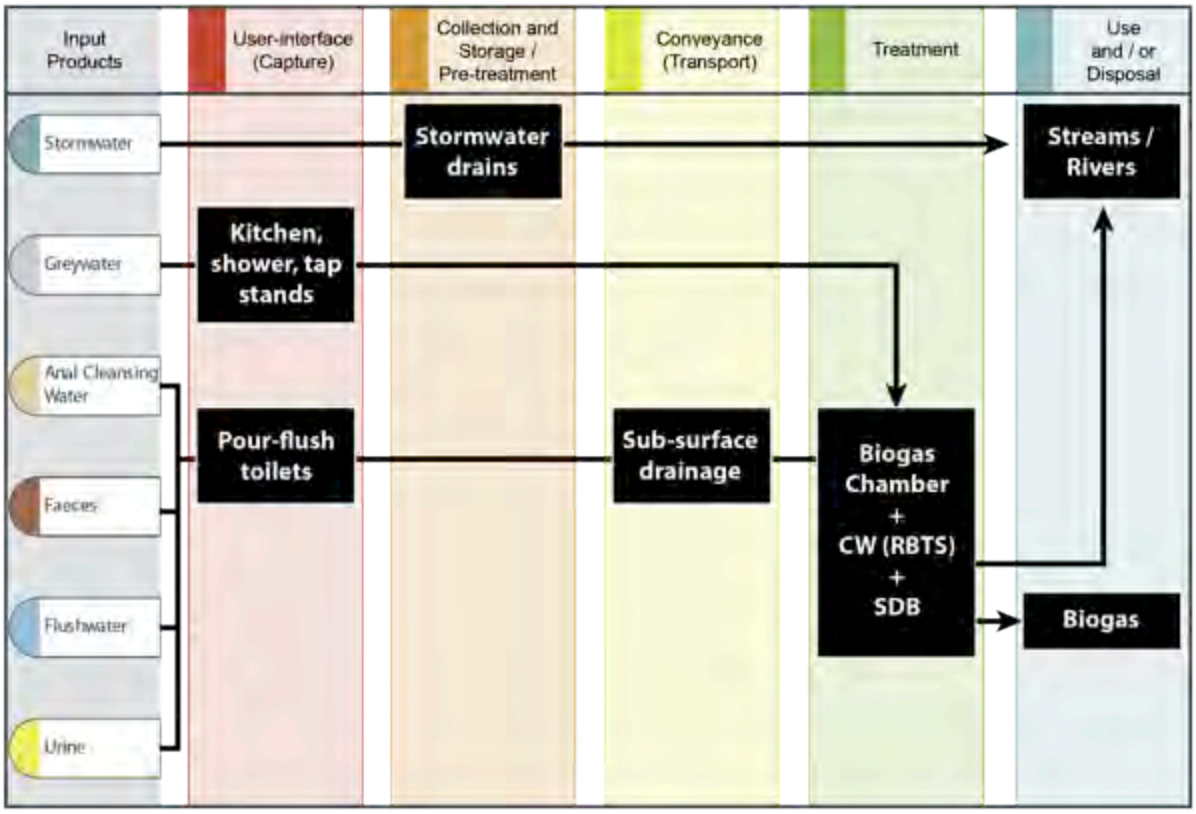


Figure 19: Sanitation Chain in Srikhandapur (Own design, adapted from Tilley *et al* 2008, 14)

1.2.5 Operation and Maintenance

The WWTP is managed by the User's Committee, who employ one caretaker on a part-time salary (ENPHO 2010c). O&M responsibilities include opening and closing the biogas valve twice daily (5:30am and 8:30am), clearing blockages from the inlet pit to the wetlands, cleaning the filter screen, grit-chamber and digester chamber, as well as seasonal harvesting of the wetland plants (Interview with Mr. Purna Bar Karmacharya 03.10.12).

Srikhandapur employs a user-pay mechanism, which is intended to help finance O&M. Biogas users are required to pay NPR. 500 per month, and households connected to the WWTP are

required to pay NPR. 200 per year (Interview with Mr. Purna Bar Karmacharya 03.10.12). According to household interviews, this price of NPR. 500 is affordable.

1.2.6 Performance, Observations and Findings

In terms of performance, the Srikhandapur DEWATS is sufficiently treating wastewater to an appropriate level for discharge into the nearby river. However, similar to Sunga, the monitoring results from 2006-2010 reveal that the BOD and COD levels do not meet with Nepal discharge standards. Therefore, there is no re-use of treated wastewater in irrigation or agriculture at this stage (ENPHO 2010c).

Positive outcomes / benefits:

Benefits associated to the implementation of the DEWATS include (Interview with Mrs. Shrestha, 03.10.12; Interview with Mr. Bhuvan, 03.10.12):

+ Economic benefits: Re-use of waste products, in the form of biogas, which is a cost-effective alternative to LPG. Previously, the local school required two cylinders of LPG gas per month for their needs (NPR. 1,500 x 2 = NPR. 3,000 per month). Now they receive sufficient biogas and pay only NPR. 500 per month as per the user service-fee. This results in a monthly saving of NPR. 2,500. Households previously required one LPG cylinder every two months (NPR. 1,500 / 2 = NPR. 750 per month). The connection to biogas results in a saving of NPR. 250 per month;
+ Environmental improvements: Wastewater is sufficiently treated before being discharged into the river, compared to open sewage and foul odours which were present before the DEWATS installation;
+ No need to de-sludge septic tanks;
+ Raised awareness levels at the local school surrounding environmental sanitation: Children in classes 9 and 10 are taught about solid waste management and drainage management, and taken on educational visits to the DEWATS.

Negative outcomes / challenges:

This project is experiencing a variety of current and foreseeable challenges, in terms of funding, O&M and sustainability of the DEWATS.

Firstly, the system was designed for 200 households with the community expecting to receive one cylinder of biogas per household, per day (Interview with Mr. Purna Bar Karmacharya 03.10.12). However, at the time of visiting, the number of households connected to the wastewater-treatment plant (WWTP) was just 125, due to the number of residents who had since re-located to Kathmandu. From the resulting households connected to the WWTP, only five households were receiving biogas from the system. This leads to difficulties with O&M, as the system is running at only 60% capacity – 125 households connected to the WWTP still require a caretaker to maintain the system, however the quantity of biogas produced is significantly reduced, along with the associated revenue. Perhaps as additional households are connected to the system in future years, this problem can be resolved as the quantity of sludge, and consequent biogas generation is increased. The addition of other waste sources, such as organic solid waste or livestock faeces, is also a possibility for this system to increase biogas output.

Table 2: User service-fee calculations for Srikhandapur DETWATS + BIOGAS (Own design, based on data from interview with Mr. Purna Bar Karmacharya 03.10.12)

	Number of users	Service fee /month (NPR.)	Service fee / year (NPR.)	Annual Total (NPR.)
WWTP	125	-	200	25,000
Biogas	5	500		30,000
				55,000

Theoretically, even with just 125 households connected, this should be sufficient to finance the caretaker's salary for O&M. The calculations above (Table 2) show that user service-fees should amount to NPR. 55,000 per year, which is approximately the same as the annual expenditure for Sunga DEWATS. It should also be sufficient to cover a caretaker's annual salary of NPR. 36,000.

However, the lack of a user service-fee collection system or enforcement has resulted in a community reluctance to pay, leading to inadequate funding for the O&M of the DEWATS. Particular difficulties arise during the rainy season, when the influx of water dilutes the system and reduces the quantity of biogas produced. During these months, some of the biogas users refuse to pay the monthly service-fee when they do not receive sufficient biogas.

An observation of the Srikhandapur DEWATS reveals potential obstacles regarding the long-term future of the on-site caretaker, who expressed significant dissatisfaction with the current employment arrangements. According to the committee president, this caretaker is only required to work whenever there is work that needs to be done; approximately once per week (Interview with Mr. Purna Bar Karmacharya 03.10.12). However, according to the caretaker himself, the tasks are much more time-consuming, and he works 6-8 hours per day (Interview with Mr. Baburam Shrestha 03.10.12). He claims that frequent blockages occur in the settling chambers, especially during the rainy season, and he is required to physically climb into the drains and clean sewerage blockages without any form of safety equipment. As a result, he suffers from on-going health implications, with the cost of associated medication exceeding his monthly salary of NPR. 1,500 (ibid). This amount is only half of the NPR. 3,000 the caretaker was initially promised when he took the position. The users committee continuously tell him that this amount will increase, but as of yet he has received no further payment. For this reason, he has voiced intentions to resign.

Challenges such as user-reluctance to pay can be attributed to the limited community participation in the planning and implementation stages and a general lack of awareness surrounding the importance of O&M. Community interviews revealed that involvement in the planning and decision-making process was minimal, as was technical support from the implementing agencies. One respondent claimed that this was the first time that anyone had come to consult her about the WWTP project, as no one had previously asked her about user needs or preferences (Interview with Mrs. Punya Devi Shrestha 03.10.12). The on-site caretaker

also reported that he had received no formal O&M training from UN-HABITAT or ENPHO, apart from basic cleaning instructions (Interview with Mr. Baburam Shrestha 03.10.12).

This example reveals the necessity for community mobilisation, involvement, awareness building and on-going monitoring and evaluation (M&E) in achieving sustainability of the DEWATS.

1.3 Nala

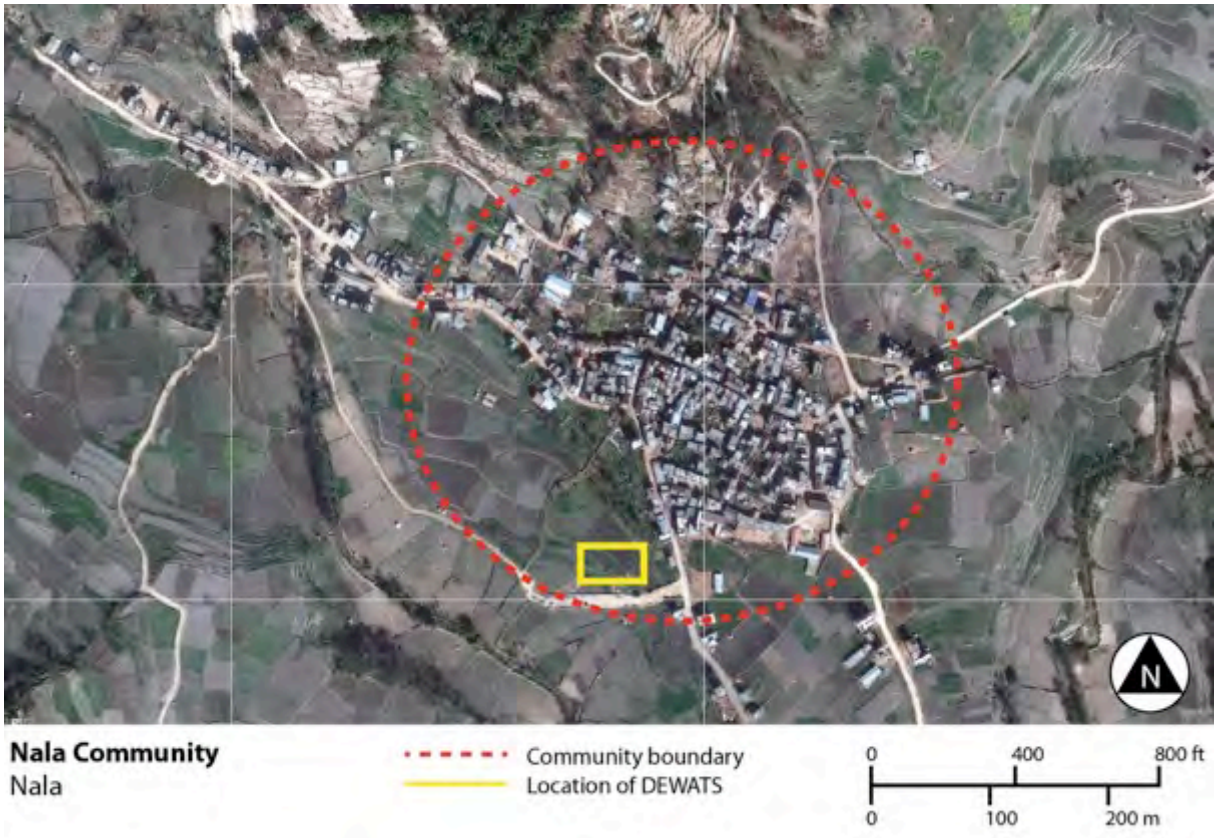


Figure 20: Satellite Photo of Nala (adapted from Google Maps 2012c)

1.3.1 Background and Rationale for DEWATS

Nala Bajar is a peri-urban settlement located in the Kavre District approximately 30 kilometres from Kathmandu (See Figure 20). The Nala DEWATS, designed to serve 294 households, has been operational since December 2012 and therefore presents the most recent example of community-led sanitation improvement in Nepal. This project was selected as a case study, as it addresses the problems experienced in the previous DEWATS examples of Sunga and Srikhandapur, and adopts alternative solutions accordingly.

Nala is one of the initial locations where the innovative CLUES planning process has been field-tested, with the intention to "*validate the planning approach, identify challenges and improve the*

process" (von Münch *et al,* comp. 2012). Nala also provides a precedent for simplified sewers, and is the first of its kind to connect an entire urban settlement in Nepal (Sherpa & Lüthi 2012).

Previously, sanitary conditions in Nala were very poor: 20% of households had no toilets, open defecation was prevalent and unmanaged wastewater was posing health threats including commonly occurring waterborne diseases (Lüthi 2012). There was also a strong demand from the community to improve sanitation conditions (Sherpa 2012). In this case, the ultimate goal of a sanitation intervention was to effectively treat wastewater while allowing an ecological solution for sludge re-use (Interview with Mr. Mingma Sherpa 18.09.12).

1.3.2 Planning and Implementation

The 12-month planning phase from March 2009 followed the 7-steps outlined by the CLUES guidelines (See Table 1) and can be summarised as follows (Lüthi 2012; Sherpa *et al* 2012; Sherpa 2012):

CLUES *'Step 1: Process ignition and demand creation'* was combined with *'Step 2: Launching of the planning process,'* which involved a mass community gathering of residents and stakeholders. Attendees were briefed on the CLUES process and expected outcomes of the project, and the project boundaries were demarcated. During this step, the community unanimously elected a 13-member users' committee: *Nala Water Supply and Sanitation Committee*, who were to be responsible for community mobilisation at various stages throughout the planning process.

'Step 3: Detailed assessment of the current situation' included the initial baseline assessment, household mapping and surveys to identify existing sanitation conditions. Community meetings and focus group discussions at ward level were held to identify user-preferences.

The outcomes of these focus group discussions lead to *'Step 4: Prioritisation of the community problems and validation,'* where a participatory scoring method was employed to prioritise user preferences. This stage also involved a stakeholder analysis, to identify the level of interest, importance and influence of the various stakeholders on the planning process and outcomes.

For *'Step 5: Identification of service options,'* sanitation experts presented three feasible service combinations during a community workshop: a waterless system with UDDTs, a pour-flush system with Ventilated Improved Pits (VIP) and a simplified sewer with a blackwater treatment system. The Compendium of Sanitation Systems and Technologies (Tilley *et al* 2008) was the main source of reference during this stage.

Throughout the process, users were educated on the various sanitation systems available through visits to other DEWATS, sanitation bazaars and focused community meetings. The outcome of these interactions between users and experts resulted in user empowerment and enhanced awareness surrounding environmental sanitation. Users were therefore in a better position to make informed decisions regarding their own sanitation service options; at which stage, the community were invited to select their desired option.

'Step 6: Development of an action plan' was based on findings of the previous five-steps, and finalised after recommendations from and consultation with the collective community. At the end of this process, a plan was developed to address the different waste streams (See Figure 21), from source to treatment to re-use, and a solution was designed.

'Step 7: Implementation of the action plan:' Following the preparation of Step 6, the outcome of this process – in accordance with the available budget – was a concrete plan with defined actions and activities, such as the construction of individual household toilets, 3km of simplified sewerage network and a DEWATS.

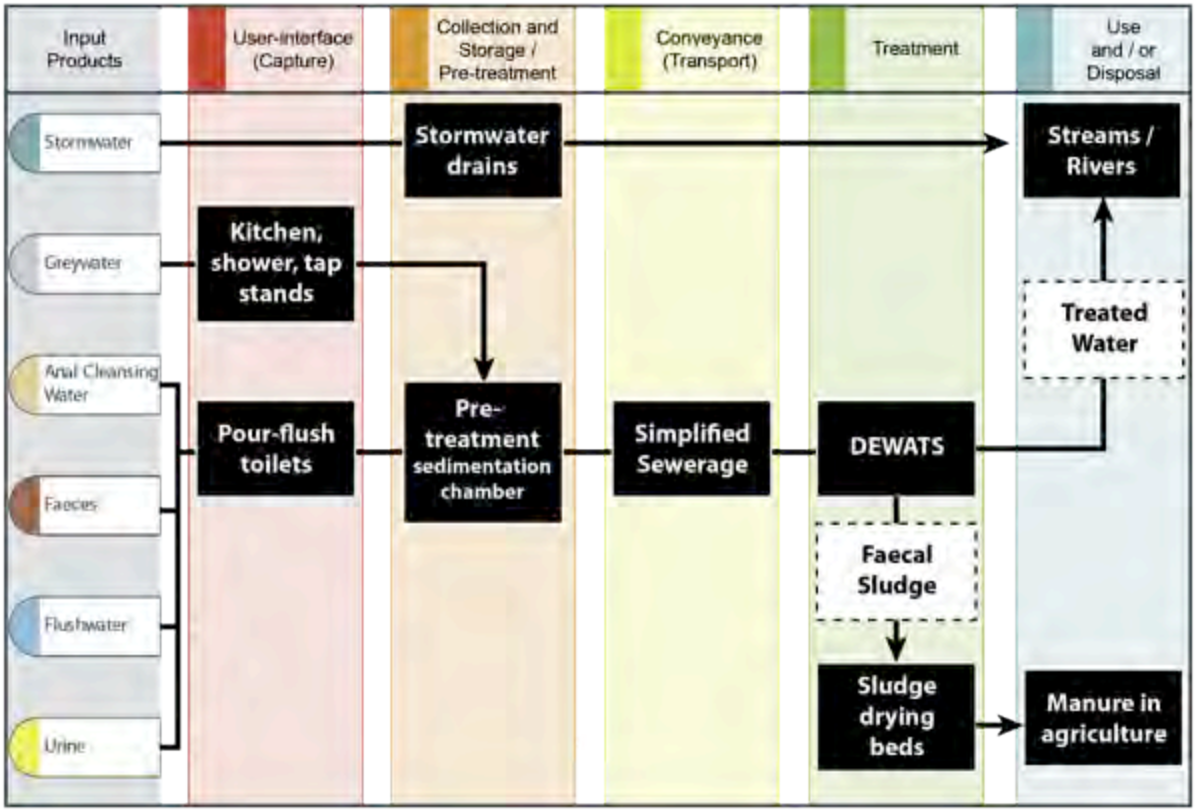


Figure 21: Sanitation Chain in Nala (Own design, adapted from CIUD 2010, 19 & Tilley *et al* 2008, 14)

1.3.3 Construction Costs

Due to the high level of community participation throughout the planning and construction process, implementation costs were kept to a minimum. Total expenditure for constructing the entire network of sewers and treatment system amounted to NPR. 12.6 million (approx. NPR. 5,500 per capita), including NPR. 1.2 million (NPR. 530 per capita) to cover costs of the planning process (Cost calculations from Mr. Mingma Sherpa 2012). From the total amount of NPR. 5,500 per capita, NPR. 3,500 was provided through external investment from EAWAG-SANDEC, UN-HABITAT and WaterAid Nepal (ibid). The remaining funds of NPR. 2,000 per person where collected from the community and local government VDC (ibid). This equates to more than 37% user contribution to the overall capital expenditure. Partial financial support was also provided by the Nala VDC for land acquisition of the DEWATS site (Sherpa 2012).

1.3.4 Technical Components

The Nala DEWATS consists of the following technical components (Lüthi 2012):

- **Preliminary treatment:** Screen/grit chamber
- **Primary treatment:** ABR
- **Secondary treatment:** CW (2 horizontal flow gravel-beds)
- **Sludge treatment:** Horizontal unplanted SDBs

Figure 22: Photos of the ABR and horizontal flow, gravel-bed filter in Nala (Bright-Davies 17.10.12)

During the implementation stages, the technical configuration in Nala was originally intended to include a biogas unit. However, due to the poor performance of Biogas integrated WWTPs in other areas in Nepal, this option was consequently discarded.

1.3.5 Operation and Maintenance

The sanitation intervention in Nala is trialling a unique O&M strategy, which is considered to be a fundamental element of the overall sustainability of the DEWATS system. This arose from the participatory planning process and a thoroughly considered financing scheme.

During the planning process, potential O&M problems were identified by experts and discussed with the community, such as bed clogging or frequency of sludge removal. Acknowledgement of these issues during the planning process, and not after construction, provided an opportunity for planners and implementers to customise the solutions where necessary and ensure community preparedness.

An integral part of the O&M plan for Nala is the associated financing mechanism and revolving fund scheme. The former is addressed through the incorporation of a monthly O&M service fee of NPR. 250 per household (Lüthi 2012). The existence of this service fee also needs to be considered as an essential element for achieving sustainability of the DEWATS, especially with community-based approaches. From the outset, the necessity of an O&M service fee was emphasised, and agreed on by the implementers as well as the community (Sherpa 2012). It is believed that the presence of a user service fee also increases the sense of user responsibility (ibid). User willingness to contribute to the establishment of the new system, as well as recurring annual O&M costs, can be attributed to their active involvement and engagement in the project from the outset. If users understand the system and are aware of the various ways in which they can personally contribute to its smooth running, then intrinsic sustainability is enhanced.

Nala's revolving fund scheme is a pool of money that is raised amongst the community for the purpose of financing implementation, as well as O&M, of the DEWATS. Funds are 'revolving' in the sense that resources circulate between the fund and the users, representing a tripartite agreement between the *Nala Water Supply and Sanitation Users Committee*, a local Cooperative and the implementing NGO (Lüthi *et al* 2011a; Lüthi & Sherpa 2012). As a part of this scheme, households can register for small loans at a nominal interest rate of 6% per annum – compared to the average lending rate of 14-16% – and flexible pay-back periods (Interview with Mr. Mingma Sherpa, 18.09.2012). The establishment of this micro-financing scheme intends to minimise the overall financial burden on households, while providing a reserve fund to ensure the on-going financing of O&M.

1.3.6 Performance, Observations and Findings

At the time of writing, the DEWATS in Nala had been in operation for only one month. Therefore, assessing the performance of the system and user satisfaction was not possible. It is, however, possible to assess the level of community support for the project by the number of applications received for household connection. The system designed for 294 households had already received 81 applications for connection, two months before the system became operational, with the remaining households expected to take out loans and connect within the following months (Sherpa & Lüthi 2012). Financial assistance is provided through the specifically designed revolving fund scheme and low interest rates (6% per annum), combined with community incentive schemes such as discounts for early connection (ibid).

Positive outcomes / benefits:

Previous studies have identified the following positive and negative effects of the project, as well as associated costs and benefits (Sherpa & Lüthi 2012):

+ Improved living environment for inhabitants of the project area
+ Increased community awareness of environmental sanitation
+ Sanitation facilities constructed for poor and marginalised residents
+ Increased access to sanitation facilities resulting in an 'open defecation free' community
+ Improved personal and environmental hygiene behaviour
+ Safe collection and disposal of household wastewater
+ Reduced health risks and financial burden of regular pit emptying
+ Revolving fund, micro-financing scheme established to help finance construction of sanitation facilities

In addition to achieving lower infrastructure construction costs, the CLUES approach adopted in Nala demonstrates the financial and social benefits of community involvement in terms of sustaining O&M and strengthening social capital. At the same time, the emphasis is on adopting natural treatment systems, unobtrusive conveyance methods and the possibility for waste reuse in accordance with the principles of environmental sustainability.

In terms of monetary benefits, households can expect to spend approximately NPR. 260 per month (NPR. 3120 annually) on O&M service fees (Lüthi 2012). Compared to NPR. 525 per year previously spent on de-sludging of pits, this is a significant increase. However, these financial impacts are offset by intangible social benefits such as:

> *"increased self-esteem and dignity after having a toilet at home, increased safety [and] security for women and children as they [no longer] need to travel far away from home to relieve themselves, residents have increased health benefits due to safe excreta disposal [and] treatment practices."*
>
> (Sherpa & Lüthi 2012, 4)

This monthly fee of NPR. 260 per household is still considered to be *"affordable and realistic"* (Lüthi 2012, 160).

Negative outcomes / challenges:

- Annual cash fund required as household contribution for system installation
- (However, the revolving fund scheme intends to minimise this financial burden. Poor households are eligible for loans at a comparatively low interest rate of 6% per annum)
- At this stage, only blackwater management has been addressed, with other waste streams such as stormwater, greywater and solid waste management to be addressed at later stages.

1.4 Comparative Analysis and Overviews from Case Studies

This chapter presents a comparative analysis of the three-abovementioned case studies, in order to assess the planning and implementation processes, technical aspects and long-term management strategies. The main characteristics are summarised in the matrix below (See Table 3) followed by an in-depth comparative analysis. The analysis will be complemented by a summary of general overviews, including the opportunities and challenges associated with implementation in other parts of Nepal and scaling-up.

Table 3: Case Study Comparative Matrix (Own design)

		SUNGA	SRIKHANDAPUR	NALA
PLANNING & IMPLEMENTATION	**Type of Project**	*Demonstration Project for Community-based Wastewater treatment*	*Demonstration Project for Community-based Wastewater treatment + Biogas*	*Pilot Project for Community-led Urban Environmental Sanitation (CLUES)*
	Planning / Implementation period	2005-2006 (ENPHO 2010a)	2008 (ENPHO 2010c)	2009-2012
	Planning / Implementation Costs (NPR.)	Total = 2.1 million (ENPHO 2010a)	Total = 7.4 million (Interview with Mr. Purna Bar Karmacharya 03.10.12)	Total = 12.6 million (US$145,771) - 1.2 million for planning (US$13,500) - 11.4 million for implementation (US$132,271) (Sherpa 2012)

	Costs per Household	NPR. 10,500 (x 200 HH)	NPR. 37,000 (x 200 HH)	NPR. 43,000 (x 294 HH) - NPR. 4,000 for planning (US$46) - NPR. 39,000 for implementation (US$450)
	Funding Agencies	ADB, UN-HABITAT, WaterAid Nepal (ENPHO 2010a)	UN-HABITAT, Dhulikhel Municipality, Srikhandapur Community (ENPHO 2010c)	UN-HABITAT, EAWAG-SANDEC, WaterAid Nepal, Nala Community, Nala VDC (Sherpa *et al* 2012)
	Community Contribution	Land donated by Municipality	Land donated by Municipality	Partial financial support provided by Nala VDC for land acquisition Community contributed 33% of planning and implementation costs (Lüthi 2012)
	Supporting Organisation	ENPHO (ENPHO 2010a)	ENPHO, BSP Nepal (ENPHO 2010c)	CIUD – NGO (Sherpa & Lüthi 2012)
TECHNICAL ASPECTS	**Designed for # of users:**	200 HH (ENPHO 2010a)	200 HH (ENPHO 2010c)	294 HH (EAWAG 2012)
	Current # of users:	82 HH (ENPHO 2010a)	125 HH (ENPHO 2010c)	*81 HH had applied for connection prior to operation, with all 294 expected to join incrementally (Bishwanath Shrestha, 2012)

	DEWATS Technical Components	1 bar screen & grit chamber 1 settler & ABR 2 parallel horizontal flow CW-RBTS 2 parallel vertical flow CW-RBTS 1 sludge drying bed 1 biogas digester* (ENPHO 2010a) * Currently not in operation	1 course bar screen & grit chamber, 2 parallel biogas chambers 6 horizontal flow CW-RBTS 1 sludge drying bed (ENPHO 2010c)	1 screen / grit chamber 2 ABR 2 horizontal flow CW gravel beds (Communication with Mr. Christoph Lüthi, 28.12.12)
	Surface area for DEWATS	1240m2 (ENPHO 2010a)	1240m2 (ENPHO 2010c)	350m2 (Communication with Mr. Christoph Lüthi, 04.03.13)
LONG-TERM MANAGEMENT	**O&M Management Agency**	Sunga Wastewater Treatment Plant Management Committee (ENPHO 2010a)	Srikhandapur Sewage Treatment User Committee (ENPHO 2010c)	Nala Water Supply and Sanitation Users' Committee (Sherpa & Lüthi 2012)
	O&M Costs (NPR.)	50,000/year* (36,000 for caretaker's salary + max 14,000 annual allowance for maintenance) (Interview with Mr. Rajendra Shrestha 27.11.2012) *This amount is currently not sufficient to cover all associated costs	55,000/year (36,000 for caretaker's salary + additional 19,000 for maintenance*) (Interview with Mr. Purna Bar Karmacharya 03.10.12) * The caretaker is not receiving this amount	1.2 million/year* (US$3 / NPR. 265 per household/month) (Lüthi 2012) * This figure is only estimation at this stage, as exact costs depend on the number of households connected.
	O&M Financing	Municipality (Interview with Mr. Rajendra Shrestha 27.11.12)	User service fees*: Biogas users (5 HH) contribute NPR. 500/month = 25,000/year Users connected to sewage system pay 200/year = 30,000/year (Interview with Mr. Purna Bar Karmacharya 03.10.12) * Payment of service fees is not enforced	O&M costs shared by households using the sewer-based system (Sherpa *et al* 2012)

1.4.1 Planning Process and Implementation (incl. Costs)

Sunga, Srikhandapur and Nala are all considered to be examples of community-based sanitation, however the planning and implementation processes employed in the first two differ considerably from the latter. In the first two projects (Sunga and Srikhandapur), implementation was top-down with limited participatory planning. Although communities in both locations were initially receptive to a sanitation intervention – with high attendance levels at community meetings in Sunga, and financial contributions from the Srikhandapur community towards construction – their actual input into the decision-making processes, general awareness surrounding sanitation options and retrospective sense of ownership of the system appears to be minimal. This could be the reason for the subsequent difficulties with long-term maintenance, described in the following chapter.

While the communities were evidently present throughout the planning and implementation processes, their participation appears to have been more tokenistic; allowing them to *"hear"* and *"be heard"* through informing and consultation, but denying them any assurance that their views would be observed (Arnstein 1969).

Both models were piloted through UN-HABITAT as demonstration projects for community-based wastewater treatment, and as such they achieved their intention of up-scaling a relatively new technology and concept of decentralisation to the community scale. While both UN-HABITAT pilots associate the term 'community-based' sanitation with the notion of decentralising wastewater management, the role of community in achieving optimal sanitation solutions and ensuring long-term management appears to have been overlooked.

Nala, on the other hand, addresses the shortfalls of the previous examples and presents a significant deviation from top-down planning. In this case, community-scale decentralised wastewater management is achieved by placing the community themselves at the centre of the planning and implementation process, hence the term 'community-led' planning. This is a more inclusive form of citizen participation, where the community hold equal weight within the partnership and can negotiate as well as engage in decisions that directly affect them (Arnstein 1969).

The emphasis of the CLUES planning approach to:

> *"integrate people's voices and choices from the very beginning was a key factor for increased stakeholder participation and ownership of the project."*
>
> (Sherpa et al 2012, 129)

Inclusive and sustained participation, combined with an increased sense of ownership and responsibility, are considered fundamental elements for ensuring sustainability of community-led projects. The three case studies highlight the difference between 'community-based' sanitation, as seen in Sunga and Srikhandapur, and 'community-led' sanitation tested in Nala.

A comparison of the total expenditure for planning and implementation reveals significant variation between NPR. 2.1 million (Sunga), NPR. 7.4 million (Srikhandapur) and NPR. 12.6 million (Nala). While positive inflation between the respective dates of construction (2006, 2008 and 2012) must be taken into account, this is only one small factor of the cost disparity. As both WWTPs in Sunga and Srikhandapur were designed to serve the same number of households (200), the main reason for higher costs in Srikhandapur was the inclusion of biogas within the service option. The extra capital was provided by external donors with the intention that biogas would help finance community management and O&M, although the biogas production and sale could never pay back initial construction costs (Interview with Mr. Bhushan Tuladhar 18.09.12). In this sense, such a system would be unaffordable for communities without some form of external assistance.

In Nala, higher implantation costs are due to a number of reasons. Firstly, the system is designed for 294 households, requiring almost 50% more capacity than the previous two examples designed for 200 households. However, due to economies of scale this is not the main cause for greater expenditure, and in fact the per capita expenditure in Nala was just NPR. 5,590 (Cost calculations from Mr. Mingma Sherpa 2012). Approximately 10% of the total expenditure went on the 12-month planning process, which included thorough community mobilisation efforts.

While such a planning process might seem extraneous, the long-term financial, environmental and social benefits are expected to outweigh – and therefore validate – the initial time and

monitory investment. The lack of such an intensive participation process in the other two communities resulted in lower initial implementation costs, but higher O&M costs, as well as subsequent difficulties with long-term financing.

These planning processes in Nala also lead to a considerably high community contribution - 33% towards overall planning and implementation costs (Lüthi 2012). Although the total expenditure in Nala was greater than in Sunga or Srikhandapur, due to the high engagement and contribution from the community, per capita costs are considered to be remarkably low for a sanitation intervention of this kind. NPR. 5,590 per capita equates to less than half of the cost estimations cited in sector literature for similar sanitation systems (GIZ cited in Lüthi 2012).

1.4.2 Long-term Management / Operation & Maintenance

In terms of functional longevity of DEWATS and sustained O&M, the case studies have shown that through the implementation phases, the attitude towards DEWATS needs to be addressed as a 'low maintenance' solution, as opposed to a 'no maintenance' solution. The inherent merits of DEWATS lie within its low maintenance requirements, but even low-maintenance systems require mechanisms for financial stability to ensure long-term management, operation and maintenance.

It has been observed in many cases of DEWATS in Nepal, that this is often not addressed until the system is constructed, if at all. In these scenarios, users are unaware of importance of O&M and therefore reluctant to pay for such service. Even in cases where the community was actively engaged in improving their environmental sanitation conditions, problems always arise after the handover process, when external support and financing stops (Interview with Mr. Sarbagya Shrestha 09.11.12).

Where the problems of poor environmental sanitation are very severe and unavoidable, residents are initially very motivated to find solutions and even express willingness to pay. However, once the problem is solved through some form of sanitation intervention and is no longer an immediate, visible inconvenience, there is a reluctance to pay for its on-going service.

This is a recurring scenario with community-scale DEWATS in Nepal (Interview with Mrs. Luna Kansakar 05.11.12).

Developing a participatory O&M plan – such as the example of Nala – can be the first step for combatting O&M challenges like those in Sunga and Srikhandapur. The strategy helps users visualise the whole sanitation system, identify immediate problems and find appropriate solutions at the local level. Heightened awareness of improved environmental sanitation and its importance means the users' willingness to pay is increased. Particularly in emerging towns and urban areas, where people are both able and willing to pay for such a service and for the long-term sustenance of the system, the inclusion of a user service fee is a must (Sherpa 2012).

In Sunga, the municipality are now considering incorporating a user-fee system, to help finance technical issues and O&M requirements (Interview with Mr. Sarbagya Shrestha 09.11.12). However, because there were no initial community mobilisation and awareness programmes, and the community was always under the impression that someone else would be responsible for financing O&M, objection to user-fees is expected (Interview with Mr. Krishna Lal 27.11.12). This situation reinforces the value of community involvement from the outset in increasing awareness and acceptance surrounding the payment of user service-fees.

1.4.3 Institutional Capacity & Stakeholder engagement

User committees were established in all three locations to assist within the implementation phases, while taking on the management responsibilities after operation. In the case of Sunga, however, the original *Wastewater Treatment Plant Management Committee* formed in 2005 has since dissolved, as the Madhyapur Thimi Municipality took over the majority of responsibility for the WWTP. However if the existence of the DEWATS is to be sustained, the previous president of this user committee has expressed the urgent need to raise awareness amongst the users, re-form the committee and introduce a user-pay system (Interview with Mr. Krishna Lal 27.11.12).

In Srikhandapur, while the *Sewage Treatment User Committee* is still active and the President is a proud spokesperson for promotion of the WWTP within the community, institutional capacity is

somewhat limited. Due to a lack of support from the Dhulikhel Municipality, the users' committee has limited authority to enforce pre-established regulations, such as regular payment of user service fees. As a result there are insufficient funds for the O&M of the system, and the future of the on-site caretaker is uncertain (Interview with Mr. Baburam Shrestha 03.10.12). Nala intends to address problems such as these before they arise, through the establishment of the *Nala Water Supply and Sanitation Users Committee*. This committee is a legal entity registered with the local authorities and has taken full ownership of the project. Thus, it is responsible for ensuring long-term O&M upon operation of the sanitation system.

The outcomes from the approach adopted in Nala are expected to highlight the importance of developing institutional capacity and stakeholder engagement in ensuring O&M sustainability. A strengthened sense of responsibility and sense of ownership can contribute to long-term management, which can achieved through stakeholder participation in the process from initial inception right through to construction, and beyond:

> *"The participatory mode of project delivery and the early inclusion of operational aspects make Nala an inspirational case for the entire country."*
>
> *(Sherpa & Lüthi 2012, 9)*

For post-construction sustainability of DEWATS, the concept of 'co-management' needs to be addressed as part of the development of institutional capacity, and not just 'community management' as there will always be limits to community expertise and awareness, even in situations where social cohesion is strong and awareness surrounding WASH is high. Co-management implies a cooperative partnership between the community and local municipality or private sector. This kind of community-responsibility is absent in the on-going operation of Sunga, while municipal involvement is absent in the case of Srikhandapur.

Nala has addressed this issue by empowering the community, not only through the establishment of a Users Committee, but by strengthening the community's financial capacities with a community-managed revolving funds scheme and local monitoring body: CIUD (Interview with Mr. Mingma Sherpa 18.09.12). All stakeholders are expected to benefit from the

arrangement, attributing to a solid partnership, and contributing to sustainable O&M of the DEWATS.

1.4.4 Technical Aspects

The sanitation systems demonstrated in Sunga, Srikhandapur and Nala do not differ considerably in terms of their technical configuration. All three have adopted DEWATS which employ anaerobic processes for primary treatment and constructed wetlands in the form of gravel beds of RBTS for secondary treatment.

The consistent selection of these technical components makes sense within the context of Nepal, for the following reasons:

- Low-tech solutions = low-maintenance
- Low capital investment required for installation
- Minimal on-going costs after initial installation
- Reliable option for localized treatment of domestic wastewater

The main technical variation is the biogas component found in Sunga and Srikhandapur DEWATS, although only the latter example is currently functional, and with questionable success. Biogas is a welcome alternative to conventional gas in a world of increasing gas prices and scarcity. However, as an addition to WWTPs it is still in the early stages of development in Nepal, and as yet, no pilot projects have yielded results convincing enough to warrant large scale adoption of this technological option. In Nala, biogas was originally included as part of the sanitation system proposal but later abandoned due to the poor performance of other biogas integrated WWTPs in Nepal.

Despite the technical and management difficulties seen in Sunga and Srikhandapur, the technology of integrating DEWATS with biogas is still believed to have significant potential within the Nepalese urban context (Interview with Mr. Bhushan Tuladhar 18.09.12). Previous failures should not cause the future of DEWATS combined with biogas to be overlooked, especially as biogas has already achieved laudable success in Nepal, with more than 250,000 plants installed across the country since 1992 (SNV 2012). Although the majority of these biogas

reactors are in rural areas, the associated benefits are also considered appropriate for adoption in urban areas. With improved technological developments, the hope is that biogas from WWTPs can return sufficient revenue to the user committee for O&M financing. This is a major attraction associated with DEWATS, as treated wastewater alone has no tangible or fiscal benefits (Interview with Mr. Prajwal Shrestha 26.09.12).

Biogas is believed to be more technically and financially feasible, when combined with organic solid waste (DISWATS). (Interview with Mr. Bhushan Tuladhar 18.09.12). Solid waste management and wastewater treatment are some of the most pressing issues in urban areas. For these reasons, UN-HABITAT are currently investigating the feasibility of DISWATS application in Nepal (ibid).

Through further research and the refining of technologies, the challenges of urban wastewater treatment and solid waste management can be combined to produce beneficial outputs, and could prove to be an effective solution for Nepalese municipalities. DISWATS could then help with the quest to achieve 'Zero Waste' towns and cities, which the *Municipal Association of Nepal* (MuAN) is currently trying to promote across the country.

1.4.5 Replicability and Scaling-up – Opportunities and Challenges

Based on the success of the CLUES project in Nala, agencies like WaterAid Nepal are attempting to promote this approach in other emerging towns (Interview with Mr. Sarbagya Shrestha 09.11.12). There is also an on-going partnership between EAWAG and ADB's *Small Towns Water Supply and Sanitation Programme,* which could see further piloting of the CLUES planning approach in upcoming years (Sherpa & Lüthi 2012).

It is also worth noting that the *Compendium for Sanitation Systems* developed by EAWAG-SANDEC (Tilley *et al* 2008) was recently translated into Nepali in 2012 and launched by UN-Habitat and the DWSS in October 2012. This resource manual is the first of its kind in Nepal, and will provide the environmental sanitation sector with an invaluable set of tools for further implementation of systems such as DEWATS.

Despite the potential of DEWATS as an appropriate and promising technological sanitation solution for Nepal – environmentally, socially, and economically – there are still challenges for promoting the widespread adoption of DEWATS.

Since Sunga introduced the first community-based WWTP in Nepal, DEWATS have been demonstrated in a handful of different locations. However, these pilot projects have not yet been adopted on a larger scale due to the lack of perspective beyond conventional systems and a general tendency towards centralised systems (Interview with Mr. Prajwal Shrestha 26.09.12). This opinion was reiterated by the director of ADB's *Small Town Water Supply Project* in the DWSS, Ramdeep Sah:

> *"One of the biggest obstacles thus far to replicating DEWATS may be lack of vision… Nevertheless, the goal is neither wholly centralised nor decentralised wastewater treatment… We have to go the middle route…"* with a combination of centralised treatment in the country's most densely populated areas and DEWATS for the emerging towns, peri-urban areas, communities, institutions and private companies.
>
> (IRIN 2012, para 24, 26 & 27).

DEWATS, therefore, cannot be considered one-off, isolated solutions, but as elements to be implemented within a greater, citywide sanitation plan. In order for the on-going O&M costs to be affordable and sustainable, the number of DEWATS operating within close proximity need to be increased. In such cases, it would then be possible for one full-time caretaker to manage four to five DEWATS, which would significantly reduce the O&M costs (Interview with Mr. Rajendra Shrestha 27.11.12). An additional challenge for the promotion of DEWATS is the common belief that sewerage networks are considered an indicator of development. People generally associate 'development' with visible infrastructure projects (i.e. road construction), not the invisible and non-invasive systems mentioned above.

The decentralised concepts of wastewater treatment (and solid waste management) are also difficult to implement and upscale, because of the tendency to remember and focus on past failures. It is therefore important to keep refining the technical solutions of DEWATS while simultaneously promoting the associated social and financial benefits to communities and local authorities.

In terms of planning policies, standards and regulations, the up scaling of DEWATS could benefit greatly from mainstreaming into institutional policies as well as city-level regulatory frameworks. Currently, the main challenge is a lack of policies legitimising DEWATS as a valid sanitation option. Another fundamental hindrance is on-going government instability and relatively fast turnover of top-level ministers. This means that despite promotion and awareness programmes, policy makers who might be convinced of the benefits of DEWATS are no longer in a position of power within just a number of months, and the process of conviction must start over from scratch (Interview with Mr. Nawal Kishor Mishra 08.10.12).

The limited economic capacity of communities in Nepal means capital investment is challenging in urban areas. Land in dense urban areas is a valuable commodity, difficult and costly to obtain, and municipalities or users are required to donate it, along with skilled manpower for construction. Depending on the size of the project, sludge will continue to be a regular problem. Therefore, the management of sludge must be incorporated into the initial technical solution and O&M plan.

However, despite the moderate capital investment and recurrent service fees associated with DEWATS, the case of Nala has shown that even low-income communities are capable – and willing – to contribute financially towards sanitation improvement, once the benefits are effectively portrayed from the outset.

Summary of Outcomes

Ensuring the sustainability of community-scale DEWATS depends on:

- The inclusion of an O&M management plan within the action plan
- Inclusion of a user service-fee as an integral part of the implementation plan
- Raised community awareness – users must realise their responsibility in making the whole system work
- Minimising potential malfunction through technological development – e.g. Biogas has potential, but only where technical efficacy can be guaranteed
- Governance at household level
- Users must understand and acknowledge the connection between paying a tariff and receiving civil services

2 Environmental Sanitation for Tansen

2.1 Introduction to Tansen

The emerging city of Tansen will provide a grounded project site for this thesis, due to the current challenge faced by the municipality in providing its steadily increasing urban population with adequate sanitation, sewerage and wastewater treatment. Tansen is also one of the six Nepali towns participating in the current GIZ supported *Sub-national Governance Programme* (SUNAG), which receives funding through the World Bank supported *Urban Governance and Development Programme* (UGDP) *Emerging Towns Project* (ETP). Technical advice and implementation of priority projects within each of these six municipalities is facilitated through the *Municipal Support Team* (MST) on behalf of *GFA Consulting Group*. Both abovementioned programs are working towards the principles of good urban governance, such as capacity development at the local level to achieve improved and socially inclusive urban infrastructure and services (Jachnow 2012). Priority projects in Tansen include the *Sewerage and Drainage Improvement Project*, which is why this municipality was selected for further research.

Tansen is located in the remote hillside location of Nepal's Western district, along the main highway between Butwal and Pokhara (See Figure 23). This historic, hillside trade centre is also the administrative centre of Palpa District and considered an important town within the western region of the country. Recognized as a municipal town in 1961, Tansen is one of the oldest municipalities in Nepal.

Tansen originally developed as a trading centre for those living in its hinterland. However, in the last fifty years, economic growth in Tansen has slumped as market activity has relocated to the nearby settlement of Butwal, which is advantageously positioned between the North-South and East-West highways (GHK *et al* 2011).

Figure 23: Map of Nepal showing the location of Tansen Municipality in Palpa District (Own design, adapted from GoN & UNDP undated; GoN & UNDP 1993)

Since the end of the civil war, Tansen has experienced an increase in population growth. The current population is estimated to be between 30,000-35,000 inhabitants – compared to 20,400 in 2001 – and is growing rapidly at the rate of 5.02% per year (GHK et al 2011; Portnov et al 2007). Due to the increasing population combined with changing lifestyles, the municipality is struggling to keep Tansen sufficiently managed and clean. Tansen also experiences a variety of infrastructure constraints and urban service deficiencies that consequently impede urban and economic development.

2.1.1 The State of Sanitation in Tansen

The sanitation situation in Tansen is in urgent need of attention, particularly in terms of sewerage, drainage and wastewater treatment. Although Tansen has a relatively high level of

toilet coverage – 88% of households have individual toilets (GHK *et al* 2011) – sewage from these facilities combined with household greywater and stormwater is currently discharged into three different gorges without any form of treatment. This leads to the contamination of natural waterways and environmental degradation, threatens public health and intensifies the spread of water-borne diseases. The combination of these health and environmental impacts ultimately impairs Tansen's economic growth and development prospects.

In response to this unsatisfactory situation, the Tansen Municipality plans to build conventional open sewers (over 5 kilometres long, 1 meter wide and 1.25 meters high) in a place with natural streams. The prospect of this invasive, concrete infrastructure is neither environmentally justifiable nor economically justifiable, and more cost-effective, environmentally sustainable alternatives need to be investigated.

2.1.2 CLUES Project Site in Tansen: Bhusal Danda Community

The community of Bhusal Danda, located in Ward 10 (See Figure 24), has been selected for assessing the feasibility of CLUES planning approach and the potential improvement of environmental sanitation in Tansen.

The application of the CLUES approach in this project site incorporates Steps 1 – 5, with the main steps summarised within the following Table 4 (below). The outcomes of this process intend to form the baseline assessment, identify user preferences and priorities, and propose potential service options while concurrently empowering the users and raising awareness surrounding environmental sanitation improvement in Bhusal Danda.

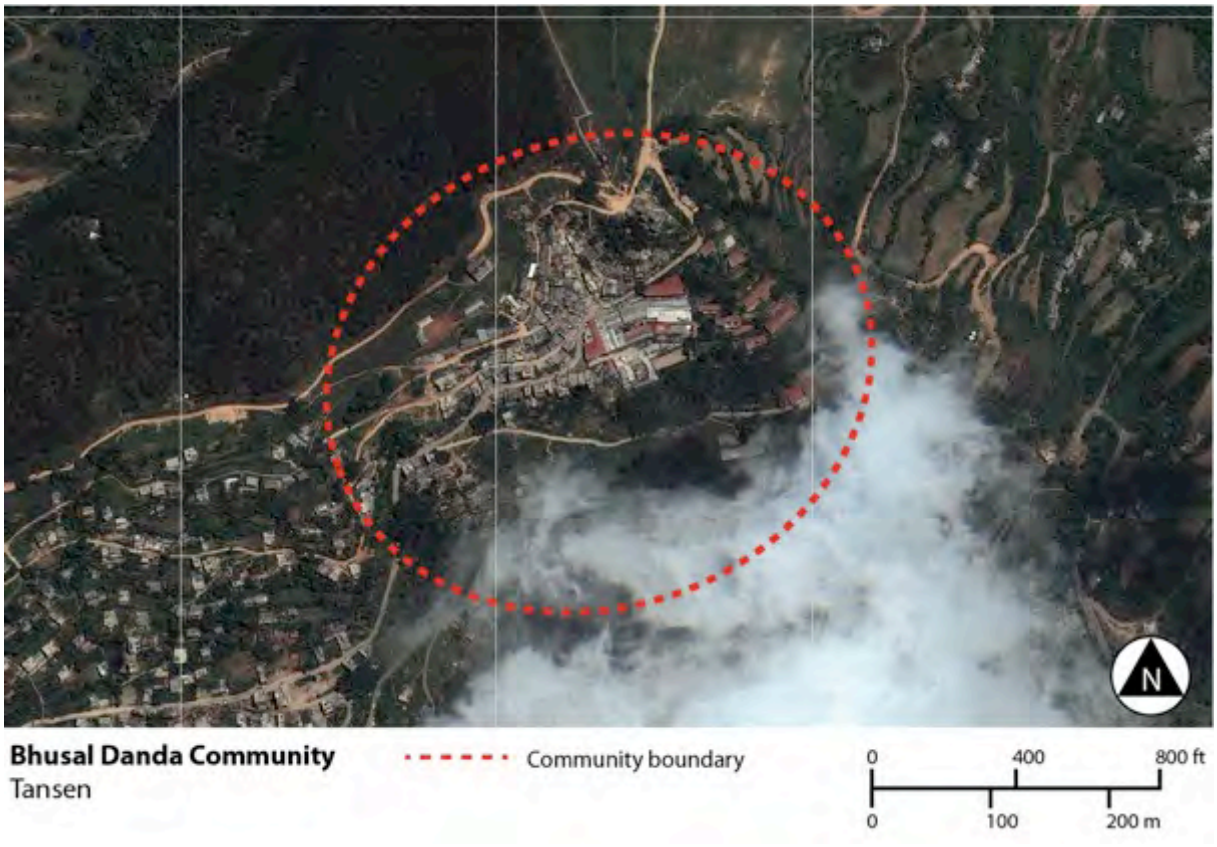
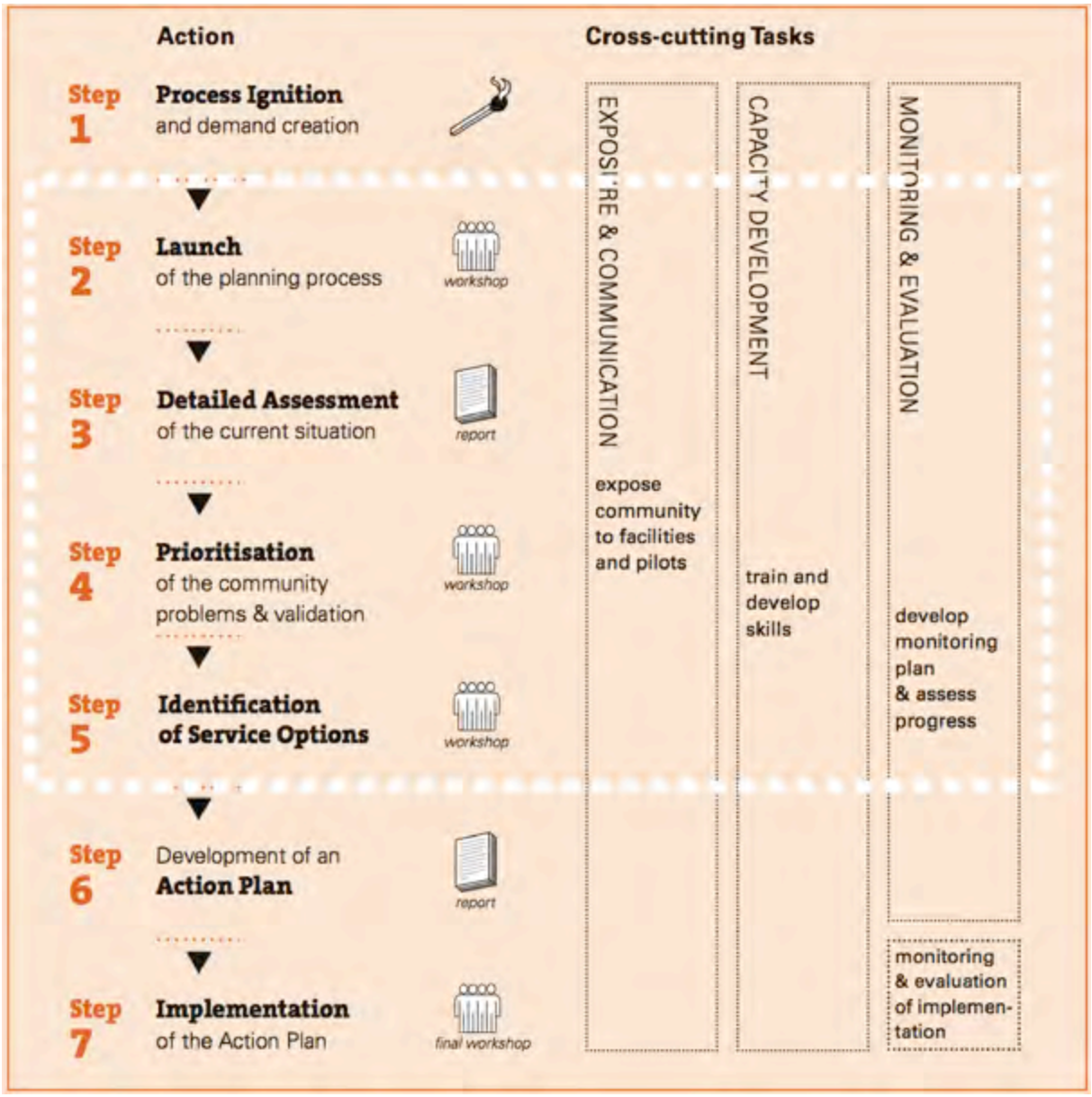


Figure 24: Satellite Photo of Tansen showing Bhusal Danda Community (adapted from Google Maps 2012d)

While the CLUES steps (Table 4, below) provide the backbone for this research process, each and all of the 7 steps were unable to be addressed to their full extent within the scope of this thesis. For example, Step 1 (Process Ignition and Demand Creation) was bypassed, as the existing levels of awareness surrounding WASH issues in Bhusal Danda were deemed sufficient enough to continue without in-depth community sensitisation efforts. However, exercises from Step 1, such as participatory community mapping and group discussion of key concerns, were incorporated into Step 4 (***Prioritisation of the Community Problems & Validation***; Page 102).

Step 2 (Launch of the Planning Process) was only partially adhered to, as the actual launching of such a process is expected to occur only after finalisation of primary research and the associated pre-feasibility study.

Table 4: Outlining the main CLUES planning steps undertaken in Bhusal Danda (adapted from Lüthi *et al* 2011a, back-cover)



Steps 6 & 7 (Development of an Action Plan & Implementation of the Action Plan) were also omitted, due to time limitations and the necessity for specialised expert input. However, section ***2.5.4 Planning and Implementation: What happens next?*** (Page 114) will attempt to provide some recommendations for how to proceed beyond Steps 1 – 5 covered in this chapter.

2.1.3 Justification of Site Selection

This community was identified after consultation with the Tansen Municipality, and coordinated site visits with municipal engineers to a number of potential project locations. The selection process was based on the following criteria:

- A community of between 200-400 households
- Strong demand for environmental sanitation improvement
- Cohesive community with willingness to tackle local problems
- Clearly defined boundary to project area or community

The Ward 10 community of Bhusal Danda satisfied all of the above requirements and was therefore deemed to be the most suitable location for a community-based sanitation intervention in Tansen. Initiating an approach such as CLUES, which is unfamiliar in Tansen, is anticipated to have higher chances of success in a location with the most favourable initial conditions. Such a case can potentially lead to a model that can be replicated in other communities throughout Tansen.

2.1.4 Socio-economic Profile

The total population of the Ward 10 is estimated at 1,525 and includes 311 households with an average household size of 4.9 people (GHK et al 2011). The majority of these households are clustered within close proximity of the United Missions to Nepal (UMN) Hospital, which is located less than one kilometre northeast from the main city centre. This hospital is one of the major healthcare establishments for deprived and poor people of the western part of Nepal. The community surrounding the UMN Hospital is known as Bhusal Danda and consists of approximately 200 households (Interview with Mr. Mukti Pd. Neupane 03.12.12). Major ethnic groups are Brahmin, Chhetri and Magar (GHK et al 2011).

The mean annual household income for Ward 10 is NPR. 28,534, which falls below the national average of NPR. 60,000 (recorded between 2005 – 2006; GHK et al 2011). Although the

residents of this ward are classified as low-income, over 20% of households are receiving remittances amounting to an average of NPR. 93,766 (ibid).

2.1.5 Geography, Topography and Climate

The geography and topography of Bhusal Danda is typical within the location of Tansen, which stretches across the steep southern crest of the Mahabharat Range or Lesser Himalaya, at an average altitude of 1300-1400 meters above sea level (Tuladhar & Vaidya 2004). The temperate/sub-tropical climate is also typical with temperatures rarely exceeding 35° in summer and 0° in winter (GHK et al 2011). The project area of Bhusal Danda is located on a steep, hilly site with an approximate area of 250m x 250m and gradient ranging between 1230 – 1320 meters above sea level (Genesis 2005).

2.1.6 Additional Background Information

During field research in Tansen, a previous proposal was discovered for a wastewater treatment plant in Ward 10. This project for the design and detail engineering for domestic wastewater collection, treatment and disposal was developed between 1999-2002, with support from the *Deutsche Entwicklungs Dienst* (DED) in collaboration with *Town Development Fund* (TDF), Tansen Municipality and ENPHO. However, for reasons unable to be obtained, this project never progressed beyond the initial Draft Engineering Design Report proposed by ENHPO. Recent internal reviews of the proposal by ENPHO reveal that the technological solutions outlined in this proposal are now considered out-dated and inappropriate, as DEWATS technologies have significantly improved within the past ten years (Interview with Mr. Prajwal Shrestha, 26.09.12). In addition, it appears the previous proposals made no attempt to incorporate community opinions or participation into the project. For these reasons, it was decided to continue with this particular site, despite the previous involvement and unrealised outcomes of a similar project.

2.2 Launch of the Planning Process (CLUES Step 2)

As mentioned in the introduction to CLUES planning in Bhusal Danda (Page 83), Step 2 was only addressed insofar as was necessary to commence with preliminary research and gain approval from the Tansen Municipality to approach and involve the community. This 'unofficial' launch was undertaken through an introductory presentation to district authorities at Tansen Municipality, where the immediate environmental sanitation problems were identified and the CLUES steps explained as an appropriate approach. The presentation was conducted in English with Nepali translations and PowerPoint projection (See Figure 25). Once initial concerns were clarified, the Municipality gave their approval for such a project to proceed, and support in selecting an appropriate project site to demonstrate the CLUES approach.

Figure 25: Powerpoint presentation to Tansen Municipality, on 02.12.12 (Own design)

The official launch of the planning process within the community would occur at a later stage, depending upon the outcomes of this dissertation and confirmed support from the relevant stakeholders.

2.3 Detailed Assessment of the Current Situation (CLUES Step 3)

This section presents a compilation of information surrounding the current physical and socio-economic environment of the Bhusal Danda project area. In addition to the baseline data – including water supply; household sanitation; neighbouring environment; and personal hygiene and awareness – the necessary elements of the enabling environment will be assessed, along with a refined stakeholder identification and analysis.

2.3.1 Physical and Socio-economic Environment

a) Water supply

Water supply in Tansen is scarce and service delivery is both intermittent and costly. The majority of the town's drinking water is drawn from two sources, namely *Bhulkhe Khola* and *Bajha Khola* (rivers), which are located over ten kilometres downhill. This water is pumped uphill and collected within the reservoir located at Srinagar, north of the main urban settlement. Additional water is transported from the same sources and delivered to individual residences using 4500L capacity tanker trucks.

Within the project area of Bhusal Danda, 42% of households have private connections to the water supply distribution network. The remaining 58% of households collect water from one of four public water stands (ENPHO 2001). From these four stands, two provide a continuous flow of water while the other two provide water only intermittently (ibid).

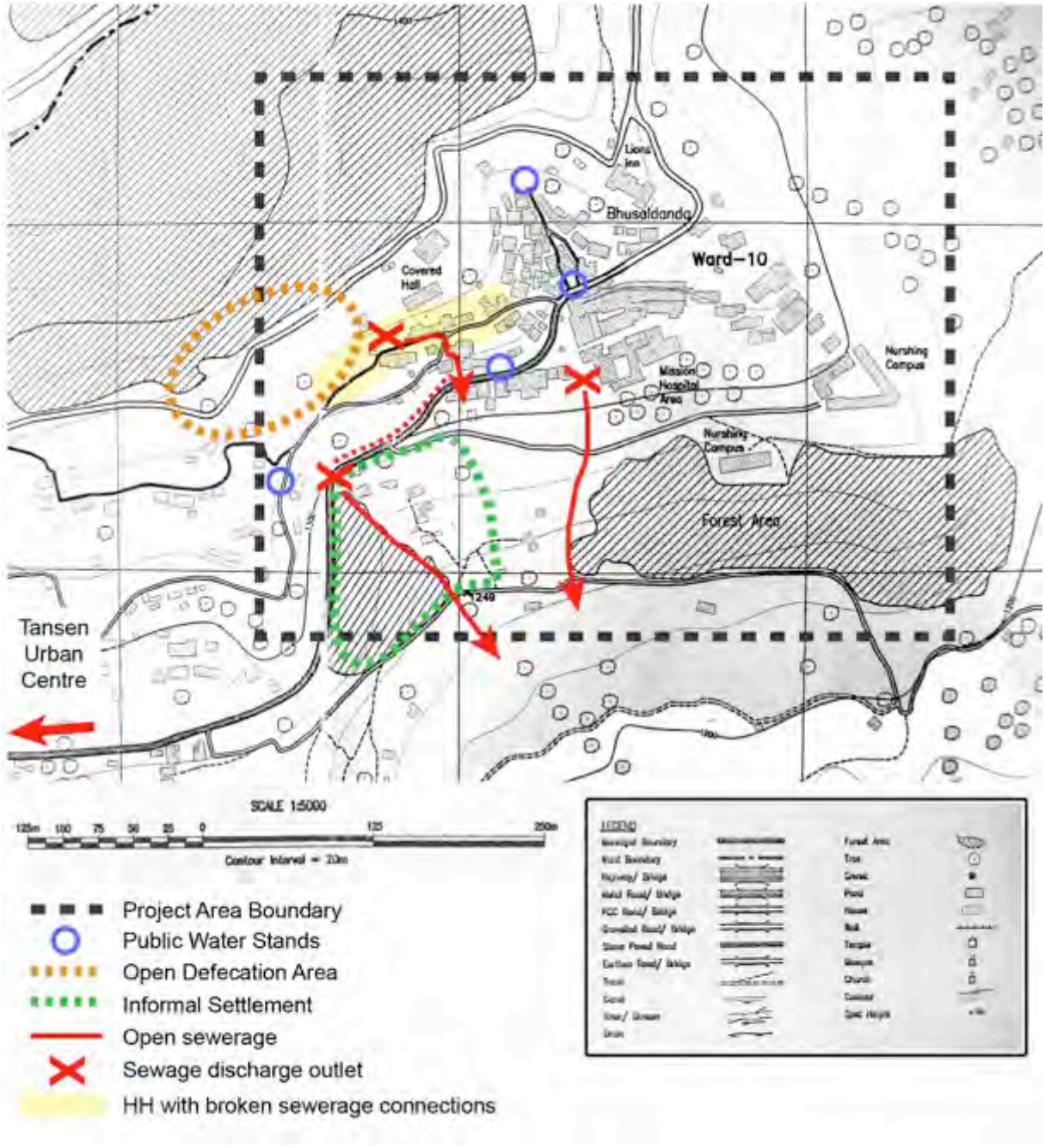


Figure 26: Tansen Base Map, showing Bhusal Danda (Bright-Davies, adapted from Genesis 2005)

b) Household Sanitation and Wastewater

Within the main cluster of Bhusal Danda around the UMN Hospital, approximately 75% of households located have access to a toilet, either shared or private (ENPHO 2001). The remaining 25% use the public toilets located at the entrance to the UMN Hospital, or simply

resort to open defecation in the surrounding forests. The majority of blackwater and greywater from these households connected to the underground sewerage drains is discharged into one of two natural streams running downhill from the UMN Hospital (See Figure 26). The remaining houses dispose of their greywater into open drains or directly onto the streets, constituting to an urban environmental hazard. Meanwhile, the majority of the hospital wastewater (40-50,000L per day) is managed on site, with septic tanks located beneath the buildings. Any overflow is directed to the same natural streams mentioned above (Interview with Mr. Bhuwaneshwar Devkota 04.12.12).

Both of these natural streams pass through a squatter settlement of approximately 30 households, located approximately 100 metres south of the UMN Hospital, below the main cluster of Bhusal Danda (See Figure 26). This squatter settlement is quite established, and almost all households have access to private toilet facilities. Some households have septic tanks, while houses situated near the aforementioned gully/stream dispose their wastewater directly into the stream or channel it into small kitchen gardens for irrigation purposes.

Bhusal Danda is no different from the rest of Tansen, in the sense that all wastewater is simply discharged into the natural water bodies without any form of treatment.

The environmental sanitation situation is particularly acute for 15-20 households on the upper, northeastern side of the settlement (See Figure 26). Although these households have private toilets connected to the main underground sewerage drains, a blockage somewhere in the system has caused wastewater to accumulate along the main thoroughfare. This unhygienic pool of stagnant wastewater gradually overflows and runs directly past the houses located downhill (See Figure 27). This blockage occurred over two years ago, and although the residents have paid NPR. 200 per household/per year for maintenance of the sewage system, the condition remains the same. As a result, these households cannot use the toilets located in their houses, instead using the public toilets at the UMN Hospital or resorting to open defecation.

Figure 27: A blocked sewerage drain causes wastewater to pool along the main thoroughfare and trickle downhill past the houses located below (Bright-Davies).

The following diagram (Figure 28) simplifies the current environmental sanitation situation in Bhusal Danda and the various waste streams:

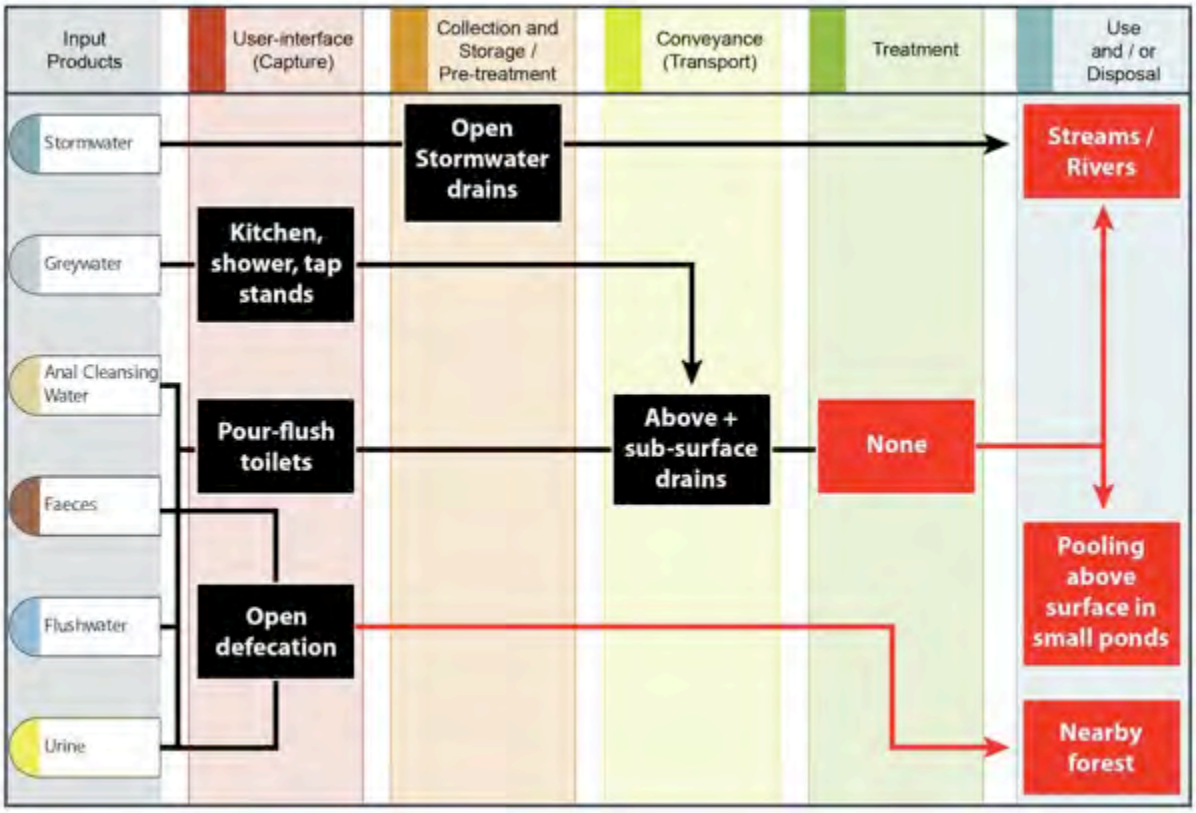


Figure 28: Sanitation Chain in Bhusal Danda (Own design, adapted from Tilley *et al* 2008, 14)

c) Neighbouring Environment: Solid Waste Management & Drainage

In terms of solid waste management, Bhusal Danda receives the Municipality's door-to-door household waste collection and daily street cleaning service (GHK *et at* 2011). A semi-aerobic landfill site was constructed in 2011 approximately 3 kilometres southeast of the city centre on the outskirts of town. This facility is not yet fully operational due to the lack of an access road. Thus, the majority of Municipal waste is transported to a temporary dumping site without any segregation or treatment.

The surrounding environment of Bhusal Danda is highly polluted with the indiscriminate dumping of non-biodegradable household waste. A number of households also reported the unsafe practice of burning plastics, which affects air quality and presents severe health and environmental risks. Some households are composting their biodegradable waste, but only in areas with access to a kitchen garden. The UMN Hospital manages all waste on-site with a small incinerator for burning hazardous, clinical waste (ibid).

Storm water is channelled into roadside surface drains, which cover the sewer conduits below, and discharged into the natural gorges and streams. During the monsoon months, it is not uncommon for excessive storm water to enter the sewage conduits, causing overflowing and bursting of pipes. Residents reported a number of such cases, when burst pipes caused raw sewage to flow through the streets. The last occurrence in 2009 led to a huge increase of in-patients at the UMN Hospital suffering from diarrhoea, dysentery, typhoid, fever and vomiting (Interview with Mrs. Parvati Gautam 03.12.12). As the number of households continues to increase and roads are damaged, there is a high probability of a repeat event.

d) Personal Hygiene & Awareness

According to the community health department at UMN Hospital, personal health and hygiene awareness in Tansen is very low, for example knowledge surrounding the washing of hands after defecation and before eating (Interview with Mrs. Parvati Gautam 03.12.12). As a result, cases of waterborne illnesses such as diarrhoea, typhoid, dysentery and vomiting are not

uncommon. In 2011, the UMN Hospital received the following number of in-patients suffering from waterborne illnesses such as typhoid (299), diarrhoea (335 - including 2 deaths) and dysentery (100) (Interview with Mr. Bhuwaneshwar Devkota 04.12.12). The frequency of these cases increases significantly during the rainy season.

In response to these health issues, there are a handful of social services facilitated through the Tansen Municipality to improve knowledge of environmental sanitation. During one site-visit, a sanitation awareness rally was held through the city-centre of Tansen, promoting messages surrounding personal hygiene and household management of solid waste (See Figure 29). The Tansen Municipality facilitated this event, in coordination with the local police force and local representatives from industry and retail groups. Although these rallies are organised on an ad hoc basis, is estimated that such events occur approximately once per year.

Figure 29: Sanitation rally held through Tansen's city centre on 03.12.12 (Bright-Davies)

Figure 30: *"Towards zero waste"* event hosted by Tansen Municipality on 30.11.12 (Bright-Davies)

During the same site-visit, the Municipality was hosting a *"Towards Zero-Waste"* event, supported by the European Union project *SUNYA: Towards Zero-Waste in South Asia* in coordination with MuAN and ICLEI South Asia (See Figure 30). This event inducted Tansen as one of the seven partner municipalities of South Asia participating in the programme to promote zero-waste cities, through encouraging the *"3Rs"* of waste management: to reduce, reuse and recycle. Attendees – including representatives from government, non-government and local organisations, as well as political parties – agreed to hold further awareness programs and necessary training promoted through the SUNYA project.

Both these events give some indication of the level of local commitment to improving environmental sanitation conditions. While there is still need for increased social awareness regarding WASH issues, the initial interest shown by local leaders presents a welcoming environment for further promotion activities to improve behaviour practices in Tansen.

2.3.2 Ensuring an Enabling Environment

Figure 31: The six elements of an 'enabling environment' (Lüthi *et al* 2011a, 49)

This section will examine key elements of the enabling environment found in Bhusal Danda. An assessment of the enabling environment is a fundamental precondition for any CLUES intervention to be successful (See Figure 31).

a) Government Support / Legal and Regulatory Framework

As mentioned previously (See ***Political Situation and Government Commitment to WASH***; Page 11, and ***Institutional Aspects, Sanitation Policy and Planning Approaches***; Page 25), Government Support for urban environmental sanitation – in the form of legal and regulatory frameworks – is relatively weak, as national policies and sector strategies are either non-existent, or only exist in draft form.

It is, however, worth mentioning the emphasis that these existing policies place on decentralising service delivery to DDC and VDC levels, particularly in the planning and implementation of WASH services (Lüthi 2012). Section 9.7 of the *National Urban Water Supply and Sanitation Sector Policy* states the importance of reallocating roles and responsibilities to local bodies – including Municipal authorities, water users and sanitation committees, private sector organisations and communities – in order to achieve an *"efficient, effective and accountable urban water supply and sanitation sector"* (GoN-MPPW 2009, 19). As a result of this 2009 draft-policy and associated government approval, major stakeholders in the WSS sector (e.g. development agencies, INGOs and civil society) have indeed taken on the responsibilities of urban water supply and sanitation.

In order for the CLUES approach to commence in Tansen, a clear legal framework needs to be established. In accordance to the aforementioned policies, this framework shall be supportive of local CBOs (e.g. Sewerage Management Committees), allowing them the responsibility to open bank accounts, sign legal contracts, enforce the collection of user service-fees and ultimately take ownership of the sanitation intervention and associated infrastructure. The application of such principles will contribute to the delivery and sustainability of the project by empowering the community and instilling them with a sense of ownership (Hill 2009).

b) Institutional Arrangements and Stakeholders

The institutional environment in Bhusal Danda, Tansen and the respective roles, responsibilities and capacities of the various stakeholders can be identified as follows:

Primary Stakeholders:

Bhusal Danda Residents (Main beneficiaries): The 200 households located around the UMN Hospital are the key stakeholders and beneficiaries, and the group responsible for decisions surrounding investment in improved sanitation facilities. Local shop and restaurant owners also fall into this category.

Surrounding Farmers: These stakeholders have an interest in accessing safe and affordable water for irrigation purposes.

Community-based Organisations (Community Task Force): There are a number of community-based organisations operating in Bhusal Danda, the most relevant ones being the two *Sewage Management Committees*, with 10-12 members in each group (Interview with Mr. Mukti Pd. Neupane 03.12.12). These groups pro-actively manage local issues that arise within the community, such as the maintenance of sewage drains when required, as well as the construction of public water supply stands. They also represent the community when approaching the Municipality for the improvement of infrastructure and service provision.

The merging of these two committees could potentially result in the formation of a community task force. The existing members already exhibit the capacity to represent community interests and concerns, and have shown strong willingness to be involved in the planning process. The two presidents of these respective committees also express the ability to take on the role of 'Community Champions[12],' in the event that they should be elected.

[12] Community champions are identified as individuals with the ability to facilitate change within the community, due to the respect entrusted upon them by the community members (Lüthi *et al* 2011a).

UMN Hospital: The UMN Hospital is a major contributor the discharge of untreated wastewater, and as such has a responsibility and interest to improve this sanitation situation. An improvement in local conditions would presumably result in a decrease of in-patients requiring treatment from waterborne diseases.

Tansen Municipality (Service Provider): has a statutory responsibility for delivering a wide range of urban environmental sanitation services and infrastructure, such as sewerage, drainage, water supply and solid waste management (SWM). Planning, implementation, O&M and M&E responsibilities are shared with external organisations, according to Table 5 (below).

Table 5: Responsible organisations for urban service delivery (GHK *et al* 2011)

Urban Infrastructure		Planning	Implementation	O&M	M&E
Sewerage & Drainage	**Management**	MUN / UG	MUN / UG	MUN / UG	-
	Financing	MUN / Donor	MUN / MLD / UG / Donor	MUN	MLD / Donor
SWM	**Management**	MUN / Donor / NGO	MUN / NGO	MUN	NGO
	Financing	MUN / Donor / NGO	MUN / NGO	MUN	NGO
Water Supply	**Management**	DWSS / WUC	DWSS / WUC	DWSS / WUC	-
	Financing	Donor	Donor	-	Donor

MUN: Tansen Municipality; **UG:** Users' group; **MLD:** Ministry of Local Development; **NGO:** Non-governmental organisation; **WUC:** Water Users' Committee.

Secondary Stakeholders:

Village Development Committee: VDCs, like Municipalities, are responsible for planning and management within their jurisdiction boundaries for governance. Each district is divided into several VDCs, with greater public-government interaction and administration than Municipalities.

Urban development authorities and Central Government Line Agencies: The Tansen Divisional Office of the DUDBC provides urban planning technical support, while assists the Municipality and district line agencies with construction and infrastructure development. The Municipality has strong links to the central government's infrastructure funding agency (TDF) and Tole-Lane organisations (TLOs) for local level infrastructure and community development projects. TLOs are grassroots community organisations, which are formed in each settlement cluster, or 'tole.'

District Development Committee: plans and coordinates the activities and programs of the district line agencies, NGOs/CBOs, private sector and VDCs (including the Tansen Municipality).

Process stakeholders

World Bank & GIZ: GIZ's SUNAG programme supports the World Bank financed UGDP-ETP with technical assistance. As specified in the Introduction to Tansen (Page 81), technical advice for the implementation of priority infrastructure and services – such as the Sewerage and Drainage Improvement project in Tansen – is facilitated through the MST on behalf of GIZ SUNAG. The contract for providing the MST was awarded to the GFA Consulting Group. MST is located at the DUDBC and supports the said *Project Coordination Office* of the UGDP.

Non-governmental organisations: A number of NGOs are implementing local programs in Tansen related to community development, while simultaneously acting as intermediaries between government and local communities. These NGOs are required to register with the DDC and can work in coordination with the DDC, VDC or the Municipality (GHK *et al* 2011). ENPHO could be considered as an appropriate choice for involvement in such a project, due to their past experience in Tansen WWTP and expertise surrounding DEWATS and alternative sanitation technologies.

c) Financial Arrangements

The financial capacity of Tansen Municipality is limited, as is the ability of residents to pay for improved environmental sanitation services. Capital Expenditure on Municipal Waste Management and Sanitation programs between 2009-2010 was NPR. 2,939,219, or 4.3% of the total budget of NPR. 67,811,000 (GHK *et al* 2011). As mentioned in ***Socio-economic Profile***

(Page 86), average household income in Ward 10 (Bhusal Danda) is NPR. 28,534, which classifies the residents as low-income (ibid).

However, the CLUES approach – which specifically caters towards low-income communities – is deemed to be appropriate response within this context. According to household interviews, 100% of respondents reported that they would be able and willing to contribute funds towards a project to improve the current state of environmental sanitation within the locale. A number of these residents are already paying NPR. 200/year for connection to the drainage system, even though their houses are not connected.

In addition, the Municipality has identified ample public land south of the UMN Hospital, which they would be willing to provide for the construction of a WWTP.

d) Skills and Capacity / Socio-cultural Acceptance

Adequate knowledge, skills and capacities – in terms of health and hygiene promotion, project administration and facilitation, community participation and technical expertise – are essential elements within an enabling environment. Promotion of WASH activities is increasingly becoming a priority within the Municipality, which is explained in more detail in ***Personal Hygiene & Awareness*** (Page 93). Skilled health workers, aware of the basics of sanitation and hygiene, are working within the UMN Hospital *Community Health Department*, although their lessons need further dissemination amongst the community.

The Municipality is aware of the urgent need for drainage and wastewater improvement within the locale, and as such, they have expressed their support for a community-led project for improved environmental sanitation. In fact, it was through their consultation and suggestion that the site of Bhusal Danda was selected. Prior to the site selection, one Municipal engineer, who was motivated and positive towards such a project, accompanied site-visits to three prospective communities. The selection of Bhusal Danda as the most appropriate site was done in collaboration with this technical expert. Municipal support, however, is constrained by limited capacities and capabilities associated with sparse human resources and a lack of funds.

In terms of knowledge surrounding community participation and social inclusion, the Municipality places a strong emphasis on pro-poor interventions, such as income generation programs for economically marginalised populations and actions to ensure their participation in various development activities (GHK *et al* 2011).

The Residents, as represented through the *Sewerage Management Committee*, appear to understand the implications of a participatory planning process for localised sanitation improvement, including basic awareness and acceptance of a user-contribution scheme. Household interviews revealed that 100% of respondents expressed willingness to participate within a community planning and decision-making process.

There is already a relatively high level of general awareness in Tansen surrounding DEWATS, which is expected to have a positive influence on the socio-cultural acceptance of such an intervention. Perhaps this is partly due to past DED involvement with the WWTP in Tansen. Thus, both community representatives and municipal officials have expressed awareness and support for such a system to be implemented. At least one Municipal engineer and one staff member from the UMN Hospital had already visited DEWATS in other parts of Nepal, such as the Dhulikhel Hospital DEWATS, and were impressed by what they had seen (Interview with Mr. Bhuwaneshwar Devkota 04.12.12; Interview with Mr. Ramji Karki 03.12.12)

In addition, ENPHO is currently working on an institutional-scale DEWATS at Lumbini Medical College on the outskirts of Tansen. At the time of writing, this system was still under construction (more than 50% complete) and expected to be operational by the beginning of 2013 (Interview with Mr. Prajwal Shrestha 26.09.12). The close proximity of this DEWATS presents the opportunity for site-visits and 'real-life' experiences.

2.3.3 Stakeholder Analysis

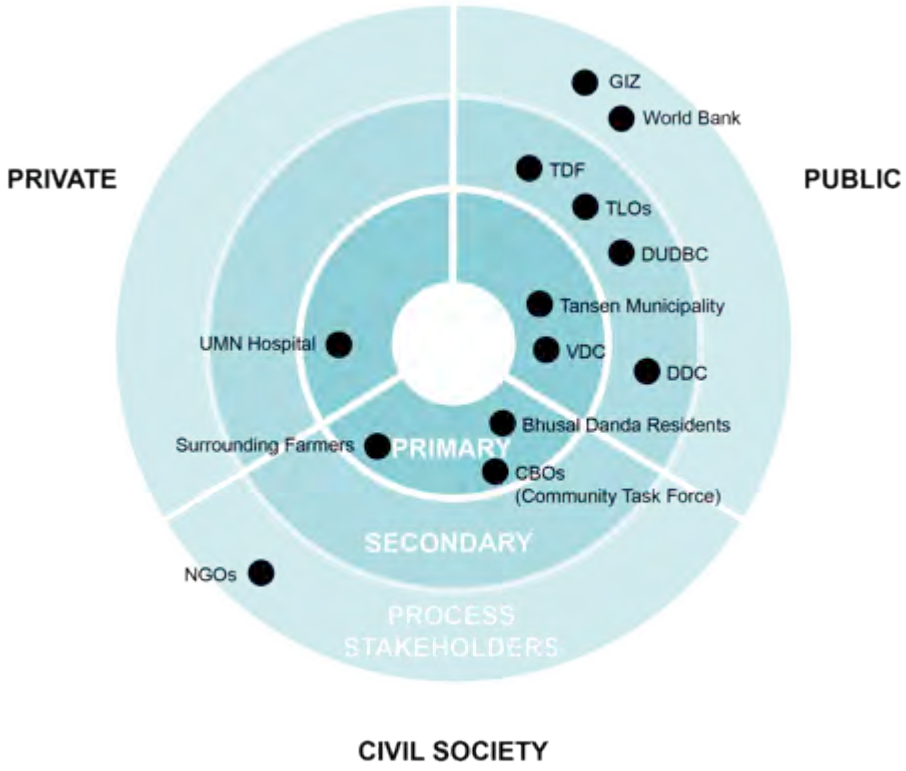


Figure 32: Stakeholder Analysis of primary, secondary and process stakeholders (Own Design).

2.4 Prioritisation of Community Problems and Validation (CLUES Step 4)

2.4.1 An Assessment of User-priorities on Environmental Sanitation Problems

This section will define the main problems and needs of the community in terms of environmental sanitation. These findings evolved as a result of a community focus group discussion and household interviews. The objective is to prioritise these user preferences, in order to arrive at an appropriate environmental sanitation response.

The half-day focus group discussion was held on 05.12.12 with the two Sewage Management Committees operating in the community of Bhusal Danda, plus other interested community members such as representatives from the UMN Hospital. A group of approximately twenty attendees (14 men and 6 women) were invited to state the most pressing issues with the current situation of environmental sanitation.

Figure 33: The half-day focus group discussion with participants from Bhusal Danda community (Bright-Davies 05.12.12)

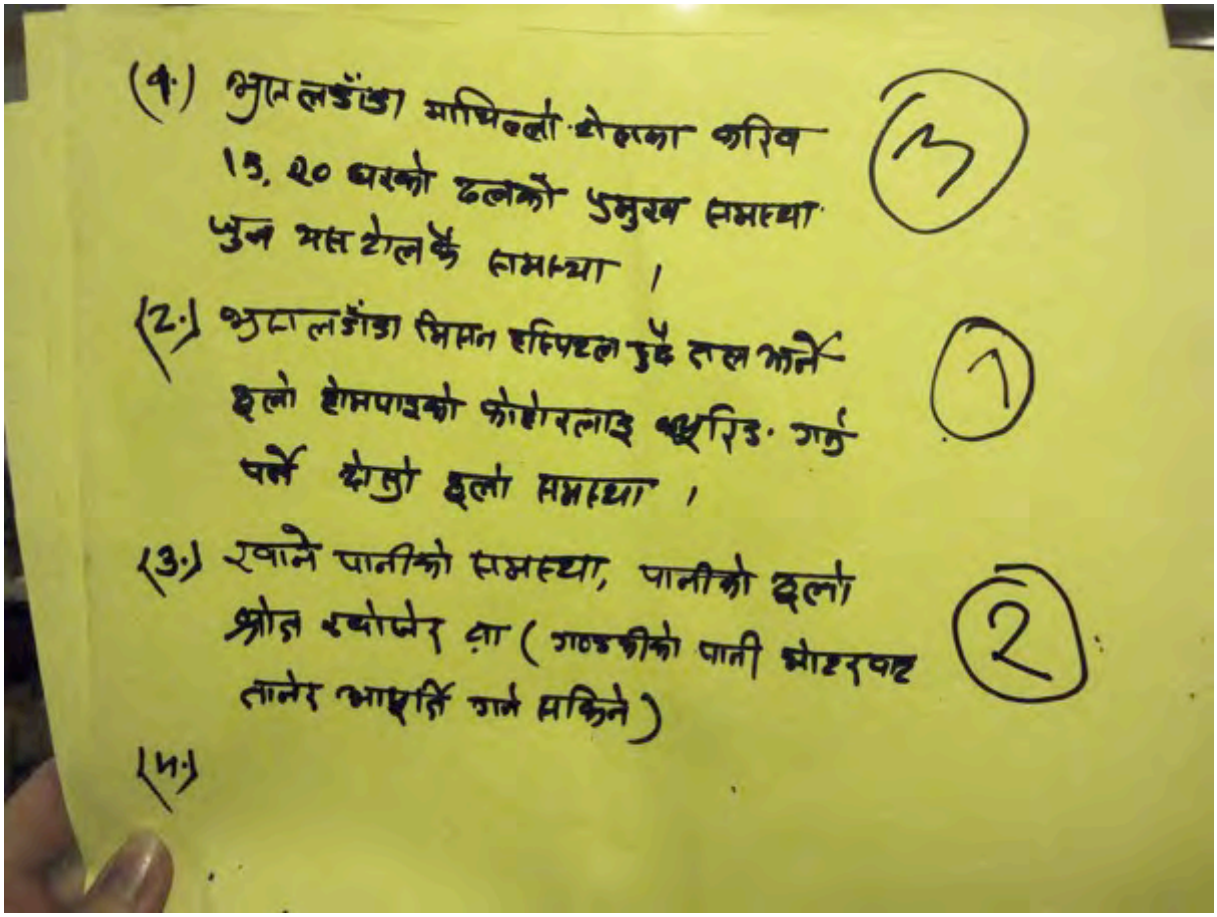


Figure 34: Outputs from the Focus Group Discussion (Bright-Davies 05.12.12)

The 'pocket-voting' [13] approach was attempted during this workshop, as a democratic and anonymous tool to gauge the participants' priorities. However, halfway through this activity the group unanimously agreed that the most immediate and visible priorities had already been defined in previous discussions, hence the formation and existence of these two committees. The group then proceeded to outline the following problems and needs (See Figure 34):

- 15-20 households located on the upper part of the community are suffering from severe sewage problems, which need urgent attention. These houses are currently not connected to the sewerage network, due to an underground pipe blockage. As a result,

[13] 'Pocket voting' is an exercise where participants anonymously vote and state their opinions on topics predefined by the facilitator (Lüthi *et al* 2011a)

raw sewage is pooling along the main street in front of their houses (See Figure 27). This wastewater then drains down towards the houses located further downhill. Therefore, this is not only a problem of for the households directly affected by the pooling wastewater and lack of sewerage connections, but for the whole town of Bhusal Danda

- Town sewage combined with some hospital sewage is released downstream without any form of treatment
- Drinking water scarcity

These topics were discussed in further detail amongst the participants, and prioritised accordingly:

1. Absence of wastewater treatment before being released downstream
2. Drinking water scarcity
3. Blocked connections and pooling sewage on upper part of Bhusal Danda

This discussion was followed by a participatory mapping exercise of the target area. The objective was to help the community visualise and analyse the local environmental sanitation situation and invite their input on local conditions (WaterAid 2005). A base map was prepared beforehand, and the community was invited to identify relevant features, such as:

- The community boundary
- Sources of pollution or open defecation
- Major problem areas (E.g. Homes without access to sanitation facilities)
- Water supply points
- Public sanitation facilities
- Drainage infrastructure and outlets

The direct output of this exercise can be seen in Figure 35, which provides an overview of the project area and its respective problems. The community-identified features were incorporated into the map (Figure 26; Page 90) and are described in more detail in: ***Detailed Assessment of the Current Situation (CLUES Step 3)*** (Page 89).

Figure 35: Outputs from the Community Mapping exercise (Bright-Davies 05.12.12)

Additional features, which are relevant for the design considerations of a potential sanitation intervention, include the following:

- Public land, south of the UMN Hospital, which the Municipality have identified as a potential site for wastewater treatment
- Identification of open defecation areas and households without private toilet facilities (located northeast of the main settlement cluster), which require either the construction of toilets or improved connections to the existing sewerage system
- Agricultural land downhill which would be directly affected by the construction of a wastewater treatment system

2.5 Identification of Service Options (CLUES Step 5)

Outcomes from the community focus group discussion, household interviews and stakeholder consultations form the basis for identifying feasible environmental sanitation options, which will be described in this chapter.

To arrive at the most suitable solution, urban sanitation experts advise focussing on the end of the sanitation value chain (and potential 'value' of output products) first, then working backwards. By doing this it is possible to design a sanitation system around demand, for example:

> *"[where] irrigation water is scarce, consider to provide adequately treated wastewater, if energy is scarce, consider the production of biogas from wastewater, if soil-conditioners or fertilisers are scarce or expensive, system design should accommodate this context specific need."*
>
> (Lüthi et al 2011b, 62)

In the case of Bhusal Danda, the output demands of any potential sanitation system are concentrated around the lack of wastewater treatment and issues of water scarcity. Therefore, an appropriate system should be designed around the demand for adequately treated wastewater - both for domestic re-use and irrigation purposes. Such an intervention should incorporate water conservation and water recycling concepts, requiring minimal water input for sewage conveyance and treatment, and ensuring efficient re-use of treated wastewater (e.g. toilet flushing or irrigation). In addition to the technical, 'hardware' options, the sanitation system(s) should incorporate non-technical, 'software' considerations.

Based on the lessons learnt from previous case studies in Nepal and recommendations from sanitation experts – combined with the context-specific considerations and user-preferences – the following service options (See Figure 36) are presented for the improved management of urban environmental sanitation in Bhusal Danda.

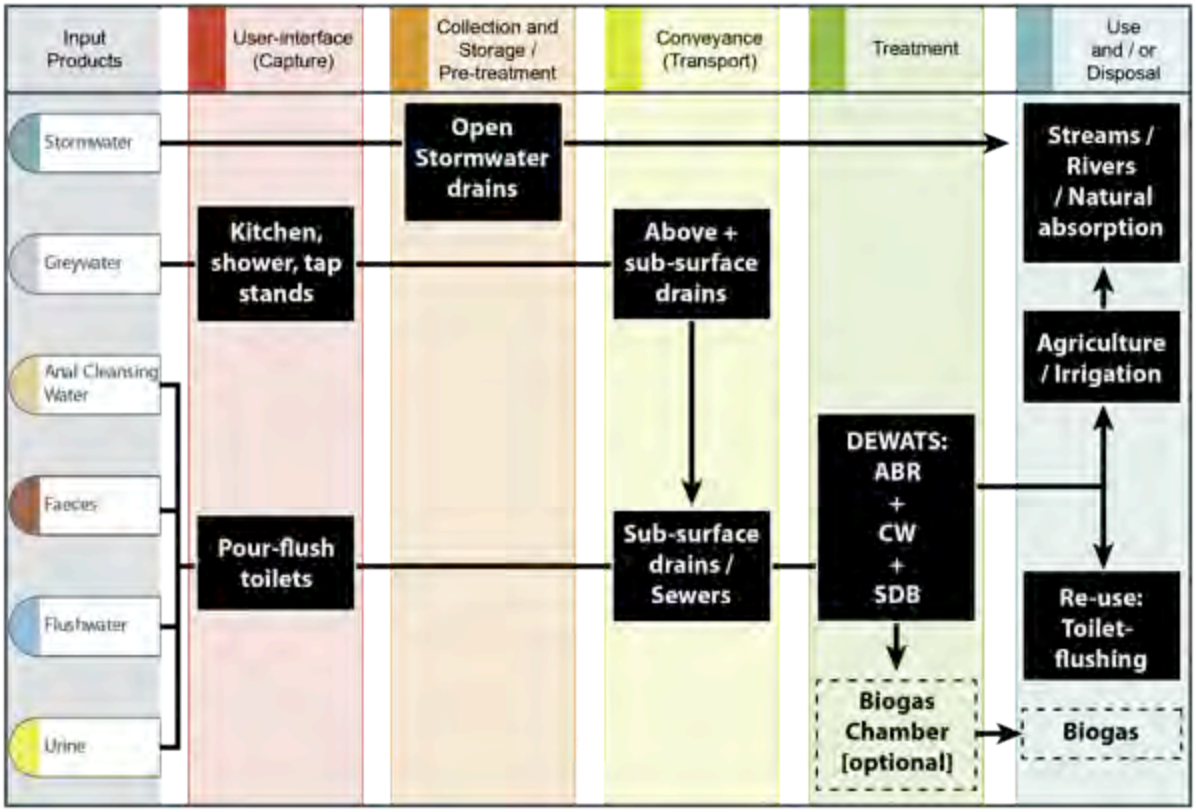


Figure 36: Proposed Sanitation Chain in Tansen (Own design, adapted from Tilley *et al* 2008, 14)

2.5.1 Technical Components

Similar to the aforementioned case studies, application of a decentralised wastewater treatment system (DEWATS) is considered to be an appropriate response for the community of Bhusal Danda. As such, the following technical components are proposed for treatment of wastewater and faecal sludge (See Figure 37):

- **Preliminary treatment:** Bar Screen or grit chamber
- **Primary treatment:** ABR + Settler (with optional Biogas)
- **Secondary treatment:** CW (Horizontal flow RBTS and Vertical flow RBTS)
- **Sludge treatment:** Planted or unplanted SDB

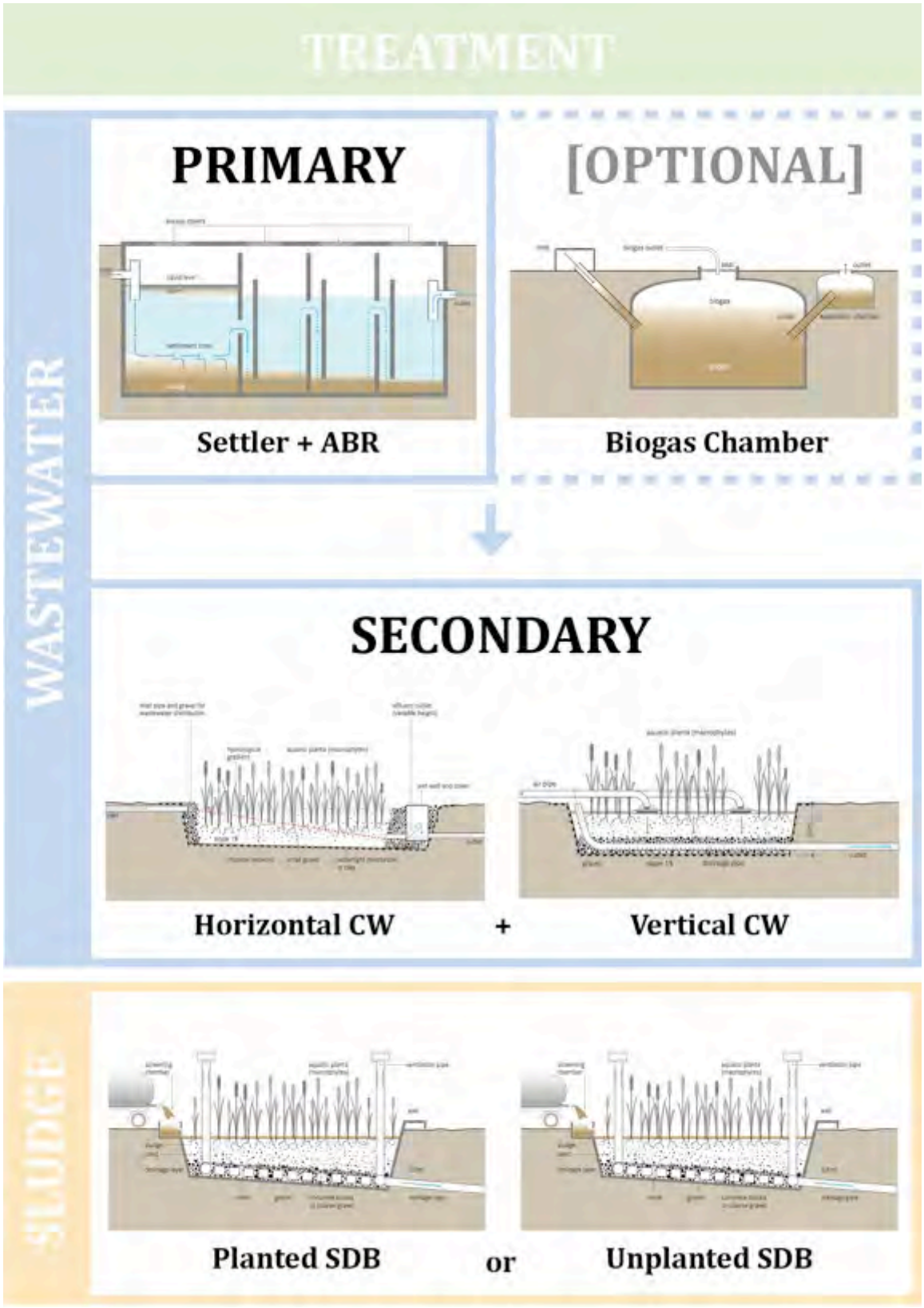


Figure 37: Diagram showing DEWATS Components (Own design, with images taken from Tilley *et al* 2008)

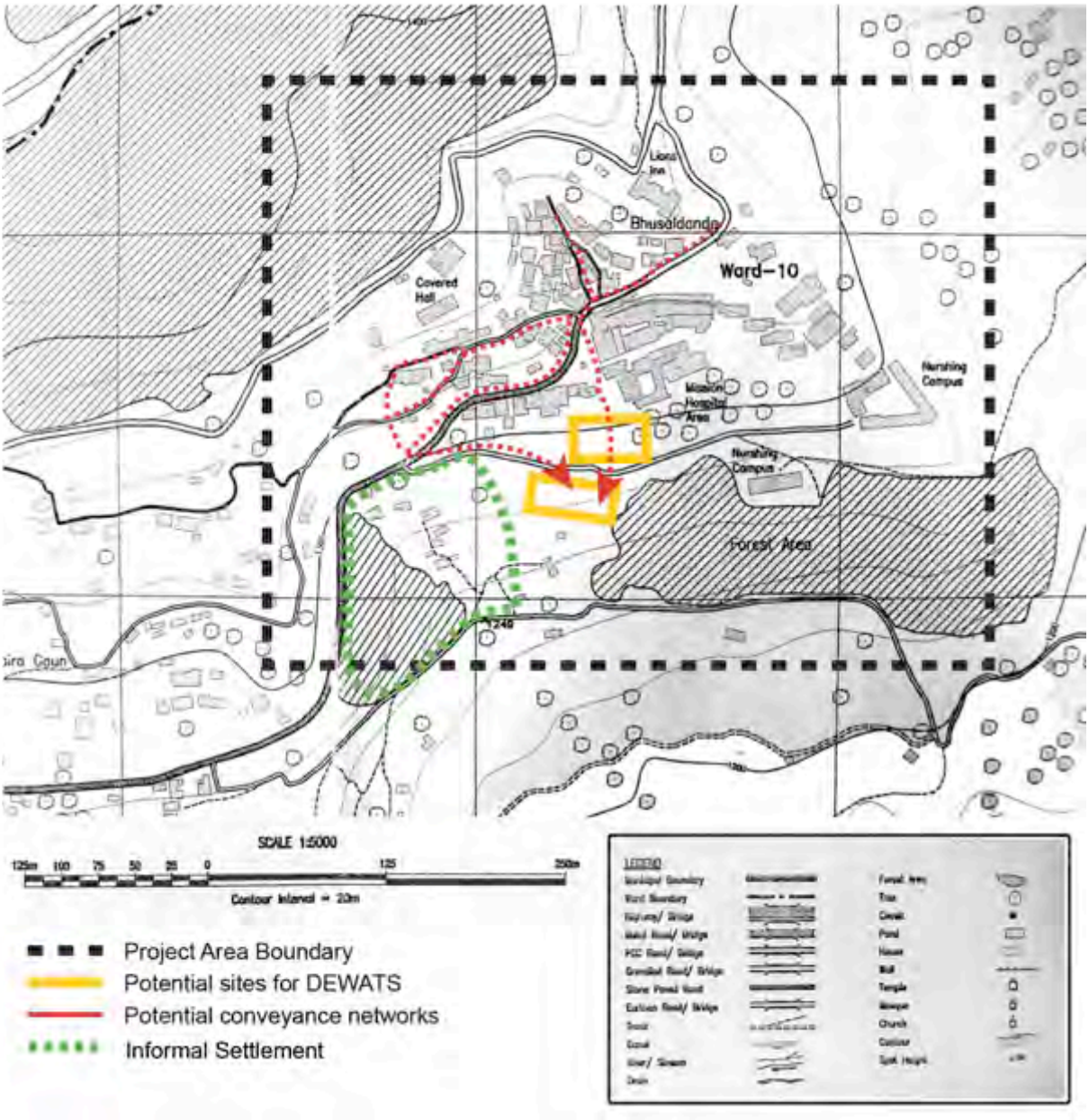


Figure 38: Map of Bhusal Danda, showing potential sites for DEWATS (Bright-Davies, adapted from Genesis 2005)

The potential site for construction of a DEWATS is located on public land, approximately 100 metres downhill from the UMN Hospital and just east of the informal housing settlement (See Figure 38 & Figure 39). The municipality have already given their support for the allocation of this public land for the purpose of a DEWATS. The gradient of the site means that wastewater would be conveyed downhill, from the houses to the WWTP, using the natural force of gravity and therefore eliminating the need for energy-dependent pumps. Such steep terrain, however, causes water to travel at a higher velocity and for solids to fully dissolve in the process.

Wastewater must therefore spend more time in sedimentation tanks, in order to separate the sludge from the water (Interview with Mr. Prajwal Shrestha, 26.09.12). This context specific challenge would require further consideration during the detailed engineering design process.

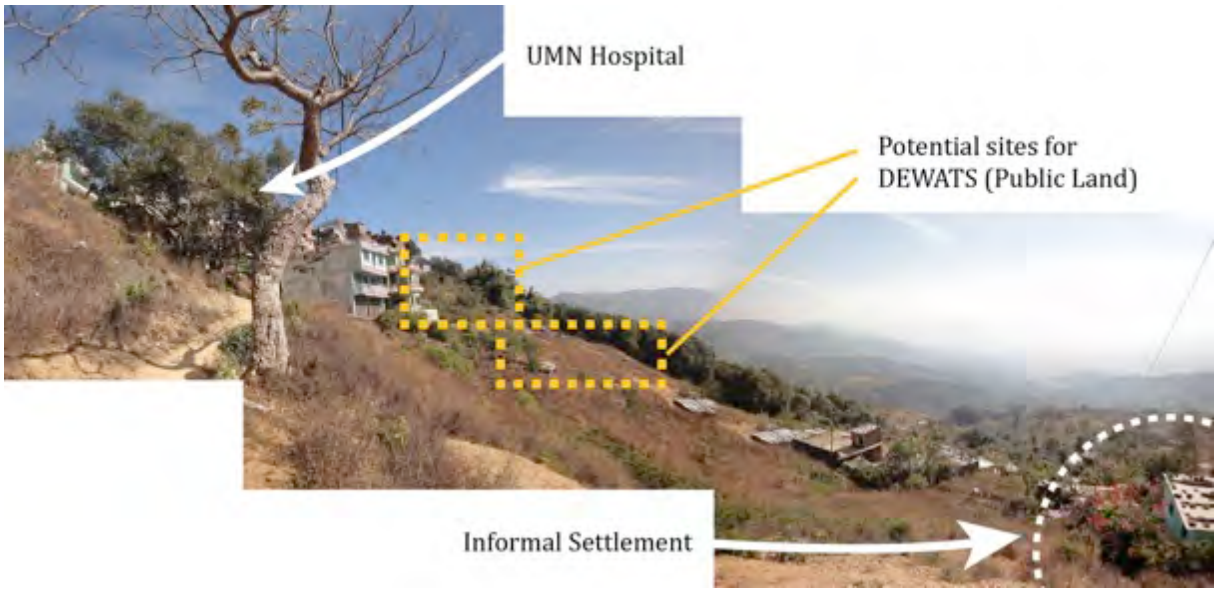


Figure 39: Photomontage of Bhusal Danda, showing the potential site locations for a DEWATS (Bright-Davies, 04.12.12)

The proposed service interventions adopt a minimal approach to improving environmental sanitation conditions, by capitalising on existing infrastructure and behaviour practices: *"small lasting improvements that are sustainable at each step"* (Lüthi *et al* 2011a, 37). These service options are deemed to be socially acceptable, environmentally sensitive and economically beneficial within this particular context for the following reasons:

- At the user-interface level, the majority of households with pour-flush toilets will not be required to install new facilities, but can simple connect to new or upgraded drainage services. Those households without toilets will be eligible to receive them.
- For the conveyance of wastewater, the existing sub-surface drainage can be rehabilitated and re-appropriated, with new extensions to the network incorporated wherever necessary.
- Sub-surface drainage connections between houses and WWTP would reduce the public exposure to open sewage and associated health risks (e.g. waterborne diseases).

- In terms of wastewater treatment, the adoption of simple technologies and natural processes (CW and RBTS) requires minimal capital investment and low-maintenance without highly skilled operators.
- The output product, as treated wastewater, could be re-used to irrigate neighbouring agriculture land located downhill from Bhusal Danda. Alternatively, water could be pumped up to the public toilet block at the UMN Hospital, and re-used for toilet flushing.
- The gravity-fed conveyance system requires minimal water to transport sewage from the households to the WWTP. This optimised usage of water, combined with the re-use potential of treated wastewater would help alleviate the on-going problem of water scarcity within the area.

The optional component of biogas has been included because of its potential to generate funds and therefore subsidise on-going O&M costs. The feasibility of this option, however, should incorporate the precautions outlined in ***Technical Aspects*** (Page 77) – i.e., increased cost implications for construction and the technological considerations for effective operation and sustained functionality. Design engineers would be required to perform a detailed cost-benefit analysis before confirming inclusion of this component within the DEWATS service options.

2.5.2 Non-Technical Components

In addition to the 'hardware' recommendations, 'software' interventions surrounding local health and hygiene need to be address concurrently, in order to improve sanitation behaviour. This could be achieved through community awareness programmes combined with household level training sessions. In addition to the awareness programmes provided by the Municipality (See ***Personal Hygiene & Awareness*****;** Page 93), the mobilisation of local groups and interventions by community health workers (E.g. UMN Hospital Community Health Department) could help to promote WASH messages.

2.5.3 Critical Analysis of the Proposed Interventions

To summarise the potential impact of this environmental sanitation intervention, the following SWOT Analysis has been developed:

Strengths

- Urgent need for improving the environmental sanitation
- Existence of active and engaged User Committee
- Support from Tansen Municipality
- Social acceptance regarding localised / decentralised WWTP
- Availability (and proximity) of public land for a DEWATS
- Interest from World Bank to finance project

Weaknesses

- The issue of water supply is not directly solved (although the re-use of treated wastewater helps mitigate scarcity)
- Solid Waste Management is also not incorporated into the service option recommendations (but could potentially be included at a later stage)
- Houses located below the proposed site for DEWATS cannot be connected (although the sanitation situation is not so severe in this location, and there are other solutions available such as individual septic tanks or UDDTs)

Opportunities

- Improved environmental conditions, public health, living standards and reduced incidence of outbreaks from waterborne diseases
- Treated wastewater could be re-used in agriculture, or for toilet-flushing in the public toilets (alleviating the already sparse water supply situation)
- Potential use of biogas as a renewable and affordable energy source
- The close proximity of another medium-scale DEWATS at Lumbini Medical College, could potentially serve as a demonstration site for increasing awareness surrounding DEWATS
- Local ambitions to achieve 'Zero-waste' in Tansen create a supportive environment for the further adoption of environmentally sensitive and responsible approaches
- Joint commitment from Tansen Municipality and the Bhusal Danda community creates a conducive environment – e.g. The Municipality can help manage / enforce the collection of user service-fees

Threats

- While municipal support for the project is a positive foundation, precautions must be made to ensure the community-led focus, without the process being dominated or overruled by local authorities. In other words, the emphasis on community-ownership and responsibility must be maintained
- Limited financial capacity of residents - difficulties might arise for low-income households to pay on-going user service-fees
- The common misconception of DEWATS as 'no-maintenance' and not 'low-maintenance' systems

2.5.4 Planning and Implementation: What happens next?

While the scope of this dissertation only intended to reach CLUES Step 5, the following section will propose suggestions for 'what happens next.'

To proceed beyond the environmental sanitation systems proposed in Step 5, a community consultation workshop should be facilitated with the key stakeholders outlined in ***Primary Stakeholders*** (Page 97). The purpose of such a workshop is to discuss the system in greater detail with key beneficiaries (Bhusal Danda residents) and the main service provider (Tansen municipality), as well as to encourage their participation in the final selection of an agreed option. At the same time, the relevant sanitation experts and engineers should evaluate the DEWATS technical feasibility and financial implications in depth. This collaborative and participatory process between the community, local authorities and external agencies is intended to form the basis of the necessary partnership.

The outcomes of the community consultation workshop and subsequent confirmation of the selected service options would be followed by CLUES Steps 6 & 7 (Development of an Action Plan & Implementation of the Action Plan). Step 6 is the *"blueprint for implementation and can be considered the main output of the entire planning process,"* incorporating an action plan that is *"costed… timed and guided by output-based targets"* (Lüthi *et al* 2011a, 39). This step also includes the development of an 'O&M management plan', which has been proven by the abovementioned case studies to be indispensible in ensuring long-term and sustainable operation of community-scale DEWATS. The action plan should also include thorough instructions on how to finance the O&M. These instructions must be developed in coordination with those directly involved in its implementation, such as the Community Task Force (or Users Committee), municipal engineers and urban planners, micro-financing specialists, DEWATS specialists (E.g. ENPHO or UN-HABITAT Nepal) and biogas specialists (E.g. BSP Nepal).

The outcome of this process, in the form of a concrete CLUES action plan (e.g. *'Environmental Sanitation Improvement Plan for Bhusal Danda'*), needs to be both accepted by the community and acknowledged by the Municipality.

This plan should cover of the following aspects:

> *"technical, institutional and human resources issues, a timeline, [and] a financing model... The plan should also include a monitoring and evaluation strategy for implementation."*
>
> (Lüthi et al 2011a, 41)

Upon finalisation of CLUES Step 6, the final Step 7 would entail the implementation of this action plan and associated O&M management plan, with the following sub-steps (ibid, 43-46):

- *Development of detailed construction and monitoring plans;*
- *Procurement and contracting;*
- *Implementation, supervision and commissioning;* and
- *Inauguration ceremony.*

The community of Bhusal Danda have already expressed willingness to take on O&M responsibilities, upon implementation of the new service infrastructure. In this case, training would also need to be provided in addition to the aforementioned sub-steps.

Conclusions

There is an urgent need in Nepal for sustainable urban wastewater management and treatment in order to protect the local environment and public health, and as a fundamental basis of economic growth. This necessity runs parallel to the potential of DEWATS as an appropriate technical solution for urban areas, as centralised systems have overwhelming proved to be ineffective.

Conventional approaches continuously fail to address the basic needs of wastewater disposal in developing countries; because of their high capital investment costs and insufficient O&M capacities combined with low- (or no-) connection rates. On the other hand, the inherent simplicity of DEWATS provides an effective, affordable and low-maintenance option for treating wastewater.

Compared to the former, linear approach to sanitation, DEWATS employ a more holistic and 'ecological' ideology, minimising the domain of waste management and 'closing the loop' between human waste creation and disposal, while optimising water usage and re-use. In this sense, DEWATS adhere to the environmental fundamentals of sustainable sanitation.

This dissertation has assessed the effectiveness of sustainable sanitation in the urban and peri-urban communities of Sunga, Srikhandapur and Nala, according to their respective planning and implementation processes, technical aspects and long-term management strategies. These various iterations of community-scale DEWATS provide valuable lessons for on-going sustainability and future replication of this approach; the findings of which are encapsulated within the fundamentals of CLUES planning, such as the importance of community participation throughout the planning and implementation stages (and beyond) combined with the appropriate selection of technological configuration and the incorporation of systematic financing mechanisms (e.g. user service-fees, or revolving fund schemes).

As demonstrated, DEWATS are more technologically and financially sustainable when implemented through the strategic CLUES planning process, which highlights the importance of O&M and gives users a sense of ownership or responsibility. In addition, CLUES incorporates the social advantages of a community-led process, such as user-centred solutions and community empowerment, with the ecological benefits of environmental sanitation and holistic consideration of all waste streams to achieve a sanitary environment. Taking the case of Bhusal Danda as an example, the technical 'hardware' aspects of DEWATS, combined with the planning and implementation 'software' aspects of CLUES planning, can be considered a most suitable response for urban environmental sanitation improvement in Nepal.

In conclusion, while Nepal has a long way to go in terms of improving environmental sanitation conditions, the current situation can be considered as a rare opportunity to implement genuinely sustainable solutions. Once people adopt the Western models of conventional sewerage and centralised treatment systems, it becomes much harder to change their behaviour and attitude towards human waste, and the chance to implement sustainable solutions on a broad-scale could be lost. The current and projected increase of attention surrounding the MDG targets on sanitation must therefore be channelled into providing sustainable solutions, such as community-led DEWATS. Such outcomes, combined with an increased awareness surrounding WASH issues and user demand, will make an impact long after the donors and initial instigators have departed.

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Appendices

Appendix I – Bellagio Principles

The Bellagio Principles governing the new approach to environmental sanitation are as follows (WSSCC 2000):

- ***"Human dignity, quality of life and environmental security should be at the centre of the new approach, which should be responsive and accountable to needs and demands in the local setting.***
  - *Solutions should be tailored to the full spectrum of social, economic, health and environmental concerns*
  - *The household and community environment should be protected*
  - *The economic opportunities of waste recovery and use should be harnessed*
- ***In line with good governance principles, decision-making should involve participation of all stakeholders, especially the consumers and providers of services.***
  - *Decision-making at all levels should be based on informed choices*
  - *Incentives for provision and consumption of services and facilities should be consistent with the overall goal and objective*
  - *Rights of consumers and providers should be balanced by responsibilities to the wider human community and environment*
- ***Waste should be considered a resource, and its management should be holistic and form part of integrated water resources, nutrient flows and waste management processes.***
  - *Inputs should be reduced so as to promote efficiency and water and environmental security*
  - *Exports of waste should be minimised to promote efficiency and reduce the spread of pollution*
  - *Wastewater should be recycled and added to the water budget*
- ***The domain in which environmental sanitation problems are resolved should be kept to the minimum practicable size (household, community, town, district, catchment, city) and wastes diluted as little as possible.***
  - *Waste should be managed as close as possible to its source*
  - *Water should be minimally used to transport waste*
  - *Additional technologies for waste sanitisation and reuse should be developed."*

Appendix II – Overview of CLUES Planning

This appendix provides an overview of the CLUES planning approach and its three distinct elements (Lüthi *et al* 2011a, 6-7):

- ***"7 planning steps***
- ***Cross-cutting tasks*** *relevant throughout the entire planning process, and*
- ***The enabling environment*** *which is required for sustainable interventions*

Summary of the 7 Planning Steps

Step 1: Process ignition and demand creation

The planning process begins with ignition and promotional activities. This step aims to sensitise the community to environmental sanitation and hygiene issues and to create momentum and a solid platform for community participation. After a participative community mapping exercise and the discussion of key concerns with the residents in a first community meeting, an agreement on action is formulated and a community task force is formed by previously identified community champions.

Step 2: Launching of the planning process

In step 2 all key stakeholders formally come together to develop a common understanding of the environmental sanitation problems in the intervention area and agree on the process of how to address them. The launching workshop must be inclusive, well-structured and attract public attention. In step 2 stakeholders generate a protocol agreement, an agreement on the project boundaries and an agreement on the overall planning methodology and process.

Step 3: Detailed assessment of the current situation

In step 3 stakeholders compile information about the physical and socio-economic environment of the intervention area. This step is important because it provides necessary background information for all future planning steps. Outputs include a refined stakeholder analysis, baseline data, and a thorough assessment of the enabling environment and current levels of service provision. The main outcome of step 3 is a detailed status assessment report for the intervention area.

Step 4: Prioritisation of the community problems and validation

In step 4 stakeholders deliberate the findings and implications of the assessment report, and identify and prioritise the leading general and environmental sanitation problems in the community. The main outcomes of step 4 are the validated assessment report and an agreed-upon list of priority problems in the community.

Step 5: Identification of service options

In step 5 the planning team, in consultation with environmental sanitation experts and key stakeholders, uses an informed choice approach to identify one or two environmental sanitation system options that are feasible for the intervention area and can be studied in greater detail. The community and the local authorities reach agreement based on an understanding of the management and financial implications of the selected systems.

Step 6: Development of an action plan

In step 6 stakeholders develop local area action plans for the implementation of the environmental sanitation options selected in step 5. The action plans must be implementable by the community,

the local authorities and the private sector. The main output of step 6 is a costed and funded action plan that follows time sensitive, output-based targets. Every action plan must contain an operation and maintenance management plan to ensure the correct functioning of the sanitation system.

Step 7: Implementation of the action plan

As the goal of step 7 is to implement the CLUES action plan developed in step 6, this last step is not strictly speaking part of the planning process. Stakeholders translate the action plan into work packages which ultimately become contracts for implementing the service improvements. The final stage of step 7 is the implementation of the O&M management plan.

Cross-cutting Tasks

There are 3 cross-cutting tasks which are relevant throughout the entire planning process:

1. *Awareness Raising and Communication are key to creating demand and raising people's abilities to make informed choices about the most appropriate systems and technologies.*
2. *Capacity Development aims to strengthen skills for process management and collaborative planning and skills like engineering, construction, operation and maintenance.*
3. *Process Monitoring and Evaluation allows one to identify and correct mistakes or imbalances or even to change the shape and direction of the project before it is too late.*

The Six Elements of the Enabling Environment

The enabling environment and how it is understood is a key determinant for successful project interventions. The six elements that define an enabling environment need to be nurtured and pro-actively fostered to provide favourable conditions for environmental sanitation planning in challenging urban environments.

- *Government Support*
- *Legal and Regulatory Framework*
- *Institutional Arrangements*
- *Skills and Capacity*
- *Financial Arrangements*
- *Socio-cultural Acceptance."*

Appendix III – Household Questionnaires

Semi-structured interview questions for:
Srikhandapur Households - Users of DEWATS with/without Biogas

NOTES	[Take photo of interviewee]		
Name of Interviewee:			
Age:		Gender:	
Contact Details:			
Name of Interviewer / Translator:			
Location:			

1. **Basic Information**

   1.1. How many people are living in this household?
   1.2. How long have you lived here?
   1.3. How many people use this system?

2. **Demand for, and satisfaction with improved sanitation facilities**

   2.1. What are the most important problems in your HH? Please name three, and list them in the order of importance (E.g. Water supply, toilets, drainage, waste management)
   1)
   2)
   3)

   2.2. How satisfied or dissatisfied are you with the [_____] solution that was implemented?
   - ☐ Very satisfied
   - ☐ Quite satisfied
   - ☐ Neither satisfied or dissatisfied
   - ☐ Quite dissatisfied
   - ☐ Very dissatisfied

2.3. Is it easy to use?

- ☐ Yes
- ☐ No

2.4. Before this system was implemented, what kind of toilet did you use?

2.4.1. What happened to the toilet wastewater?

2.4.2. Did you have to pay for any connection to drainage or collection of sludge?

- ☐ Yes (How much?)
- ☐ No

2.4.3. Who did you pay to receive this service?

2.5. Did the building of this system include the installation of toilets in the household?

- ☐ Yes
- ☐ No

2.6. Does everyone in your HH use this toilet, or do some people still prefer to go outside?

- ☐ Yes
- ☐ No

2.7. Where/how do you source water?

2.7.1. How much does this cost?

2.7.2. Who do you pay?

2.7.3. How often do you pay?

2.7.4. When did you pay last?

2.7.5. When will you pay next?

2.8. How do you deal with household waste?

2.8.1. Organic? Where is this being disposed/used?

2.8.2. Non-organic?

2.9. What cleaning products do you use for the toilet / kitchen?

_____

3. <u>Ability to pay for services</u>

3.1. Who is responsible for the cleaning/maintenance?

3.2. Do you have to pay to use this service?

3.2.1. How much per week/month?

3.2.2. Who do you pay?

3.2.3. When did you pay last?

3.2.4. When will you pay next?

3.2.5. How easy or difficult is it for you to pay this service fee?

- ☐ Very Easy
- ☐ Quite Easy
- ☐ Neither easy nor difficult
- ☐ Quite difficult
- ☐ Very difficult

Why?

3.2.6. Do you think other community members will pay their fee in the next month?

- ☐ Yes
- ☐ No (If NO, please explain why not)

3.3. What happens if you do not pay?

4. Other socio-economic information

4.1. Do you own a mobile phone?
- ☐ Yes
- ☐ No

4.2. How much does it cost per month?

4.3. Do you own a television?
- ☐ Yes
- ☐ No

4.4. What is the weekly expenditure of this household?

4.5. How much do you save each week?

5. Participation Process

To establish whether they were involved in the planning process and decisions that lead to the implementation of this particular system

5.1. Before the construction of this new system, did somebody come and ask you questions about your sanitation problems and needs?

5.2. Who?

5.3. How often did you participate in a meeting or workshop regarding this project?

5.4. Who made the decision for choosing this system?

5.5. Were you involved in decisions regarding the choice of this particular system? Can you briefly describe your role?

5.6. What other options were presented?

_____

5.7. Why did you choose this type of system instead of other options?

_____

5.8. How satisfied or dissatisfied are you with the option that was selected?
- ☐ Very satisfied
- ☐ Quite satisfied
- ☐ Neither satisfied or dissatisfied
- ☐ Quite dissatisfied
- ☐ Very dissatisfied

5.9. Are you active in a CBO / user-committee?
- ☐ Yes (explain)
- ☐ No (do you know of any?)

6. Benefits from improved sanitation

Identify tangible benefits experienced since the system was implemented

6.1. Biogas:

6.1.1. How much do you now spend on LPG (or alternative) gas each week/month?

6.1.2. How much did you spend, before the implementation of this project?

6.2. Health:

6.2.1. Have you experienced improved health, since this project was implemented?

6.2.2. Before this system was built, how often did you (or someone in your HH) suffer from illness (diarrhoea or other diseases)?

6.2.3. Since this system was built, how often do you (or someone in your HH) suffer from illness?

6.3. Compost / Fertiliser (where applicable):

6.3.1. Have you experienced an increased yield of crops? More food?

6.4. Other benefits:

6.4.1. Have you experienced any other benefits since this system was implemented? (Explain)

6.5. Do you think the benefits of this new system are worth the effort or investment?

- ☐ Yes
- ☐ No
- ☐ Not sure (explain)

6.6. If you were to move from this location to another town or village, would you be willing to invest in a similar system?

- ☐ Yes
- ☐ No (explain)

6.7. How much would you be willing to pay?

7. WASH Education and user-training

To establish whether they have received any education on water, sanitation and hygiene (E.g. hand washing, using soap, etc).

7.1. Have you ever attended a class on water, sanitation and hygiene?

7.1.1. Who offered these lessons?

7.1.2. What did they teach you?

7.2. Did you receive any training on how to use this system (E.g. separation of household waste, etc)?

7.2.1. What did they teach you?

8. Questions they might have about the study or interviewer

8.1. Do you have any questions you would like to ask me/us?

Semi-structured interview questions for:
Bhusal Danda Households

NOTES	[Take photo of interviewee]		
Name of Interviewee:			
Age:		Gender:	
Contact Details:			
Name of Interviewer / Translator:			
Location:			

1. **Baseline Household Information:**

1.1. Position in household?
- ☐ HH head
- ☐ Spouse
- ☐ Adult + 18yrs

1.2. How many people are living in this household?
1.3. How long have you lived in this community?
1.4. Do you rent or own this house?
1.5. Do you plan to move to another house within the next year?

2. **Demand for improved sanitation facilities**

2.1. Do you see a problem with the current sanitation situation in this community?
- ☐ Yes, very much
- ☐ Yes, a little bit
- ☐ No, not at all

2.2. What are the most important problems in your HH? Please name three, and list them in the order of importance (Egg. Water supply, toilets, drainage, waste management)

a)
b)
c)

2.3. Does this house have its own toilet facility?
- ☐ Yes
- ☐ No

2.4. **What type of toilet facility is it?** Flush toilet / pit latrine / other – specify:

2.5. Is this toilet connected to wastewater drainage?

- ☐ Yes
- ☐ No

2.6. What happens to the toilet wastewater?

2.7. Did you have to pay for any connection to drainage or collection of sludge?

- ☐ Yes (How much?)
- ☐ No

2.7.1. Who did you pay to receive this service?

2.8. Would you be able / willing to give time for a community planning and decision-making process?

- ☐ Yes (How much?)
- ☐ No

2.9. Would you be able / willing to invest a small amount to improve drainage and/or wastewater treatment?

- ☐ Yes (How much?)
- ☐ No

2.10. Where/how do you source drinking water?

Public pipe / Shared tap / Private well / Unprotected well / private water vendor / Other – specify:

2.10.1. How much does this cost?

2.10.2. Who do you pay?

2.10.3. How often do you pay?

2.11. How do you deal with household waste?

2.11.1. Organic?

2.11.2. Non-organic?

3. WASH Education and user-training

To establish whether they have received any education on water, sanitation and hygiene (E.g. hand washing, using soap, etc).

3.1. Have you ever attended a class on water, sanitation and hygiene?

3.1.1. Who offered these lessons?

3.1.2. What did they teach you?

3.2. Did you receive any training on how to manage waste? (E.g. separation of household waste, composting bio-waste, not-burning plastics?)?

3.2.1. What did they teach you?

4. Questions they might have about the study or interviewer

4.1. Do you have any questions you would like to ask me/us?

Appendix IV – List of Interviewees

WASH Experts:

- **Mr. Mingma Sherpa**
  EAWAG PhD student, AIT University
- **Mr. Bhushan Tuladhar**
  Head of UN-Habitat Nepal
- **Mr. Prajwal Shrestha**
  WATSAN Programme Manager, ENPHO
- **Mr. Jeeban Shrestha**
  Private DISWATS/Biogas consultant
- **Mr. Kabir Rajbuandari**
  Senior WASH Advisor, SNV Kathmandu
- **Mr. Rajendra Shrestha**
  DEWATS Engineer & M&E Specialist, UN-Habitat Nepal
- **Mr. Kashi Kant Thakur**
  Project Officer for *Nepal Node for Sustainable Sanitation* at ENPHO
- **Mr. Nawal Kishor Mishra**
  Regional Director DWSS, GoN
- **Mrs. Luna Kansakar**
  DEWATS Expert, ENPHO
- **Mrs. Yasoda Shrestha**
  DEWATS Expert, ENPHO
- **Mr. Sarbagya Shrestha**
  Urban Programme Officer, WaterAid Nepal
- **Mr. Ram Buhadur Ghimire**
  Urban Programme Officer, WaterAid Nepal

Community Members and Households:

Sunga

- **Mr. Krishna Lal** (President of the Users' Committee)
- **Mr. Krishna Shrestha** (Paid caretaker at Sunga DEWATS)

Srikhandapur

- **Mr. Purna Bar Karmacharya** (President of Users' Committee & volunteer caretaker at Srikhandapur DEWATS)
- **Mr. Baburam Shrestha** (Paid caretaker at Srikhandapur DEWATS)
- **Mr. Bharat Bdr. K. C.** (Biogas user, School Principal at Srikhandapur Local School)
- **Mrs. Narayani Shrestha** (Biogas user, Head of Household 01, Srikhandapur)
- **Mrs. Punya Devi Shrestha** (Biogas user, Head of Household 02, Srikhandapur)

Nala

- **Mr. Bishwanath Shrestha** (CIUD Engineer, Nala)
- **Miss. Sandhya Ranjitkar** (Member of Nala Users' Committee)

Tansen

- **Mr. Ramji Karki** (Engineer at Tansen Municipality)
- **Mrs. Shiv kumara Bashyal** (Head of household 01, Bhusal Danda)
- **Mrs. Bina Thapa Magar** (Head of household 02, Bhusal Danda)
- **Mrs. Laxmi Thapa Magar** (Head of household 03, Bhusal Danda)
- **Mrs. Rina Rana** (Head of household 04, Bhusal Danda)
- **Mrs. Devi Kala Nepali** (Head of household 05, Bhusal Danda)
- **Mr. Mukti Pd. Neupane** (President of Bhusal Danda Sewerage Management Committee 01)
- **Mr. Khadananda Neupane** (President of Bhusal Danda Sewerage Management Committee)
- **Mrs. Parvati Gautam** (Community Health Department Supervisor, UMN Hospital, Tansen)
- **Mr. Bhuwaneshwar Devicota** (Hospital Administrative Officer, UMN Hospital, Tansen)

Thank you

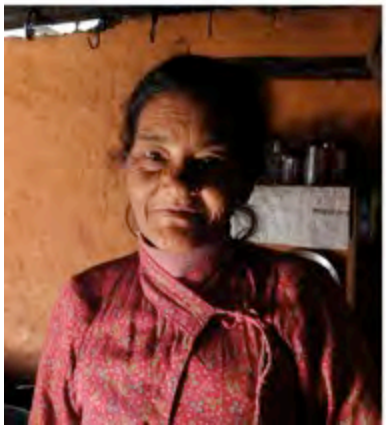
धन्यवाद

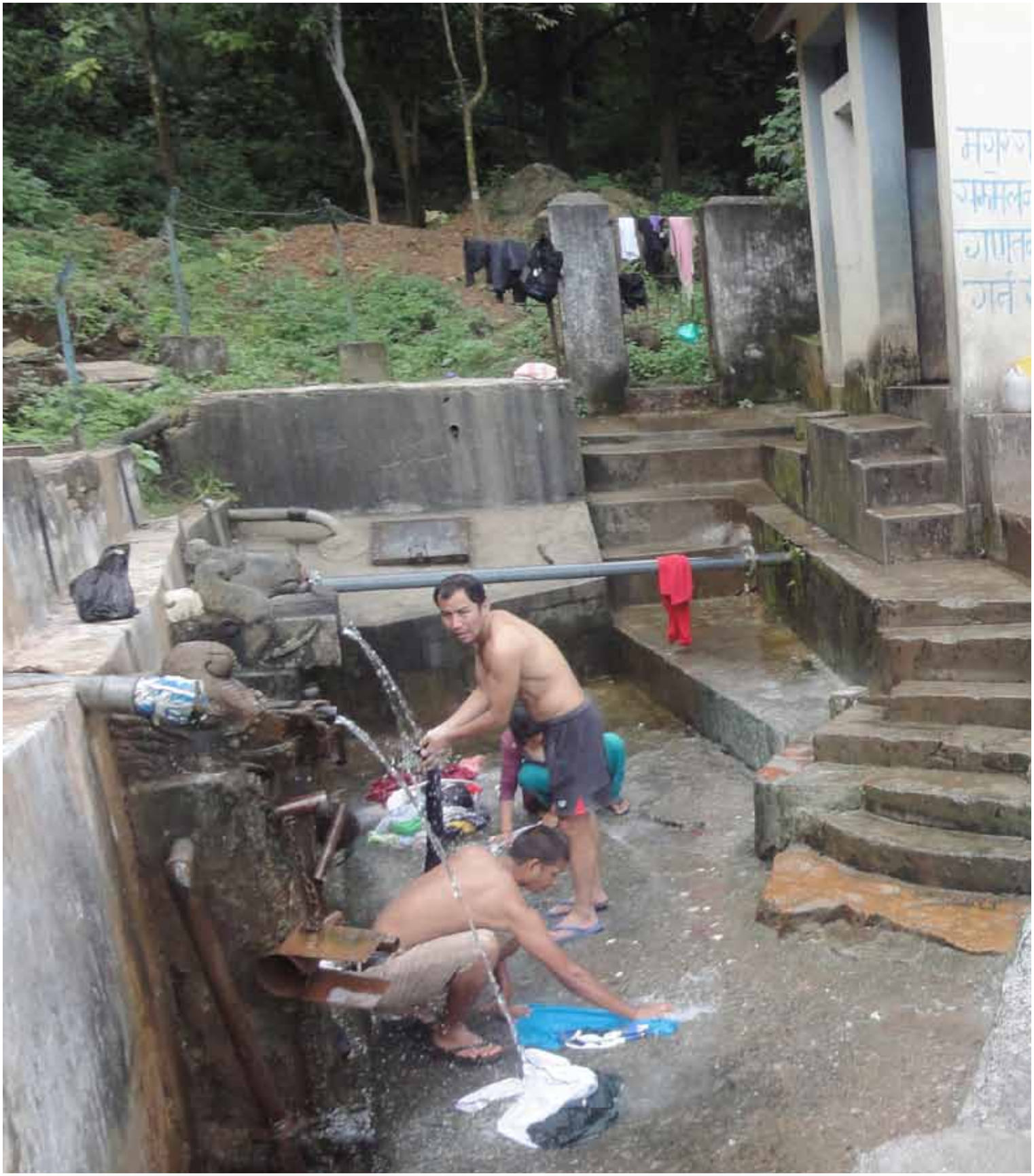










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