School of Forest Science and Resource Management

Technical University of Munich (TUM)

Master of Science in Sustainable Resource Management

A Master's thesis on:

Ecological sanitation efforts in Africa: Lessons learned and further recommendations for future project design

The case study of Valley View University in Accra – Ghana

Supervisors:

Dipl.Geogr.Sandra Fohlmeister

Chair for Strategic Landscape Planning & Management, TUM

Dr. Klaus Wagner

Chair for Forest and Environmental Policy, TUM

Elaborated by: Paul Nii Kwei-Mensah Okan-Adjetey (BSc)

18th May, 2012

TABLE OF CONTENTS

Acknowledgements

First and foremost I will like to give thanks to God for sailing me through this long and boisterous storm.

This thesis elaboration would not have been possible without my supervisors, I would like to express my sincere gratitude to my supervisors, Dipl. Sandra Fohlmeister and Dr. Klaus Wagner whose relentless support, advice, push and encouragement helped me carry on, many times when I got confused and felt I could never finish this thesis.

My abject gratitude goes to the Hans Seidel Foundation who sponsored my entire Masters Study program, making my stay in Germany possible, specific thanks to Dr. Michael Czepalla and Mrs. Monica Gerhard both of the Hans Seidel Foundation, who like parents were always apt to address my financial needs.

I would also like to thank all staff and members of the GIZ-Ecosan department. Dr. Elisabeth von Muench, project leader, who introduced me to the VVU project. Christian Rieck my internship supervisor at GIZ, who found the need for conducting such a thesis and was there in every possible way to support and help me finish this thesis. More thanks to Mr. Michael Gajo of the GIZ evaluation department who enlightened me on some of the important procedures for evaluation in Development Cooperation.

I wish to also acknowledge the efforts of my family in supporting me in completing this study. My sincere gratitude and abject appreciation goes to my parents Rev. Stephen M. Okan-Adjetey and Mrs. Evelyn Okan-Adjetey, Rev. Dr. G.O. Lartey, as well as all my siblings Cornelious, Mary, Ruth and Samuel for their prayers, words of encouragement and their thoughtfulness in meeting my every need in completing this study.

I would like to express my gratitude to all the stakeholders and project partners of this project who contributed their interviews to help build up this thesis study. Mr. Wolfgang Berger, whose project materials helped to kick off this thesis, Dr. Jorn Germer, Mr. Toni Mitterer, Mr. Solomon Addae, Mr. Patrick Arkoh, Mr. Emmanuel Kwandahor, Prof. Seth Laryea, Mr. Gunther Geller and Prof. Dr. Dr. Daniel Buor, current Vice Chancellor of VVU who gave me the green light to conduct such a study at VVU.

My credits finally go to Mehmet Can Guilersomez, Stephanie Holzwarth, Katharina Patzelt, Emmanuel Odei-Lartey, Ofori Odei-Lartey, Dietelinde Mueller, Verena Waldov, Natalie Ditschke, Veronica Obermeier and all those who have been very helpful to support me in finishing this Master's programme.

Executive summary

Water and sanitation problems in countries in transition especially in Africa cannot be overemphasized. Conventional methods of solving sanitation problems over the years are reported to have not been effective enough universally (UNESCO/IHP and GIZ, 2006: V). New "sustainable" and "smart" technologies such as Ecosan (a sanitation revolution concept which practices the simple recycling of waste to ensure safe reuse and return in the environment) possess practical and innovative solutions to meet the current problems being faced globally. Many aid agencies worldwide recognize this and are engaged in Ecosan projects around the world.

So far, aid interventions related to the Ecosan concept for countries in transition and so-called developing countries have mainly been executed through foreign aid and technical assistance. Hand-in-hand with these interventions, the debate remains whether foreign aid should continue to undertake and assist such efforts or not. Foreign aid projects in some cases have and are still making some impacts in helping alleviate the problem of water and sanitation worldwide on the one hand. On the other hand, clear evidence of significant impacts is still difficult to generate. Thus, there are arguments for and against the motion.

The advent of the Paris declaration of 2005 and the Accra Agenda for Action of 2008 nevertheless have steered aid efforts in a different direction, increasing the demand for evaluation to ensure aid effectiveness. There are growing concerns covering questions on how efforts can leave indeed "sustainable results" in the partner countries. One crucial way which has emerged and been adopted by many aid agencies in recent years is the RBM (Results Based Management) approach., seeking to "learn from evaluation results" and possessing potentials for serving as a guiding light to enhance sustainable results in ongoing and future projects.

Ghana like most developing countries worldwide has over the years been experiencing severe sanitation problems. Current national centralized sanitation solutions tend to fail due to administrative challenges, which demands alternative decentralized solutions like Ecological Sanitation (Ecosan) technologies.

The central purpose of the study was thus to contribute to research efforts for eradicating a clear evidence on the effectiveness of Ecosan aid interventions and to learn lessons for future project design. The focus was hereby set on Valley View University's "Development of ecological cycles" project in Accra, Ghana, which served as a case study for evaluation from an ex-post-perspective, two years after the project's ending. The evaluation consisted of a field visit to the study area over a one month period and comprised analyzing the activities of the project on an output, outcome and possible impact basis, adopting the RBM approach.

Key lessons identified are the need for locally generating building and maintenance materials for the establishment of ecological systems, the importance of a constant and continuous training of both users and managerial staff of Ecosan technologies, the mandatory incorporation of local stakeholder participation during all stages of a project's cycle as well as the consideration of local habits and socio-cultural beliefs of Ecosan project areas.

Keywords: Ecosan (Ecological Sanitation), Ghana, VVU, UDDTs, evaluation

List of Abbreviations and Acronyms

WWF-World Wide Fund
WTO-World Toilet Organization
WSUP- Water and Sanitation for the Urban Poor
WSP-Water and Sanitation Program
WSMP- Water and Sanitation Monitoring Platform
WHO - World Health Organization
VVU -Valley View University
USDA- United States Department of Agriculture
USAID- United States Agency for International Development
UNWATER-United Nations Water
UNICEF- United Nations International Children's Education Fund
UNFPA-United Nations Population Fund
UNESCO-United Nations Educational, Scientific and Cultural Organization
UNEP- United Nations Environmental Programme
UNDP- United Nations Development Programme
UHOH- University of Hohenheim
UDDTs-Urine Diversion Dehydration Toilets
UD- Urine Diversion Toilets
SuSanA- Sustainable Sanitation Alliance
SUDEA - Society for Urban Development in East Africa
SROI- Social Return on Investment
SIDA - Swedish international Development Cooperation Agency
SEI- Stockholm Environmental Institute
SANDEC- Sanitation in Developing Countries
RESPTA -Re-use of Ecological Sanitation Products in Tropical Agriculture
QCA- Qualitative Content Analysis
PPR- Project Progress Reviews
OECD- Organization for Economic Co-operation and Development
ODA- Official Development Assistance
NRCS- Natural Resources Conservation Service
NGO- Non Government Organization
MfDR- Managing for Development Results
MDGs- Millennium Development Goals
KVIP- Kumasi Ventilated Improved Pit-latrine
JMP- Joint Monitoring Programme
IWMI- International Water Management Institute
IUCN- International Union for Conservation of Nature
IÖV- Ecological Engineering Society
IIED- International Institute for Environment and Development
GTZ- German Technical Cooperation
GmbH- Limited Liability Company
GIZ- German Society for International Cooperation, Ltd
GAA Government Aid Agencies
FOE- Friends of the Earth
FAO- Food and Agriculture Organization
EES/IOEV- Ecological Engineering Society
ECOSAN/Ecosan-Ecological Sanitation
EAWAG- Swiss Federal Institute for Aquatic Science and Technology
DfID-Department for International Development
DC- Development Cooperation
DANIDA-Danish International Development Agency
CIM- Centre for International Migration and Development
CIDA-Canadian International Development Agency
CIA-Central Intelligence Agency
BUW- Bauhaus-University Weimar
BMU - Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
BMBF - German Federal Ministry of Research and Education
BioAbfV - Ordinance on Biowaste
BBG -Berger Biotechnik GmbH
BBC- British Broadcasting Cooperation
AU- African Union
AMA- Accra Metropolitan Assembly
AAA-Accra Agenda of Action

List of Tables

List of Figures

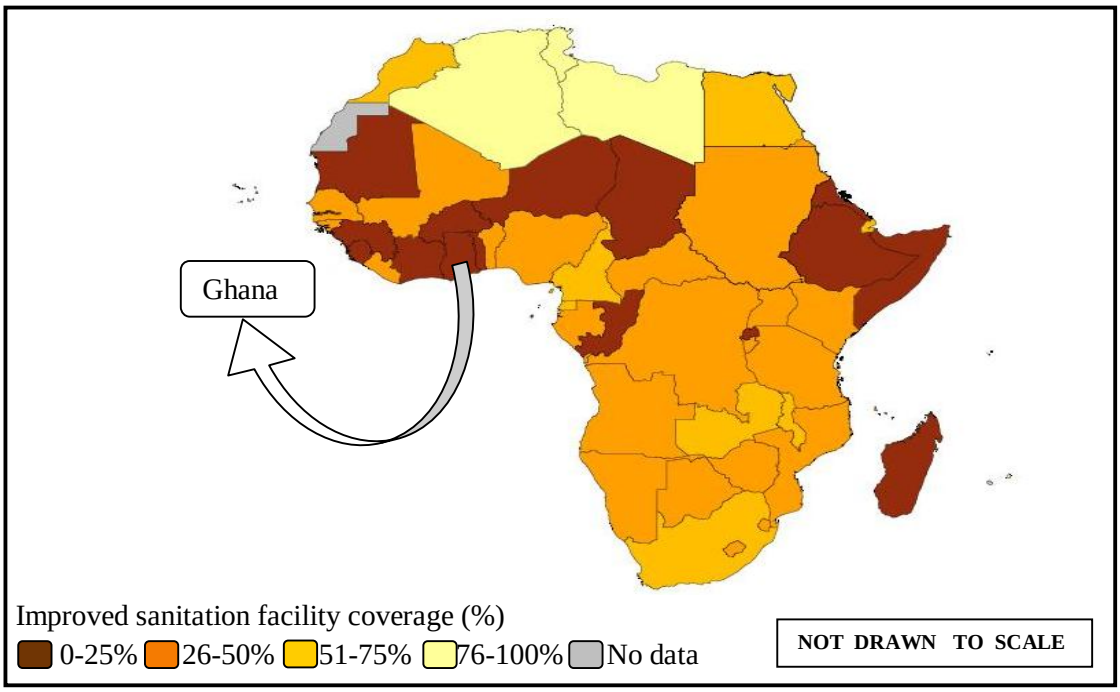
1. Introduction

1.1 Background

Water and sanitation go hand in hand, every human being must "respond to nature"[1] when it calls, whether it's a call for thirst or to do the "number one or two"[2]. The type of toilet or urinal system used in the latter is one of great importance as improper disposal especially of fecal matter (such as open defecation) affects the fore, creating conditions for life threatening infectious diseases such as cholera, typhoid fever, infectious hepatitis, polio, cryptosporidiosis and ascariasis. Developing countries are the worst afflicted since they have little or no access to adequate sustainable sanitation facilities. The WHO in 2004 estimated that 1.8 million people die yearly from diarrheal related diseases alone, sadly 90% of these dying people constitute children under the age of five (UNWATER, 2008: 2), the FAO in 2010 also estimated that 1 billion people, especially in low income countries have no access to basic health, water and sanitation services (FAO, 2010: 2).

As far back as 1981, Article 16 of the African Union's (Banjul) Charter of human and people's rights obliged states to provide basic services such as sanitation and safe drinking water. Under this charter, individuals in Africa in theory should have the right to enjoy the best attainable state of physical and mental health (AU, 1981: 5)[3]. This however, is not the case in the day-to-day life of Africans.25 years after the African Union's charter was established, 16 out of 54 countries in Africa still have a sanitation facilities' coverage of less than 25 percent. Ghana belongs to this cluster (see figure 1).

Figure 1: Coverage of African populations using an improved sanitation facility in 2006



Source: Own design based on WHO/UNICEF, 2008: 3

[1]A slang commonly used in Ghana when people have to use the toilet.
[2]Slang for defecation or urinating, "number one" refers to urinating, and" number two" refers to defecation. Taboo words as *feces* and *urine are* often coded in slang words for many cultures. See http://en.wiktionary.org/wiki/Appendix:English_toilet_slang[last accessed 14th October 2011].
[3]See http://www.africa-union.org/official_documents/treaties_%20conventions_%20protocols/banjul%20charter.pdf[last accessed 20th October 2011].

According to the WHO/UNICEF's Joint Monitoring Programme (JMP)[4] for the year 2006, out of Ghana's population of approximately 23 million, 18% used unimproved sanitation facilities [5]and another 20% resorted to open defecation (WHO/UNICEF, 2008: 21).

Even though global strategic interventions such as the Millennium Development Goals (MDGs) are underway and dedicated to halving the proportion of people without sustainable access to safe drinking water and basic sanitation by 2015 (UNDP, 2011)[6], the question still remains whether this can come to fruition. Some critics clearly estimate that the MDGs cannot be attained by the set target date of 2015, especially judging by the current pace of development. For instance, DFID (Department for International Development) is one with such a critical voice, estimating that both Asia and Africa will miss their sanitation-related targets by 2015 (SEI, 2008: 2). As crucial as this is, feces and urine have still not been very popular discussions when development efforts on water and sanitation are concerned. According to Jack Sim of the World Toilet Organization (WTO),*"Sanitation and hygiene are the cheapest and most effective preventive medicines for the poor"*, however, *"most of the time, sanitation sits in the shadow of her more glamorous sister, water"* (BBC, 2011).[7]

Closely related to the problem of sanitation as mentioned above is that in Africa there is a great stress on the freshwater resources available for people. According to WWF, 14 countries in Africa are already experiencing water stress, and another 11 are expected to add up by 2025. The impact of this problem is that half of Africa's population will face water scarcity by 2025.Out of 1.45 billion people nearly 51%, which is approximately 700 million, reside again in Sub-Saharan Africa where there is a severe lack of access to the supply of safe water and adequate sanitation (WWF, 2002: 1).

"*Africa's rate of urbanization of 3.5 percent per year is the highest in the world*" (UNEP, 2011)[8], the resultant effect of which is a peak in the population especially for urban areas. Accompanying this soaring population is a natural expansion of existing urban built up areas (UNEP, 2011) which will require hygienic sanitation facilities. Ghana, which is no exception to this high rate of urbanization in Africa, has an urbanization rate of 3.4 percent per year (CIA, 2010), almost the same as that of the African continent's. Consequently, the water and sanitation issues directly affect residents in fast growing cities such as Accra. The pace of urbanization is resulting in stress on the existing sanitation facilities, the carrying capacity of which is rapidly exceeded. The AMA (Accra Metropolitan Assembly), whose main responsibility is to ensure effective management of the city lacks suitable strategies to handle the city's sanitation problems (Tsiboe et al., 2004: 7). A more current expression of the problem was the outbreak of cholera in the city of Accra in September 2010, which claimed the lives of about 64 people (GhanaWeb, 2011)[9].

1.2 Problem statement

To address the current water and sanitation problems facing the city of Accra, effective and proactive measures and interventions are needed. The closed loop concept of ecological sanitation (Ecosan) is one of such proactive methods which might play a critical role in helping address the given challenges in the context of water, sanitation and waste treatment in urban areas of many African cities. The government of Ghana, in collaboration with many international bi-lateral and multi-lateral development partners and local and international NGOs such as World Bank, World Health Organization (WHO),United Nations Children's Fund (UNICEF),Canadian International Development Agency (CIDA), Danish International

[4] JMP stands for Joint Monitoring Program and is the WHO/UNICEF's official UN mechanism charged with monitoring progress towards the MDGs (Millennium Development Goals).
[5] An improved sanitation facility is defined as one that hygienically separates human excreta from human contact (see page 4 *of Snapshot of Sanitation in Africa*) by WHO/UNICEF.
[6] As stated in http://www.undp.org/mdg/goal7.shtml [last accessed 13th October 2011]
[7] As stated in http://www.bbc.co.uk/news/business-13742217 [last accessed 13th October 2011]
[8] As stated in http://www.unep.org/dewa/africa/publications/aeo-1/203.htm [last accessed 10th April 2011]
[9] For more information, see http://www.ghanaweb.com/GhanaHomePage/NewsArchive/artikel.php?ID=205713 [last accessed on 20th April 2011]

Development Agency (DANIDA), Department for International Development (DfID), United States Agency for International Development (USAID), PLAN, WaterAid ,Water in Africa (W.A.T.E.R), and World Vision (WSMP, 2010: 1,2)[10]have initiated different projects to curtail the problem of water and sanitation in the country, and it is against this background that the BMBF (German Federal Ministry of Research and Education) supported a pilot project at Valley View University (VVU) in Accra from 2003 to 2009, focusing on the application of ecological sanitation (Ecosan) technologies such as water saving flush toilets, urine diversion flush toilets and UDDTs (Urine Diversion Dehydration Toilets). Whether or not such "*new paradigm efforts in sanitation*" (GTZ-ECOSAN, 2009: 01)[11] might in fact play a critical role in helping address the problem of water and sanitation in African cities remains to be proved.

Indeed, many governments and agencies in Africa are exploring the role of ecological sanitation, within their environmental sanitation and hygiene improvement programs. However, despite convincing environmental and economic reasons to support this approach, acceptance of the technology has been very limited so far (WSP, 2005: 02)[12]. Apparently, there is a gap between International Development Cooperation interventions on the one hand and local ownership or acceptance of the efforts undertaken on the other hand.

Among these numerous Ecosan interventions, the research project "Ecological development at Valley View University in Accra, Ghana" was supported by the German Federal Ministry of Research and Education (BMBF) from 2003 till 2009.Partners of this joint venture were the Valley View University (VVU) in Accra, the University of Hohenheim (agriculture), Palutec (grey water treatment and storm water harvesting), Berger Biotechnik (water saving and waterless sanitation) and the Ecological Engineering Society (EES/IOEV) as project leader[13]. The introduction of Ecosan technologies intended to support the VVU to cope with the effects of the forecasted increasing number of students, which was 1200 at the start of the project in 2003 and projected to be 10,000 by 2015. The focus of the project was thus to effectively and efficiently save water by making use of all water and nutrient inputs to support agriculture as a central and sustainable element in the closed loop recycling management, given the scarcity of water on the campus (Berger et al., 2008).

1.3 Thesis objectives and research questions

Although the theoretical aspects of the Ecosan concept have been sufficiently researched in the last decade, it still remains an open question to which extent the efforts are really successful on the ground. Interesting for implementing DC agencies are e.g. topics such as the acceptance of individual Ecosan technologies by the users, current advantages and challenges and answers to the question whether UDDTs are utilized correctly or not after a project's ending[14]. Understanding and identifying such attributes is essential in the future development of the Ecosan technologies and their corresponding international aid interventions, to facilitate better user satisfaction and adaptation in developing countries. The focus of this master's thesis is thus laid on the exploration of the Ecosan technologies' utilization and functioning at Valley View University in Accra-Ghana by executing an ex-post-evaluation of the project, two years after its completion in 2009.

[10]WSMP stands for Water and Sanitation Monitoring Platform, see :http://www.wsmp.org/downloads/4d4bce9d3227c.pdf(accessed 27thNovember 2011)
[11] As stated in first paragraph, GTZ-Ecosan topic sheet (Division environment and Infrastructure) see;http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=99 (accessed 4th May 2011)
[12]Taken from report of WSP (Water and Sanitation Program) of the World Bank. See from:http://www.susana.org/docs_ccbk/susana_download/2-295-jackson-2005-ecosan-experience-in-eastern-southern-africa-wspes.pdf (last accessed on 4th May 2011)
[13]See chapter 4.1 case study description
[14]Based on e-mail correspondence with Ecosan department of GIZ (March 17, 2011).

In order to reach this study's goal, the specific research questions of the thesis have been defined as follows:

1. What is the overall status-quo of the VVU Ecosan project today (focus: water and sanitation and agriculture and connected managerial aspects) in comparison to the intended aims at the project's start and final set-up stage of 2009?

2. To which extent are the Ecosan technologies (focus: UDDT units) used today?

3. Which barriers related to the use of Ecosan technologies can be identified from the perspective of the involved stakeholders?

4. Which success factors and lessons learned concerning the project design, set-up, implementation and follow-up can be derived from the observations done?

The thesis' study borders shall hereby be clearly set on the ecological water and sanitation aspects of the research project "Ecological development at Valley View University in Accra, Ghana". It spotlights the urine and toilet systems' effectiveness in generating fertilizer for application in agriculture on the University campus.

1.4 Organization of the study

The thesis is organized into seven chapters. The first chapter encompasses the background and justification of the study, introducing the reader to the subject matter of sanitation in Africa as well as the research gap that exists while outlining why there is the need to carry on such research.

The second chapter provides the reader with the theoretical background of the concept of ecological sanitation efforts worldwide, in Africa, and especially the case study country of Ghana. It also justifies why evaluation has become this meaningful in recent International Development Cooperation.

The third chapter presents the research methodology used in the study. It especially highlights the single steps of the evaluation approach selected for this thesis.

Chapter four makes the reader familiar with the case study area, giving a sound introduction to the project's location, its development and current state of the art.

Chapter five forms the core part of the study, presenting the results obtained from the data analysis of this thesis and evaluation of the VVU project. It contains a thorough content analysis of the identified overarching project objectives related to the study's borders (water and sanitation & agriculture as well as connected managerial aspects) against the background of their respective outcomes which have been derived in the framework of local empirical surveys undertaken in Ghana in August/September 2011.

Chapter six encompasses a discussion of the results of the study, based on the hypothesis and research questions developed from the introduction. It extracts the findings from the study, outlining the lessons, challenges and successes encountered in the project in comparison to reports and other project documentation. Further discussion in this chapter is centered on the methodology applied by the author in the study, identifying shortfalls and making recommendations for future researchers who want to carry out similar studies.

Finally, chapter seven presents the conclusions drawn by the author, answering the research questions formulated for this study. At the same time it proposes tangible recommendations in order to contribute to the further evolution of Ecosan projects in Africa and beyond.

2. Ecological sanitation as an issue of development cooperation

2.1 General background of Ecological Sanitation (Ecosan)

Early traits of Ecological sanitation

As far back as 1973 and 1989 respectively, the emerging practice of using wastewater and excreta in agriculture and aquaculture led the World Health Organization (WHO) to produce publications on the re-use of effluents: *Methods of wastewater treatment and public health safeguards (1973)* and *Health guidelines for the use of wastewater in agriculture and aquaculture (1989).* The aim was to provide a guiding framework on how to protect public health and at the same time facilitate a rational utilization of these "emerging resources" at the time (WHO, 2006: VII).

History of Ecological Sanitation (ECOSAN)

The idea of Ecological sanitation (Ecosan) goes back to 1994 when the Society for Urban Development in East Africa (SUDEA) submitted a sanitation proposal to the Swedish International Development Agency SIDA for a sanitation project in Ethiopia. The project was named ECOSAN, short for Economy, Ecology and Sanitation. The project proposal was based on the utilization of urine as fertilizer, which initially provoked many criticisms and discussions between SUDEA and SIDA. However, based on evidence provided to justify the claims, both parties finally agreed and later accepted the concept (Almaz and Gunder, 2007: 1).

The Concept of Ecosan

The core philosophy behind Ecosan closed loop systems as the name implies, consists of closing the natural nutrient and water cycle loop. Conventional toilet systems such as WCs (Water Closets) flush away essential plant nutrients like nitrogen, phosphorus[15] and potassium in the form of mixed fecal matter, water and urine which mostly end up in landfill sites. The main rational behind the concept of Ecosan closed loop systems is to promote "*ecologically and economically sustainable wastewater management systems tailored to local needs*" (GTZ, 2004; 27-28), thereby intending to recycle these natural nutrients and water which are usually lost.

The recuperation of these essential nutrients contained in human excrements and wastewater, can be used in agriculture. By doing this, the fertiliser used facilitates the improvement of soil fertility and food security, at the same time reducing the consumption and pollution of water resources. What is more, renewable energies can also be derived from the biogas systems as part of the concept. "*Ecosan does not equate to a specific technology, but is rather a way of thinking*" (GTZ-ECOSAN, 2009)[16]. Depending on the local given situation, it incorporates different technologies such as urine-diversion dehydration (UDDTs) toilets, composting, rainwater harvesting, constructed wetlands, vacuum sewers, biogas reactors and many more (GTZ-ECOSAN, 2009).

Currently existing Ecosan technologies

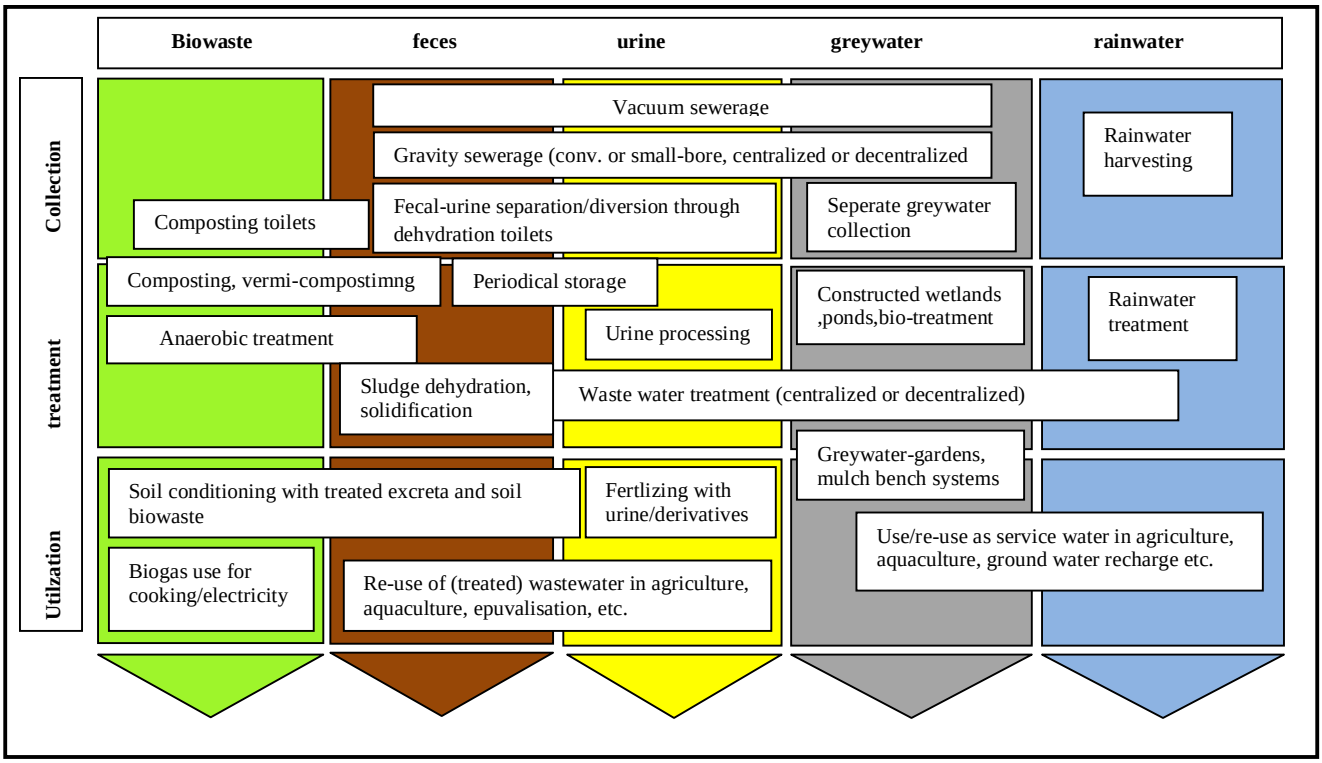
Ecosan technologies can be seen to revolve among five main crosscutting facets; biowaste, feces, urine, greywater and rainwater and usually represented by light green, brown, yellow, grey and light blue respectively (see figure 2)[17]. To allow for closing the Ecosan nutrient loop, all five facets need to go through some form of collection and treatment before final utilization.

[15] This could be a viable option for solving the world's "peak phosphorus" problem, see: http://en.wikipedia.org/wiki/Peak_phosphorus [last accessed 5th May 2011)

[16] See GTZ-Ecosan topic sheet for more info;http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=99

[17] See http://en.wikipedia.org/wiki/Ecological_sanitation [last accessed 21st April,2012]

Figure 2: Range of technologies of Ecosan systems



Source: Own design based on GTZ, 2008: 4

Biowaste- In the context of Ecosan and based on the European Commission's (2011: 11) classification, it can be defined as waste mainly in the form of biomass[18] generated either commercially or from households, usually decomposed aerobically/anaerobically for further re-use. Commercial sources for collection include agricultural residues, animal waste and manure, sewage sludge and commercial food waste. From households, they include kitchen scraps and garden waste, paper and cardboard, as well as natural textiles (FOE[19], 2004: 2; EC, 2011: 3). Treatment strategies for biowaste involve composting or co-composting for further utilization as fertilizer in Agriculture. Biowaste can also be treated anaerobically in biogas digesters, or combined with feces together as substrates for the generation of methane gas for cooking or alternatively electricity production (EcoSan-Club, 2011: 5; GTZ[20], 2005: 1).

Feces and urine- Collection procedures of human fecal matter and urine in Ecosan are through a number of technologies. For urine, waterless (dry) and Vacuum[21] urinals and for feces, separation toilets such as UDDTs, UDs (Urine Diversion), Aborloos[22], Vacuum toilets, Water Saving Separation Flush Toilets (WSSFTs)[23], pour flush toilets, squatting pans and "PeePoo toilets"(biodegradable usually used in emergency situations), to mention a few. Water Saving Separation Flush Toilets are usually not favored as they demand the use of water and are much more expensive than conventional Water Closet (WC)

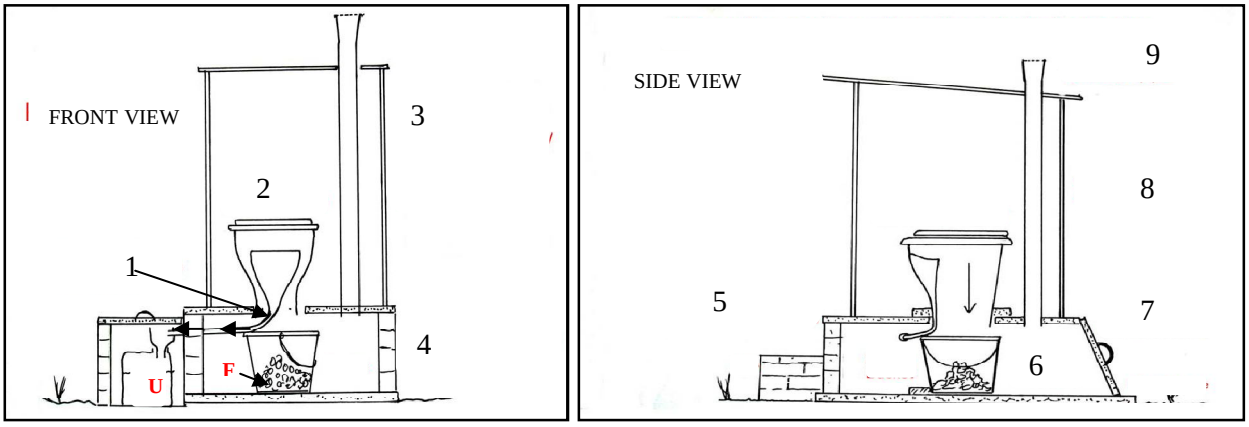
[18] Biological material derived from living or recently living organisms. see http://www.biomassenergycentre.org.uk/portal/page?_pageid=76,15049&_dad=portal [last accessed 20th April 2012]
[19] See http://www.foe.co.uk/resource/briefings/biowaste_guide.pdf [last accessed 20th April 2012]
[20] See http://www.gtz.de/en/dokumente/en-ecosan-pds-006-germany-waldmichelbacherhof-2005.pdf [last accessed 20th April 2012]
[21] Vacuum sewerage technologies http://www.netssaftutorial.com/fileadmin/DATA_CD/04_Step4/Vacuum_technology__vacuum_sanitary_installations.pdf [last accessed 20th April 2012]
[22] An ecological dry toilet system whose utilization ends with the planting of a tree see http://www.ecosanres.org/pdf_files/PM_Report/Appendix1_The_Arborloo_book_a.pdf [last accessed 20th April 2012]
[23] Implied Acronym from the author as identified from VVU project case study.

toilets, even though minimal and more environmentally and economically profitable in comparism to conventional WCs.

UDDTs

The much favored and promoted toilet facility is the dry toilet technology (Germer et al., 2009: 185) such as UDDTs (see figure 3). The mechanism usually employed for most ecological toilets such as the UDDTs is to allow for source separation of urine from fecal matter. Source separation (from the front view), starts from a urine diverting toilet pedestal (2), in use, urine (U) diverts to a collection tank or gallon with the help of a urine pipe via a funnel (1), and feces (F) into a collection medium with gravity (for e.g bucket) right under the toilet pedestal. To facilitate treatment, absorbents such as soil, ash or sawdust are sprinkled on the feces right after use and for later composting in nearby compost sites. From the side view, a concrete slab and base supports the UDDT unit, elevating it off the ground so a step is required, a vault (6) houses the collection medium, shutting it away from flies with the help of a rear volt cover (7).The toilet superstructure (8) is usually made from wood or bricks depending on the local given situation and a ventilation pipe (9) is connected directly to the vault to allow heat to escape and also eliminate smell.

Figure 3: Working principle of Urine Diverting Dehydration Toilets (UDDT)



Source: Modified illustration after Morgan and SEI, 2004: 11.3

Usually, urine is treated through storage and used as liquid fertilizer and the fecal matter is allowed to dehydrate for further composting with the help of solar heat. Dehydration of fecal matter in UDDTs is very essential, as it seeks to evaporate or dry out the fecal matter to reduce the moisture content, urine or water should not be added to the pre-compost mixture. Desiccation[24] process becomes faster when combined with preferably high solar heat (temperature), natural evaporation, ventilation and the addition of "absorbents".

According to Germer (2011: 195), the health condition of users plus a number of influencing factors control the presence of "disease producing agents"/pathogens in a compost mixture"[25], other factors like humidity, temperature and "absorbents" (WHO, 2006: 83) like toilet paper, ash and woodchips also play a role in determining the presence of pathogens/"disease producing agents". Environmental conditions, management and the design of the toilet facility affect the presence of humidity and temperature in the "pre-faecal compost mixture". Usually UDDTs are built with chambers found protruding under the toilets

[24] Preserve by removing all water and liquids

[25]"Pre-faecal compost mixture": for the case of this study refers to faecal matter yet to be used as compost. In the case of the BBTs in VVU Sawdust was used as the absorbent to produce a sawdust/faecal matter mixture later taken to the composting sites for further composting and use as fertilizer.

superstructure; this allows easy access, increases air temperature, exposes the chamber to solar radiation and enhances the flow of air (Germer, 2011: 195).

Greywater-The main sources of greywater collection is from bathrooms, kitchens and laundry. Under the Ecosan concept, greywater is separated from fecal matter to prevent any adverse environmental problems (Ridderstolpe-EcoSanRes, 2004: IV). In the absence of a centralized greywater treatment facility, some technologies employed in Ecosan for the decentralized treatment of greywater mainly involve detention and infiltration through constructed wetlands and ponds with biological treatment using plants. Depending on the given situation, whether centralized or decentralized, pollutants are extracted from greywater to render it safe for the environment and facilitate groundwater recharge (EcoSan-Club, 2009: 26; GIZ, 2011: 12). According to the USDA-NRCS, (1995: 8) "Wetlands are transitional areas between land and water", and the main components include a water basin, substrates and vascular plants[26]. Ponds include DTS (Decentralized Treatment Systems) or DEWATs (Decentralized Wastewater Treatment Systems) that make use of natural local terrains such as gravity, local temperature and surrounding microbiological activity for greywater treatment. The main difference between ponds and wetlands is the "surface area to volume ratio and water level fluctuation" (Wong et al., 1999, 1).

Rainwater harvesting- Rainwater is usually harvested through roofs of buildings through the installation of rainwater receiving gutters, firsthand treatment is usually by percolation with the use of sieves, channeling it to a storage tank to be later used for cleaning, hand washing or for further irrigation in agriculture. Rainwater harvesting is usually encouraged for most Ecosan toilet building designs, especially for rural communities with no access to regular source of water to guarantee the safe washing of hands to promote good hygiene. In some cases, rainwater treatment is done by recycled filtration, pressurized filtration and advanced filtration by activated carbons which render the rainwater hygienic for drinking (Hao et al., 2010: 281).

Ecological sanitation efforts worldwide

Since 1985, approximately 313 projects[27] based on the concept of Ecosan have been implemented for about 2,810,000 users worldwide (GIZ, 2011). These projects have mainly been carried out by GOs, NGOs, International bi-lateral and multi-lateral development organizations, for many regions of the world in Sub-Saharan Africa, Middle east and North Africa, Asia and the pacific, Europe, Caucasus and central Asia, Australia, Latin America and the Caribbean's and North America. Several projects exist ranging from the establishment of simple innovative UDDT toilet systems, biogas and DEWATS, constructed wetlands, composting systems, fecal sludge management systems, flush toilets (with/without urine diversion), Urine diversion dehydration toilets (UDDTs) and other treatment systems (SuSana, 2012)[28].

Depending on the given situation Ecosan technologies can be employed, for e.g in emergency situations such as the earthquakes in Haiti, UDDTs and "PeePoo toilets" were installed by Oxfam GB to cater for the victims of the disaster, who expressed acceptance in comparism to the alternative pit latrine toilet facilities installed (SuSana, 2011: 1).

Based on GIZ's (2011) worldwide project list, India currently ranks highest in the total number of Ecosan projects, a wide variety of Ecosan projects ranging from the provision of UDDT toilets for households, schools and communities, the reuse of fecal compost in agriculture, the testing of Ecosan toilets for Indian trains, decentralized wastewater treatment and reuse systems and biogas digester systems. In China, in an

[26] Vascular plants are good conductors of water and minerals see http://www.wisegeek.com/what-are-vascular-plants.htm [last accessed 21st April, 2012]
[27] Small research projects not included in the approximation, see http://www.gtz.de/en/dokumente/giz2011-en-worldwide-ecosan-project-list.pdf [last accessed 21st April, 2012]
[28] See http://www.susana.org/lang-en/case-studies?showby=yeardesc&vbls=2&vbl_2=9&vbl_0=0 [last accessed 21st April, 2012]

attempt to combat the increasing energy demand and prevent the logging of wood for energy purposes, national scale programs were established, supported by the Ministry of agriculture since the 1970s, under a "Biogas for every household" program (Balasubramaniyam et al., 2008, cited in SuSana, 2011: 5). There are also positive reports of increased agricultural productivity and economic situation of urban gardeners in the Philippines, who have been using the compost generated from UDDTs for gardening purposes (GIZ, 2009: 2).

In Europe, Germany ranks second with Ecosan projects' mainly involving vacuum toilets and biogas plants, wastewater treatment and reuse systems for national parks, greywater recycling, constructed wetlands and Composting toilets. Historical "Ecosan" practices involving the use of composting toilets and grey water treatment, far back as 1980 and 1986 were established in family houses of Germany (Berger, 2008: 1). In 2006, a urine-diverting sanitation system was established at the GIZ headquarters' in Eschborn to mainly prove the workability of Ecosan systems in urban areas (GIZ, 2009: 2). Other small scale projects mainly involving the use of UDDTs and greywater treatment systems in mountain huts, game reserves and community toilets are currently being practiced in countries in Eurasia such as Austria, Sweden, Azerbaijan, Belarus, Denmark, Kazakhstan, Romania etc (GIZ, 2011). According to Berger, (2008: 4) , there is also the need for more projects with composting toilets in the "so called developed countries" to boost up scaling of the technology by research institutes and authorities before further transferring the technology to developing countries.

In Latin American countries such as Peru, Bolivia, Mexico and El-Salvador a number of Ecosan technologies exist for small households and large communities, ranging from simple innovative UDDT toilet systems to biogas digesters, public sanitary facilities as well as greywater treatment plants (GIZ, 2011).

Africa-Quite a number of Ecosan projects have lately been implemented in Africa by different aid agencies like GIZ, IUCN, CREPA, SANDEC, SUDEA, IWMI and EAWAG etc. According to Cross and Salifu (2002: 1), for projects in Africa to meet the much needed impacts, a different approach in the form of long-term up-scaled programs needs to be adopted other than pilots and short-term interventions. They further outline two key challenges facing Ecosan promotion in Africa: the first is on the sensitization at regional and country levels, of issues concerning the safe-guarding of resources and the protection of the environment which constitutes the main justification for Ecosan, and the second includes the evolution from technology promotion. Concerning the latter, Cross and Salifu (2002: 1), outline seven crucial recommendations for the promotion of sanitation in Africa from lessons gathered over the last two decades; 1. Marketing sanitation should not only be based on health drivers, 2.Sanitation solutions should not be on "predetermined standards" but around target prices as households willingness to pay for technologies they recognize is based on direct impacts. 3. Subsidization can do both harm and good and that subsidies should be on promotion rather than production. 4. The focus of sanitation should be attached more to the business side because there are target markets and great potential for creating livelihoods, and rather not on a supply driven approach since they don't work.5. Simplicity as complex sanitation plans don't work due to the low capacity at local levels.6. A more integrated approach of upgrading and city-wide linkages facilitated by evidence and benefits from the evolution of sanitation trunk infrastructure[29] investments involving communities and households' and 7. The judgment of sanitation results should be on a longer term and demand increase in sanitation is dependent on the facilitation of change in people's current lifestyle.

In spite of many barriers and challenges, the implementation of Ecosan projects is still ongoing, with a number of up-scaling efforts currently being made. In Sub-Saharan Africa alone, a number of Ecosan

[29] "The 'higher order' or 'shared' development infrastructure required to ensure the healthy and safe functioning of the uses it is servicing. Trunk infrastructure's primary purpose is to service 'catchment' areas with a number of users or developments, rather than servicing individual developments or users" taken from http://lgam.wikidot.com/trunk-infrastructure [last accessed 6th May 2012]

projects have been or are currently being undertaken in countries like Ghana, Botswana, Burkina Faso, Chad, Kenya, South Africa etc. The dominant technologies employed include UDDTs for entire rural and urban communities, households, schools, health centers' and in some cases even refugee camps (SuSana, 2011).

For example, in 2002 CREPA commenced a project meant to cater for up to seven different West African Countries, which included Benin, Burkina Faso, Côte d'Ivoire, Guinea, Mali, Senegal and Togo. The aim was to improve sanitation and the production of food. Positive results could be realized in the form of higher yields and extended harvest periods, on the use of urine for the fertilization of crops by the farmers (Dagerskog et al., 2008: 41, 42). In Senegal, some schools report that the Ecosan technologies provided were able to generate revenue which was used in the restoration of school infrastructure. The benefits of Ecosan technologies were realized locally to the extent that the Senegalese government incorporated its use in its policies for solving water and sanitation problems in the country. Nevertheless, some cultural beliefs exist that could potentially hinder local acceptance (Camara, 2009: 1, 3).

Essential for the functioning of UDDTs is the separation of urine from fecal matter. According to Morgan and SEI (2004: 11.1), "There must be no malfunction of the urine diverting pedestal. In other words, urine must always go down the front and feces down the back. If there is an error made in this use, the system can malfunction badly". Local sustainability and acceptance of UDDTs has close ties to the low cost needed to construct and maintain UDDTs. Growing experience worldwide demonstrate that local innovation is key and helpful in serving to sustain constructed UDDTs, as future maintenance will depend on how readily available construction materials can be accessed.

Further key aspects are a careful and proper use, operation and maintenance, feces composting and urine storage for treatment, before final application. There are other methods of treating dry toilet fecal matter, however composting forms "the only way to transform human waste into earth" (Berger, 2008: 4), and conforms better to the climate conditions in humid climates. Unlike composting with plants and animal matter, human fecal matter for composting has to be treated before its use in agriculture, as potential health risks may arise if proper handling and management of the faecal matter and dry toilet facilities are not properly taken into consideration (Morgan and SEI, 2004: 6.1). According to Smith (2011: 15), during composting, organic matter is broken down into smaller components which form humus and help in the fertilization of plants and the "amendment" of soil. Compost is usually made from decomposed plants and animal matter. "Surface spread raw compost does not heat in the soil (even though it may release large quantities of energy), on the other hand, a stable compost, if placed in a large-enough pile, can heat up considerably (Parnes, 1989: cited in Brinton et.al, Unknown: 2).

Ecological sanitation efforts in Ghana

Even though the concept of Ecosan has been on the continent for over a decade, actual realization of Ecosan projects and the use of its technologies in Ghana appear not to have taken place until recent years. It has, however, been reported of some farmers engaging in the use of human fecal matter for agriculture purposes in the Northern part of Ghana and some studies have been conducted to that respect (Cofie et al., 2004: 1). According to Thrift (2007: V), Ghana offers promising prospects for the implementation of Ecological Sanitation technologies especially for fecal composts, due to an existing ready competitive market for the buying and selling of fecal sludge in several of its districts. Moreover, what makes it an even more viable situation is the existence of quite a number of private-sector involvements in the sanitation provision. Other actors, apart from the private sector, include Governments and civil society and sanitation policies seem rather well developed. Unfortunately, in spite of these positive conditions, the implementation side of sanitation is nowadays still inadequate as previously mentioned in the first chapter[30].

[30] See chapter 1: 2

According to Keraita et al., (Unknown: 2), in many of the urban cities in Ghana and its surrounding environs, agricultural production of perishable crops over the years has taken the centre stage of farming, with urban farmers making use of any available empty space they come across. Farmers in the urban areas of Ghana grow vegetables in the dry season with their major source of irrigation being streams and dug out wells which have been polluted with fecal matter due to the bad sanitation practices and insufficient sanitation infrastructure in the cities (Cornish and Kielen, 2004; Keraita et al., 2003; Keraita and Drechsel, 2004, cited in Keraita et al., Unknown: 2). In the wet season when rain is abundant they plant mainly cereals such as maize. The urban farmers in theory do not have the freedom to operate with greywater as there are bylaws not properly enforced, that prohibit the re-use of wastewater for irrigation (Keraita et al., Unknown: 2).

So far, it seems the only well known Ecosan project undertaken in Ghana include the "Ecological cycle Development" project at Valley View University, co-financed by the University and the German Federal Government from 2002 till 2009 which forms the subject of this thesis study. The second is a pilot scale co-composting fecal sludge and organic solid waste project in Kumasi, currently not in operation. Besides, some smaller pilot projects are underway also known as the Ghanasan[31] which adopted Ecosan toilet technologies using a so called "Uniloo" (urine diversion toilet) in Kumasi- Ghana. The project was collaboration between IDEO, Unilever and Water and Sanitation for the Urban Poor (WSUP).

2.2 Evaluation in International Development Cooperation (DC)

According to UNESCO (2007: 5), "evaluation is the systematic and objective assessment of an activity, project, program, strategy, policy, topic, theme, sector, operational area or institution". Usually four main kinds of evaluations exist depending on the timing in a project lifespan (UNDP, 2009: 137). The first is an *ex ante* evaluation which constitutes a continuous practice aimed at preparing the way for a "new or renewed" (UNFPA, 2004: 5) development measure, essentially to gather information and examine it to assist in the formation of feasible objectives which can be evaluated in the future(UNFPA, 2004: 5).

The second is a formative evaluation, which is meant to assess preliminary or running project activities. The third is a summative evaluation, which assesses the results of a fully completed project (Westat, 2002: 7), and the fourth is an ex-post evaluation that can be seen as a kind of evaluation, whose central purpose is to assess the sustainability of results in the form of outcome and impacts, as well as ascertaining the driving forces that led to the project's success or failure, to allow for lessons which can be applied in further related future project design (UNFPA, 2004: 5).

In a formative evaluation, the aim is to justify or fine-tune new or ongoing project activities and summative is to appraise an implemented project for its quality and impact (Westat, 2002: 7) [32].On the other hand an ex ante evaluation is usually conducted prior to the beginning of a project or development measure whilst an ex-post evaluation is conducted after a project's completion (ODA, 2009: 1, 2).

Why evaluation in development cooperation

The main aim of evaluation is to provide a trusted and reliable basis of justifying the results of a development endeavor, which helps in the learning of lessons that in turn facilitate the quality of up-scaling efforts. There has been a paradigm shift in DC worldwide over the last decade, mainly due to the Paris Declaration of 2005 and the Accra Agenda of Action (AAA) of 2008 (OECD, 2010: 1). Evaluation has taken a central driving seat to hold all development partners mutually accountable for development

[31] See http://ghanasan.files.wordpress.com/2011/05/ghanasan_publicshare.pdf [last accessed 27th April , 2012]

[32] According to evaluation theorist Bob Stake (cited in Westat, 2002: 08) evaluation types are synonymous to tasting of soup by a soups cook and guests, "When the cook tastes the soup, that's formative; When the guests taste the soup, that's summative."

efforts (OECD, 2010: 1). This move was geared at helping accelerate efforts in achieving the Millennium Development Goals whose attainment currently seems rather bleak.

On this background, several debates about the topic of aid effectiveness have emerged over the years with some authors referring to it as a "single resource" (Bourguignon and Sundberg, unknown: 1) for development and questioning the basis of whether more and more aid to developing countries generates the needed outcomes. Some authors have argued that aid has no correlation especially to the development of countries in Africa (Easterly 2006, cited in Bourguignon and Sundberg, unknown: 2), and others argue that the development situation without aid would have worsened the current state in Africa (Collier 2006, cited in Bourguignon and Sundberg, unknown: 2).

More and more, the need for evaluation in DC projects has gained a key position with donor countries wanting to have transparent accountability and a real worth for the aid being given their partner countries (UNDP, 2009: III). Whether in the form of material or financial aid, there is the need to ensure measures that will "unlock the full potential of aid in achieving lasting development results" (AAA, 2008: 1). In a bid to conform to the agreed principles of the AAA and the Paris declaration, different NGOs, GOs, multi and bi-lateral organizations have adopted diverse strategies for monitoring and evaluating their projects worldwide. Some of these organizations include the GIZ, CIDA and UNDP who have developed guidelines for results-based monitoring and evaluation. According to the UNDP (2009: 127), the main aim of conducting evaluations at the UNDP is to generate transparent information which will assist in informed planning and strategic decision making process to facilitate effective human development. According to the UNDP, "when evaluations are used effectively, they support program improvements, knowledge generation and accountability" (UNDP, 2009: 127).

Results-Based Management (RBM) - How can projects be evaluated in DC?

To understand what can be evaluated in a project there is the need to first know the basis and framework under which evaluations can be done. Depending on the given project situation, time and motive of an evaluation, what can be evaluated constitutes an iterative process in a project life cycle. Evaluation does not simply entail an appraisal at the end of a project life, but at different points in a project's lifetime. According to the UNDP, evaluation starts from the very beginning of a project's conceivement. A process referred to as the RBM (Results-Based Management), and defined as "a broad management strategy aimed at achieving improved performance and demonstrable results" (UNDP, 2009: 10).

A RBM process is needed to ensure an effective evaluation process, sometimes referred to by many bilateral and multilateral development organizations as MfDR (managing for development results).With an RBM approach, right from the beginning of a project's life, an ex-ante evaluation usually commences the evaluation process, already paving the way for future further evaluations. The ex-ante evaluation ensures that "new or renewed" development measures already prepare the way for the formation of feasible objectives which can be evaluated in the future. There is an interconnection between planning from the beginning, evaluation and monitoring in the cycle of a development measure (UNDP, 2009: 10).

After an ex-ante evaluation is conducted in the planning of a development measure, what follows in the course of a project is formative evaluation and monitoring[33], which ensures that whatever was planned are carried out effectively till set project activities are completed. Monitoring can be said to be a continuous evaluation "focused on reviewing progress against achieving a goal" (UNDP, 2009: 9). According to the UNDP (2009: 9), the main dichotomy between the two is that evaluation is usually done independently, to allow for an objective external perspective of identifying whether planned development measures are on track to the set results.

[33] Can be defined as "the ongoing process by which stakeholders obtain regular feedback on the progress being made towards achieving their goals and objectives" (UNDP, 2009: 9).

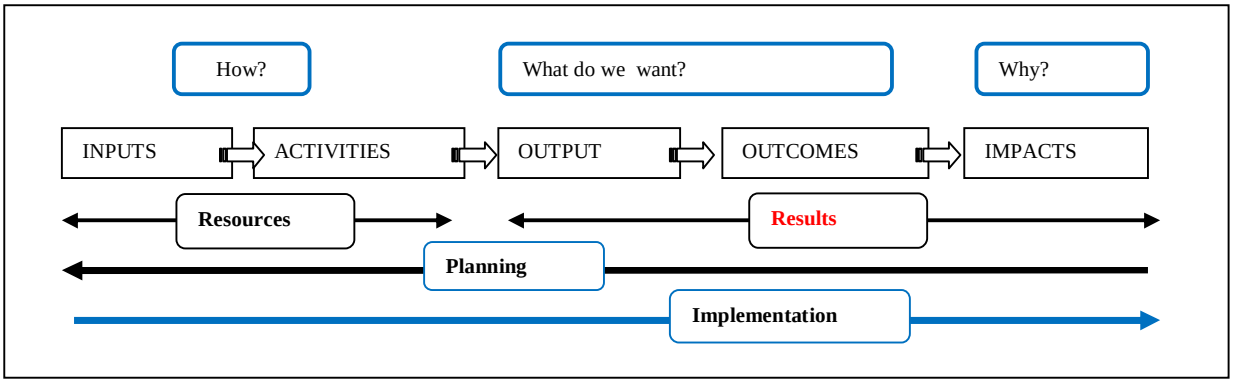
The completion of project activities doesn't signify the end of a project, what comes after the planned activities have been conducted matters most with the RBM approach. An ex post evaluation seeks to determine how effective the activities and inputs employed will generate the needed "overall value" (CIDA, 2004: 4). However, essential for carrying out an efficient and effective ex post evaluation is the existence of a logical framework/ result map and RBM framework which contains clearly worked out goals and objectives.

The EC under title IV; chapter I article 47"On evaluation for effectiveness under general provisions", requires member states to carry out an ex ante evaluation before carrying out an operational program (EU, 2006: L 210/50). Thus, the *log frame matrix* usually forms one of the outputs of an ex ante evaluation (EU, 2001: 12). According to the WWF (2005: 2, 3), several international NGOs and GAAs (Government Aid Agencies) make use of log frames, as it provides a clear and understandable medium of communicating the concise motives of a project. It normally also forms an important basis for writing action plans and proposals for funding. Log frames provide an easily accessible answer to the question: "Why are we doing the things we are doing?" (WWF, 2005: 2, 3)

What can be evaluated in projects?

Usually results can be evaluated in a project, defined as change in development due to the products of a cause-effect relationship that can be expressed or measured (UNDP, 2009: 55). Usually contained in a logical framework, are project activities, inputs, outputs, outcomes, impacts which can be evaluated through a formative, summative and ex-post evaluation respectively. In the RBM results chain (see figure 4), Inputs are combined by conducting activities to produce outputs, and the outputs result in immediate/short-term outcomes and outcomes in the long term ultimately result in the overall impacts a project intends to have.

Figure 4: The RBM results chain



Source: Own design based on UNDP, 2009: 55

Inputs are referred to what components of production are needed; in the form of financial, human and material resources for the realization of the development measure in question (UNDP, 2009: 55). Activities are referred to as the combination of actions, using inputs to generate a particular output.

Outputs embrace what was actually done in the course of a project, i.e. they represent what was produced in a given time period. They are defined as "the direct and tangible products from an activity, that is e.g. the number of people trained or trees planted" (SROIs, 2004: 3.1).

Outcomes can literally be seen as that which followed the project's activities mentioned in the output. It can been defined as "changes to people resulting from the activity" (SROIs, 2004: 3.1), meaning what target groups were able to do after the outputs were provided. Outcomes thus signify results or the

consequential effects, phenomena that follow after the outputs are utilized or not utilized by the target groups.

Impacts are effects on a higher level, a broader consequence from the resulting outcomes, such as poverty reduction, better education or provision of healthier living conditions and environment (GIZ, 2008: 20). Often, they represent the much wider spectrum of "changes in human development as measured by people's wellbeing and improvement in their lives" (UNDP, 2009: 55), e.g objectives in the MDGs. Impacts are a big challenge to evaluate, as they occur on a higher level and are often difficult to be attributed to individual aid interventions (Gri-4).

Evaluation strategy of GIZ

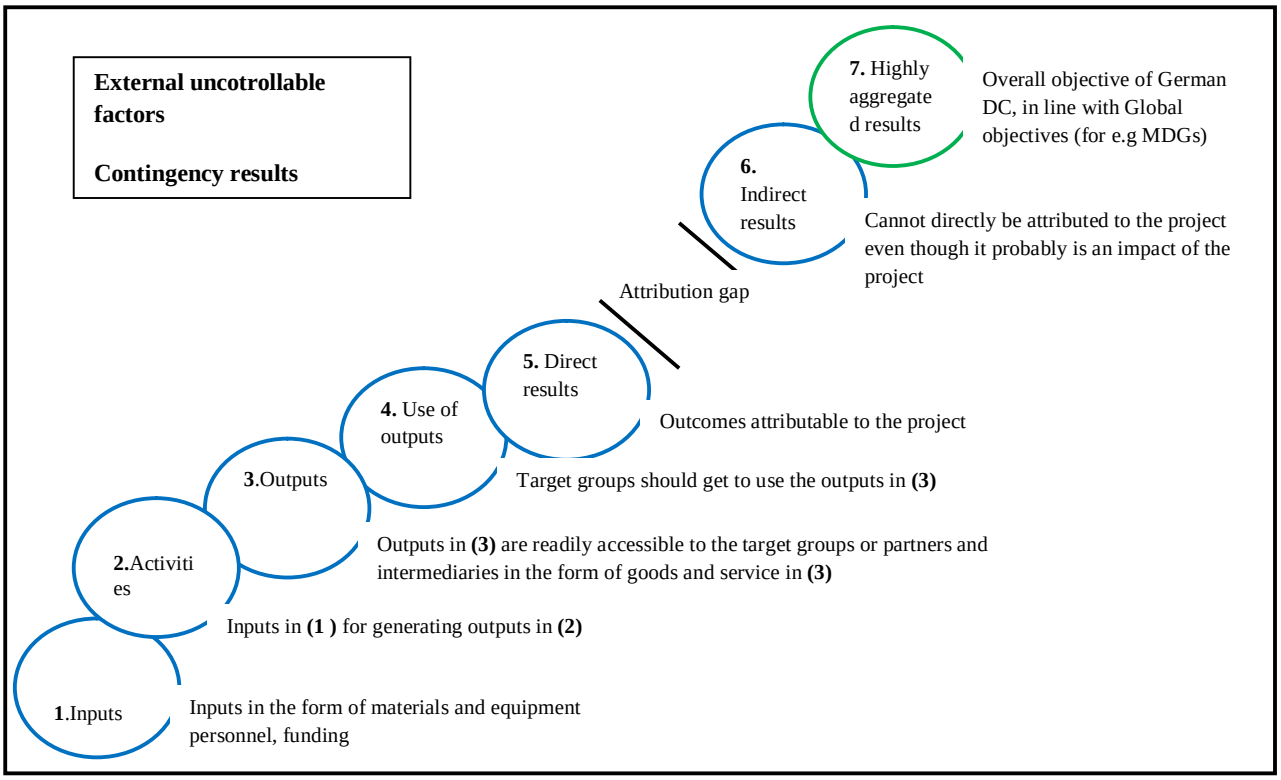
Achieving "sustainable results" can be summarized as the central theme behind efforts in the evaluation of projects under GIZ. Two key terms are embedded in the central theme for evaluating projects by GIZ, the first is "sustainability" and the second is "results" (Gri-4). The implication is that, project activities are not simply implemented to attain just any results, but instead to achieve long term (sustainable) results in line with the agreements of the AAA and Paris declaration to promote and accelerate the objectives of the MDGs Millennium Development Goals. Like the UNDP (2009:130), two main types of evaluations are conducted in GIZ, one is Project Progress Reviews (PPR) and the second is independent evaluation. To promote some form of neutrality and the conduct of evaluations without any form of intimidation, the evaluation department on the organizational structure of GIZ is independent and reports directly to the office of the managing directors (Gri-4).

To ensure the effectiveness of aid given for projects, GIZ conducts so called portfolio evaluations where they supervise 15-20 evaluations every year from one sector to find out how effective development measures have been. Every year one particular sector (for e.g, health, water, decentralization etc) is selected for this kind of evaluation. Results are published and reported back to the departments who undertook the projects under evaluation. This is to help them learn from the evaluation results and incorporate lessons and recommendations in their future work. Such departments through a signatory are obliged to incorporate the results in their work (Gri-4).

A key tool used in carrying out such evaluations is the results chain (see figure 5). It is the common concept for evaluating projects within GIZ and many other donor organizations. The main rational behind the result chain is to expect from projects to not simply implementing activities and monitor them, but rather to find out what results (outputs, outcomes and impacts) have been caused by the implemented project activities. The chain implies that projects do not only end when the different activities involved are implemented; however, highly important in the chain is what are the results or impacts that have been obtained as a result of the project conducted (Gri-4).

Evaluations conducted at GIZ are hereby additionally examined and ranked under indicators of relevance, effectiveness, impacts, efficiency and sustainability in accordance with the Evaluation criteria of the OECD (Gri-4; OECD, 2010: 10).

Figure 5: Result chain by GIZ for monitoring and evaluation of projects.



Source: Own design based on GIZ, 2010

Evaluation in Ecosan projects

Currently there are no specific laid down evaluation procedures for Ecosan projects under GIZ[34] yet, apart from the general evaluations carried out by the GIZ department of evaluation. So far, the Ecological sanitation sector hasn't yet received its turn of evaluation within the portfolio evaluation approach. Thus, current evaluation strategies for Ecosan projects consist of the conducting of case studies, dissertations and thesis studies like the present study. WSP reports of low acceptance of the technologies of Ecosan despite its environmental and economic profits (WSP, 2005: 1) which implies there should be more efforts in the direction of evaluation to facilitate up scaling and provide accountability for development measures in especially Ecosan projects. The present thesis research is thus seeking to contribute to these efforts.

[34] Follow up call to Staff of GIZ sustainable sanitation-ecosan department

3. Research methodology

The methodology of this study refers to the precise procedures, techniques, ideas and thought processes that were followed in carrying out the study to help address the target problem and research objectives outlined in Chapter one.

3.1 Overview to research methodology and qualitative approach

According to Muijs (2011: 1), two main typologies of research methodologies exist in education and social sciences: quantitative and qualitative methodologies for research or education respectively. Generally, what constitutes quantitative analysis involves the use of numbers and statistical methods. Aliaga and Gunderson (2000, cited in Muijs 2011: 1) define quantitative research as "explaining phenomenon by collecting numerical data that are analyzed using mathematically based methods, in particular statistics". The qualitative research method on the other hand as defined by Shank (2002: 5, cited in Ospina, 2004: 2) is "a form of systematic empirical inquiry into meaning".

Even though both typologies provide a good and credible basis for research, researchers are at liberty to tackle empirical research in a way best fitting to them and the study. The assumptions that argue on clarifying the distinction between the two research methods have been rightly put by Everet and Louis (1981, cited in Ospina, 2004: 4) as two research stance: the first is "inquiry from the outside" which is often implemented using quantitative studies and the second is "inquiry from the inside" which is usually performed by qualitative studies.

The topic for this thesis seeks to mainly find *lessons learned* and to elaborate *further recommendations for future project design related to the application of Ecosan technologies in Africa.* The more suitable approach to meet these goals seems to be an "inquiry from the inside", providing a systematically developed constructive basis for making the evaluation.

In order to make sure that the study would obtain its results as efficiently and systematic as possible, the concept of triangulation was employed to back the qualitative approach. Triangulation[35] has been broadly defined as the "synthesis and integration of data from multiple sources through collection, examination, comparison, and interpretation" (WHO, 2009: 07). Triangulation according to Olsen (2004) is not only aimed at validation, but on "deepening and widening ones' understanding".

Four different methods exist for triangulation identified by Denzin (1970, cited in Bryman: 2004):

1. Data triangulation, which involves using multiple sources of data in such a way that "slices" of data at different periods and collective situations, from a variety of persons can be put together in one.
2. Investigator triangulation, referring to a situation where multiple researchers set out in the field to collect and interpret data.
3. Theoretical triangulation, entailing the use of multiple theoretical positions in the interpretation of data.
4. Methodological triangulation, constituting the use of several methodologies for gathering or assembling data

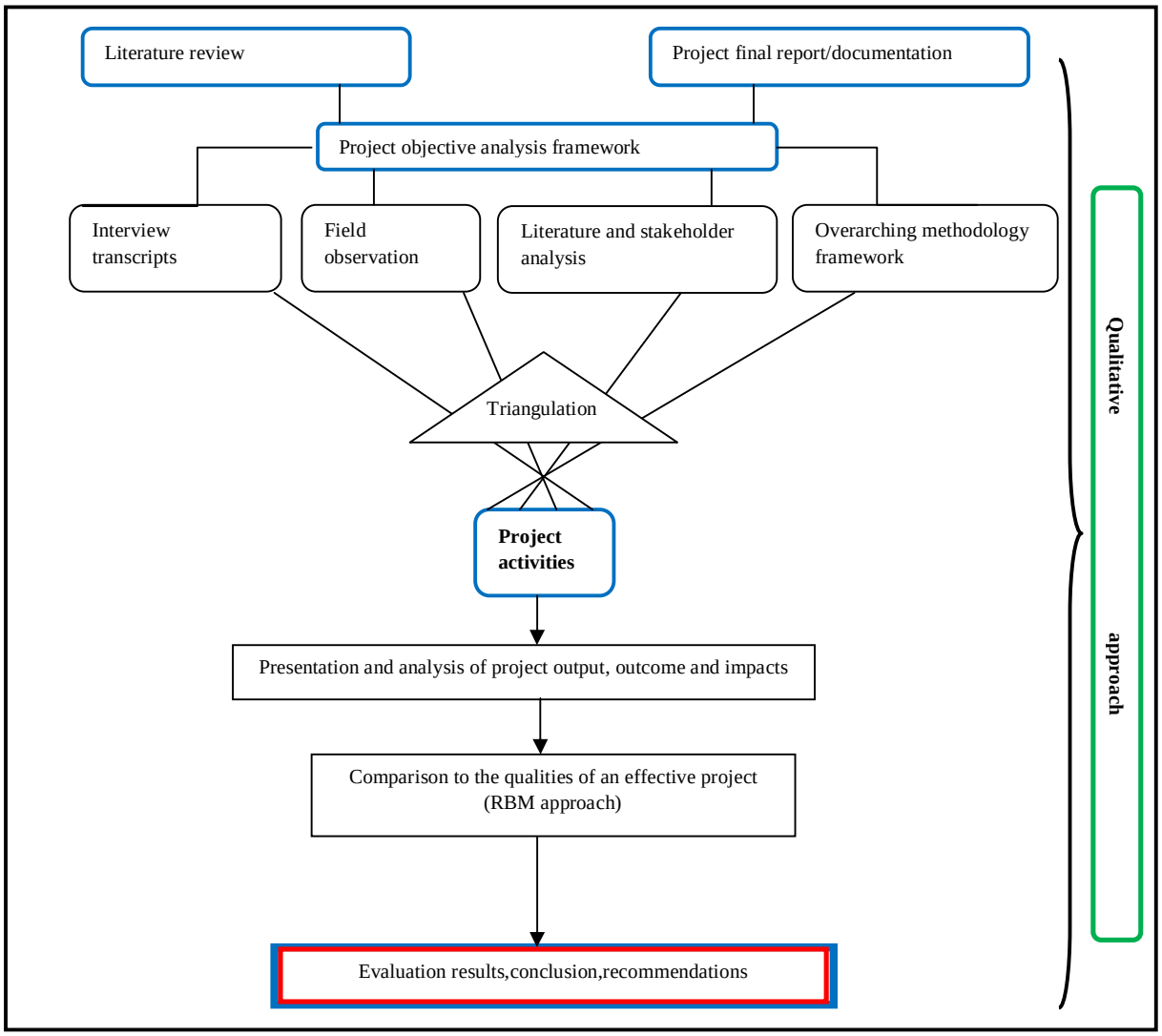
Data and methodological triangulation were the methods employed by the study, gathering pieces of information from the different stakeholder groups being the Ghanaian VVU project staff interviewee

[35] "Campbell and Fiske were the first to apply the navigational term triangulation to research. The metaphor is a good one because a phenomenon under study in a qualitative research project is much like a ship at sea" (Streubert & Carpenter, 2011: 350)

group, Ghanaian VVU cleaning, plumbing and farm maintenance staff group, Ghanaian VVU Student representatives group and the German research group (for group classification, see chapter 3.5.2). Also, methodological triangulation involved literature analysis, local surveys and field observation in order to sample the data.

The research methodology of this thesis embraced several tools and steps (see figure 6), which will be introduced to the reader within the following sub-chapters.

Figure 6: Overview to thesis methodology



Source: Own design, 2011

3.2 Literature and project documents' research and review

To be abreast with relevant and up-to-date information regarding the subject matter, there was the need for conducting a literature review. The BMBF/BMU final project documentation, journal articles, books, brochures, conference proceedings, web documents and other related thesis reports concerning the project were among some of the literature consulted to gain an indebt understanding and familiarization of the topic understudy.

The review of literature covered three main categories. The first one concerned all accessible literature regarding the research project "Ecological development at Valley View University" in Accra, Ghana. Hereby, different facets of the project were identified for further analysis utilizing other items such as a project's life stages (planning, technical implementation and management / follow-up) and important areas of intervention of the project, such as[36]Stadtschaft and cell model, agriculture, environmental protection, water and sanitation, energy supply, roads, open space, fields, consensus building, cost effectiveness and monitoring. The basis for doing this was to identify the project objectives and main activities and consequently uncover possible indicators to measure the project's effectiveness.

The second category of literature included general sanitation and ecological sanitation or any related literature on similar projects from the African perspective, narrowing down to Ghana with special emphasis on Accra. Looking into such literature helped raise important questions concerning the current state of sanitation in Ghana and Africa as whole.

The third group of literature constituted evaluation and assessment methods in international development cooperation in general as well as their application to Ecosan projects more specifically. Last but not least, the literature search also included a review of relevant material dealing with qualitative interview strategies and analysis.

3.3 Stakeholder selection and analysis

The literature and document review unearthed the most relevant stakeholders that were involved in the running of the project. According to Schmeer (1999: 1), stakeholders constitute "actors" who are charged with the responsibility of advancing the "interests" of a particular policy (project). Referring to the stakeholders as "interested parties", an analysis of stakeholders may examine the actors' following characteristics:

1. Knowledge of the project;
2. interests related to the project;
3. position for or against the project;
4. potential alliances with other stakeholders;
5. ability to affect the policy project process (through power and/or leadership).

Equipped with knowledge about these items of stakeholders further steps (see chapter 3.3.1) were taken to carry out an effective stakeholder analysis in order to further prioritize and identify important stakeholders that need to be given the requisite attention in securing a wide range of information to be used for the evaluation and analysis.

3.3.1 Facets of the stakeholder analysis

For the various phases[37] of the "Ecological development at Valley View University" project, different stakeholders emerged who undertook various tasks needed in attaining the final objectives of the entire project. To identify what was done, who was responsible for what, what actual experiences, challenges and success stories could be shared by the direct project partners in relation to the project's planning, implementation and follow-up the steps described as facets below were adopted in the analysis of stakeholders. This paved the way for compiling a list of relevant interviewee groups for the semi-structured interviews which were conducted in the further course of the study. For an overview and further explanations related to the single steps of the stakeholder analysis (see figure 7).

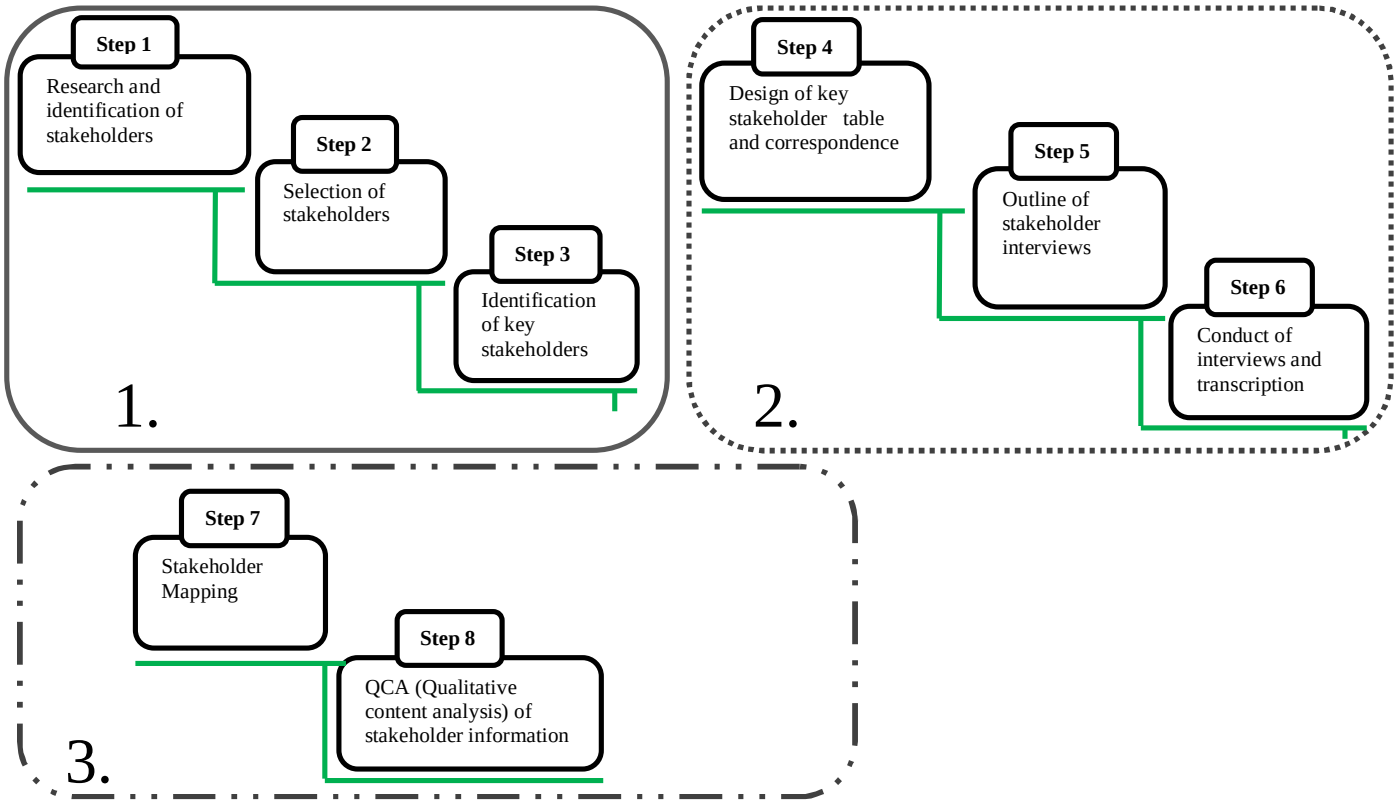
Facet one (1)
This facet comprises three main steps (1-3); the *first step* was concerned with the initial research and identification of stakeholders. As mentioned earlier, project documents and other project-related

[36]An overview of the project analysis framework is available in Appendix 5.
[37]See project timeline in Chapter 4:34

documents were consulted which provided firsthand information regarding stakeholders/partners directly involved in the ecological sanitation and agricultural aspects of the project. Consulting experts and books in the field of evaluation and post-evaluation, plans were made on how to rightly choose stakeholders that could serve as key informants in order to find answers to the research questions raised in the first chapter.

After identifying respective stakeholders, the *second step* was to clearly allocate the relevant project stages and related project functions to them which assisted in mapping stakeholders to various activities. This information was later used for finding out where both smooth and conflicting interactions existed to understand the rationale for such interactions for further analysis and evaluation. This later led to *step three* of the first facet, which was the identification of "Key" stakeholders. The "Key" stakeholders refer to those stakeholders who were directly related to the focus of this thesis (ecological sanitation and agricultural systems) realized within the scope of this study.

Figure 7: Overview of important facets of the analysis of stakeholders



Source: Own design, 2011

Facet two (2)

After identification of the key stakeholders, this ushered the way to the second stage/facet of the stakeholder analysis. *Step four* took the form of clustering stakeholders and designing a related stakeholder compilation[38]by groups, the result of which was a list of coded interviewee groups (see Appendix 2: in Annex). In order to secure the anonimousity of interviewees, the groups were summarized under five sections: German research interviewee group, Ghanaian VVU project staff interviewee group, Ghanaian VVU cleaning, plumbing and farm maintenance staff group, the Ghanaian VVU Student representatives' interviewee group and finally the "Other resource persons"group. Later, correspondence

[38]See qualitative approach for more information on this.

through e-mail and telephone calls was undertaken; to the direct resource persons to schedule interview dates and appointments.

Step five was to outline specific stakeholder interviews for the different interviewee groups. This was based on a project objectives analysis framework elaborated by the author from the projects' overall documentation (see Appendix 5). The following step was then to conduct the interviews using the guidelines and later transcription.

Facet three (3)
Facet three finalized the stakeholder analysis; it involved a qualitative analysis of the stakeholder information obtained through the interviews. Making use of the transcripts, qualitative analysis was made based on the information extracted. Objectives set by the project were compared to the objectives identified by the interviews and a stakeholder map was elaborated to display the project constellation as a whole, individual functions and roles of stakeholders within the project as well as their relationships to one another. A comparison was made to draw conclusions about the projects stakeholders' views whereas further recommendations were prepared for future project design (*steps 7 and 8*).

3.3.2 Stakeholder mapping

According to the IIED, (2005: 2) stakeholder maps serve as a tool which "enables better understanding and explicit discussion of who influences a policy" (project). The stakeholders' influence can hereby be represented in the map by the various group sizes, group inter-relationships and the degree of influence they hold in the attainment of project objectives. It can be made even more profound by incorporating different time periods to give a graphical description of the direction with respect to different time periods of the project life cycle.

For the purpose of explaining the interactions between all relevantly connected stakeholders in the stakeholder map, four main stakeholder groups[39] were identified in the study (see stakeholder map chapter 4: 32), who influenced the activities of the focus of this study which is "water and sanitation and agriculture". These four groups included Ghanaian project partners, German project partners, project sponsors and other stakeholders. The students and staff of VVU were incorporated in the Ghanaian project partners as they didn't play a big role in the realization of activities. The other stakeholders were introduced in the map because they greatly influenced the activities of the remaining three groups but were not actual partners of the project; however they were incorporated in the mapping because of their influence.

3.4 Project objectives' analysis framework

As a logical framework or clear cut project objective outline was not available to the author of this thesis at the time of realizing this study, projects' objectives and corresponding project activities had to be identified and sampled from available project-related documents at first place. Later on, the objectives and activities could be cross-checked in the framework of the local surveys undertaken by the author and adapted to the necessary extent.

The author hereby opted for sampling the project objectives and activities into a guide lining analysis framework in order to be able to understand the dynamics of the complex activities implemented in the framework of the VVU project, and furthermore to secure a clear path for the intended evaluation.

[39] These four groups, do not constitute the groups that formed the basis of the interviews of the study (even though they are included), but were meant to help explain the interactions that existed in the course of the project.

The elaboration of the analysis framework was done as follows: First, the ultimate goal of the university was identified, which was to become the first ecological university in Africa. The overarching objectives were broad based, with corresponding individual sub-objectives and activities in relation to environmental goods[40]and targeted to achieving the ultimate goal. From reports and project documentation, the author realized that the major procedures under which this was to be conducted was first through the establishment of an ecological master plan to guide broad areas of planning, technical implementation and managerial aspects. Classified under the broad areas identified under the project, the next step was to identify mentioned project activities which fit in the aforementioned categories that directly or indirectly lead to the ultimate goal.

Based on identified project activities directly under planning, the project mainly intended to conduct urban and landscape planning. For the urban planning sector, it intended to conform to the development of a "Stadtschaft" and cell model (not further analyzed as not part of the focus of the thesis). The second element under landscape planning, intended to adopt some agricultural ecological cycles and measures for the protection of the environment in the VVU campus, the latter also not part of the thesis.

Under the agricultural aspect, the project intended to achieve some overarching objectives in line with implementing some Ecosan technologies in order to close the ecological nutrient loop. These overarching objectives did not correspond directly to environmental goods constituted activities that did.

Moreover, under technical implementation it was identified that the project intended to construct some ecological buildings, roads, open space and fields. Other ecological building designs were conducted, relevant however for the study were the buildings directly related to the water and sanitation aspect of the VVU project such as the sanitary block by the cafeteria and the Berger biological toilet buildings.

Also, another broad sector was the managerial sector, which sought to carry out consensus building, monitoring and some cost effective measures realized within the "Holistic quality management" approach of the VVU project (IOV, 2010: 3.06, 07; 8.04, 06).

Last but not least, the extended overview of project objectives also helped the author to make transparent the links between project objectives on the one hand, and related environmental goods on the other hand. Doing so, the author was enabled to define the relevant selection of overarching project objectives which were directly connected to the items "Water and sanitation" and "Agriculture", which had been defined as the study borders when starting out on this thesis. Due to the complexity of the VVU project, a full evaluation of all project objectives would doubtlessly have been desirable, however, by far gone beyond the research scope of this thesis. Instead, the author opted to execute a selection of project objectives to be evaluated in a more in-depth manner (see chapter 5).

3.5 Semi-structured interviews

Due to the complexity of the given stakeholder constellation (see 4.2.2), and with the intention of dealing with information on a trustworthy basis, steps were taken to eliminate tracing of information given back to interviewees in order to avoid any form of conflict on completion of the thesis research. "Ethical dilemmas that may rise from an interview are difficult to predict but the researcher needs to be aware of sensitive issues and potential conflicts of interest" (Orb, et al., 2001: 2). As a result steps were taken to ensure the anonimousity of interviewees by coding the names of all the interviewees and whatever inputs were provided for the study (Appendix 2).

Hence, the research questions and interview guidelines were formulated to inquire into obtaining the experiences that could be shared by the different groups or stakeholders involved in the course of the

[40]See appendix 5 in Annex

project and this provided an essential point for rationalizing the use of the qualitative approach as mentioned before; that is to gain as much information as possible from the perspective of the involved persons/interviewees concerning the project.

The semi-structured interview approach sought to get a wide fraction of the project stakeholder groups' attitudes/opinions/insider information on the VVU project's effectiveness looking at it from an ex-post perspective after the project's termination in 2009. Due to the present thesis' study scope which had been defined at the outset of this research, a special emphasis was hereby laid upon the ecological sanitation systems and their application in agriculture. Based on these study borders, five key interview groups were identified and differentiated by their coded names Group 1 which is the German research interviewee group, Group 2, Ghanaian VVU project staff interviewee group , Group 3, Ghanaian VVU cleaning, plumbing and farm maintenance staff group, Group 4 which is the Ghanaian VVU Student representatives' interviewee group and finally group 5 named as "Other resource persons" interviewee group made up of other resource persons who were not directly involved in the project but contributed or provided Ecosan-related information/information to assist in the development of this thesis (see Appendix 2).

Open questions and semi-structured interviews were used and were consciously not sent to interviewees in advance; one, because of fear they might not all be filled in on time (in relation to the thesis schedule) and two, to avoid the tendency of having them look into reports to find answers which will not give the true picture of the situation. Nevertheless, permission to carry out interviews and to use the info was obtained from the interviewees and most interviews were voice-recorded with permission and transcribed verbatim. All text was read in its raw form highlighting goals, lessons, problems, successes and recommendations; wherever text was not clear, audio recordings were replayed to highlight points being made and to check the tone of what was being said to judge the trustworthiness of information.

3.5.1 Interview design

The semi-structured interviews to be undertaken at the locality in Ghana were developed based on the previously designed project objectives' analysis framework in order to be able to evaluate the VVU project's effectiveness in relation to the goals defined by the project partners. The interview guideline questions were hereby oriented and formulated in correlation with the output, outcome and impact levels[41] of the intended project impacts.

Table 1: Stakeholder interview content framework

	German researchers	Ghanaian VVU project staff	Ghanaian VVU cleaning, plumbing and farm maintenance staff	Ghanaian VVU Students	Other resource persons
Goals of the project	On a strategic level	On the strategic and technical level	X	X	X
Development of the project	On a strategic/ lesson level	On the strategic and technical level	Own contribution, Communication and participation	Communication and participation	On a level of knowledge and extent of practice
Output of the project	On a broad perspective	Detailed for agriculture and sanitation	Detailed for agriculture and sanitation	Level of involvement	X
Outcome	On a broad perspective	Detailed for agriculture and sanitation	Detailed for agriculture and sanitation	On acceptance and ownership level	X
Impact	On a broad perspective	On a broad perspective	On a broad perspective	On a broad perspective	On a broad perspective

Source: Own design, 2012

[41] See chapter 2: 13

This served to streamline inputs from the interviewees with reference to the overarching objectives of the project. Further/additional questions were added as the interviews were conducted (see Appendix1 in Annex for interview guidelines).

3.5.2 Categorization of interviewee groups

Five main categories of interviewees were planned for interviewing. Coded as (Gri-1-5) and representing the German research interviewee group, the first group involved the German project stakeholders/partners who served as the international partners with technical and engineering backgrounds to facilitate the implementation of the Ecological sanitation systems' project objectives. They included the German Ministry of Research and Development (BMBF), Bauhaus-University Weimar. (BUW), Centre for International Migration and Development (CIM), Berger-Biotechnik GmbH, University of Hohenheim (UHOH), Ingenieur Ökologische Vereinigung (IÖV) and Palutec GmbH.

The second category of interviewees, coded as (Vui-1-10),represents the Ghanaian VVU project staff interviewee group, and covers Ghanaian project stakeholders/partners who served as local partners and "providers of the research site" to undertake the research project. From this category, were locally based technical, engineering and managerial staff, some of whom are currently in Valley View University's Physical plant department, currently ensuring the continuation of the ecological systems and another group of interviewees who have since left their positions and are no longer serving in the university after the project ended.

The third category of interviewees, coded as (Vcpf-1-10), represents VVUs cleaning, plumbing and farm maintenance staff group, who worked together with both partners from Germany and Ghana. Amongst the tasks performed, one was carrying out maintenance and service to help in the effective running of the project systems. They consist of cleaners, technicians and farmers directly responsible for the day to day continuation of the ecological water and sanitation systems.

The fourth group of interviewees constitutes the largest group, also in terms of the users of the installed ecological water and sanitation systems. Coded as (Vsr-1-5), they are made up of VVUs student and student representatives. Two groups of student interviewees can be found in this group, the first category of students involve student associations from the Valley View University's elected student governing body as well as other departmental student associations. The second group of student interviewees involves students from the Bediako Hall of residence who are the immediate users of the UDDT located in the Bediako hall of residence.

Finally the fifth group of interviewees "Other resource persons" were made up of supplementary resource persons not directly involved in the project but who contributed or provided Ecosan-related information/information to assist in the development of this thesis, were coded as (Orp-1-4). They comprise people that benefited from VVUs project in the form of training and assistance and in establishment of local Ecosan technologies. The aim was to find out the current condition of their Ecosan systems and to share any relevant experiences.

3.6 Field Observation

Based on a sound literature review, stakeholder and project objectives' analysis, the author furthermore opted to apply field observation next to the semi-structured interviews. In this way, advantages such as the structuring and systemization of the information collected during the field survey should be achieved. A negative aspect of this technique however is that there is the tendency of the observer to have a preconceived notion of what is being studied and this sometimes affects the performance of the subject of study. The main benefit of direct observation is the fact that whatever is being studied "can be studied in its natural setting, thereby providing a richer understanding of the subject" (USAID, 1996: 1).

Field observation was done in two forms; the first was through a reconnaisant[42] survey of the different water, sanitation and toilet systems without guidance. A personal use of the systems unveiled some of the important issues that would otherwise not have been revealed by a demonstration of the systems provided by the local VVU staff. The second form took place after an "official tour" of demonstrating the water and sanitation systems; field notes were taken again and pictures retaken to compare and notice any significant changes, also during stakeholder interviews sessions field notes were taken. With the help of a digital camera for taking pictures, notes were also taken for each visit in a field notebook.

3.7 Qualitative Content Analysis (QCA)

Different methods exist for the analysis of text data apart from Qualitative Content Analysis (QCA); some of them include ethnography, grounded theory, phenomenology and historical research. Researchers usually choose whatever research method they deem appropriate for their study as long as it best explores and suites the objective of the research study. On the other hand, "how to research" should usually be informed by "why research" (Holden and Lynch, 2004: 02).

QCA is defined according to Hsieh and Shannon (2005: 02) as "a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns". According to (Weber, 1990: 09), the specific type of content analysis approach chosen by a researcher depends on the "theoretical and substantive interests" of the researcher and the problem being studied.

Procedure for QCA

Interview results were evaluated following the information provided by the interview transcripts that relate directly to the overarching project objectives and their corresponding activities planned for implementation of the VVU project (see Appendix 5). Furthermore, the collected information was categorized along the result levels of the RBM ex post evaluation approach(see chapter 2: 13, 14). Next, the information categorized was cross-validated adopting data triangulation; making reference to project reports, field observation and interview transcripts to confirm the trustworthiness of information.

Interview transcripts were structured according to the overarching project objectives (see Appendix 5):on the result levels of output, outcome and impacts (see also chapter 2). Within these categories, the most important notions were summarized. Next, the information categorized was cross-validated adopting data triangulation; making reference to project reports, field observation and interview transcripts to confirm the trustworthiness of information.

[42] A type of field survey, which allows initial examination of an area to have first hand information of what is or not present to facilitate further research see http://palmettohistory.org/archaeology/ReconnaissanceSurvey.htm [last accessed 10th May 2012]

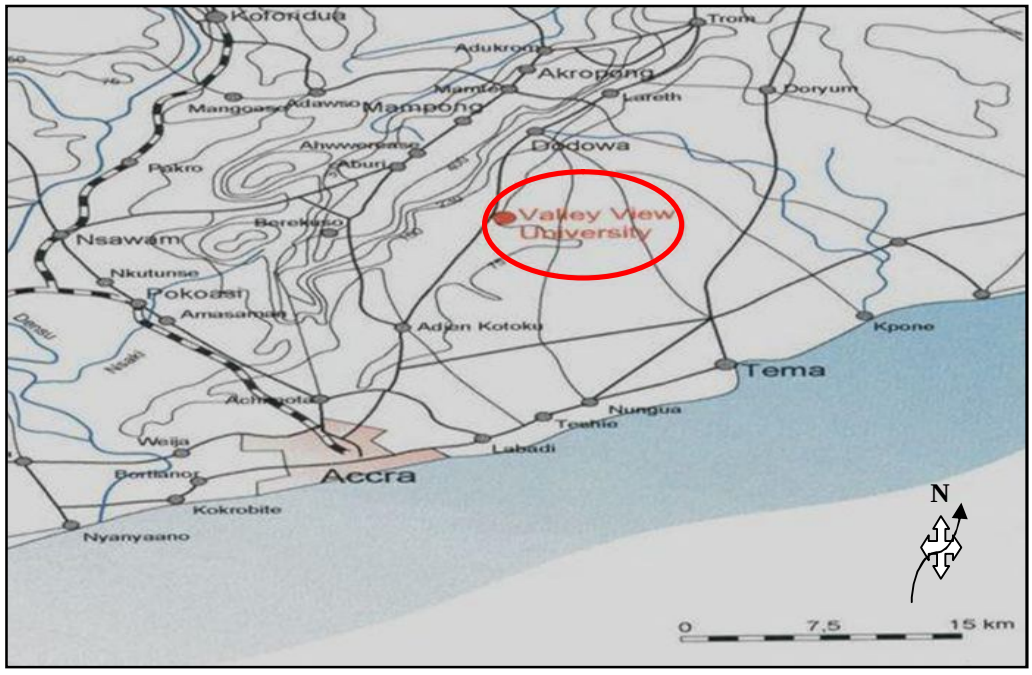
4. Case study description

4.1 Case study area and location

The republic of Ghana can be found in the West Coast of Africa and occupies an area of about 24.10^6 hectares of land under geographical coordinates 4°44´N and 11°15´N; 3°15´W and 1°12´E. Ghana is estimated to have agricultural land potential of about 13.6 000 000 hectares of which only 29% is currently reported as under production (Agodzo et al., 2003: 12).

The capital city Accra, is located south of the country under latitude 5° 36' N and longitude 0° 12' W with an approximate elevation of 65 meters above sea level in the Greater Accra Region of Ghana. Valley View University is also located close to the capital in a settlement called Oyibi. The University lies within Accra's plains and is bordered to the west by the Aburi-Akuapem Mountain range, to the east by vegetation and small rural settlements of the Oyibi community, to the south by the Adenta Municipality which is a suburb of the capital city Accra and to the north (about 16km/10 miles) by the town[43] of Dodowa. Approximately 30km (19miles) north of the Capital city of Accra, the Oyibi settlement can be found (See figure 8). Valley View University's campus spans up to an estimated 300 acres (121.5 hectares), and is estimated to have an average elevation variation of about 17 meters (56 feet), with the highest points being 86 meters in the south western Corner of the University and the lowest points, 69 meters (226 feet) in the eastern corner of the campus above sea level respectively. The immediate area surrounding the University is hilly and the University campus is situated on the highest point in the area, characterized by an irregular gradient pattern. There are no clear slopes found on the campus (IOV, 2010: 2:02).

Figure 8: Case study area and location in the context of Ghana



Source: Modified, based on IOV, 2010: 2.02

Surrounding villages are mostly rural in nature, even though a number of "modern buildings" have sprung up by the influence of the student populations. These new buildings serve as hostel accommodation for

[43]In Ghana a town is defined as a geographical settlement with a population above 5000 people.

some of the students who cannot find accommodation on campus. The communities are linked to each other by dusty roads and a view of the Akuapem mountain range can be seen in a distance, probably giving the University its inherent name. According to the (IOV) the rural communities often lack infrastructure in terms of electricity and water supply.

Climate-Valley View University is located in the coastal savannah zone of Ghana, this area has two main raining seasons which extends first from April to July and then September to November. At an altitude ranging from 600 to 1150mm.VVU falls within the coastal Savannah zone which is the so called "Ghana dry zone" and therefore has less rainfall in comparism to other areas of the country (Vollmert et al., 2003, cited in IOV, 2010: 2.07). Mean annual temperature is estimated to be around 26.7°C and actual rainfall altitudes recorded on campus by the campus weather station were recorded as 830mm.

Soil-The predominant soil types found in the VVU area consist of deeply weathered soils with a thin A horizon (topsoil) no thicker than 10cm. The C horizon is highly weathered and very compact containing sand, quartzite gravel and stones. Through excavation for construction work to begin, the regolith[44] was found to be at least 6m thick. According to Kortatsi and Jorgensen, (2001: cited in IOV, 2010: 2.06).Weathering in the Akuapem ridge is greatest on the Accra plains. Weathering activities in this area could reach a depth of 47m.

Vegetation-The vegetation zone in which Valley View University is found falls under the coastal savannah belt of the country, predominant vegetation found within this region include evergreen and semi-deciduous forests with various varieties of trees, herbs, shrubs, grass and bushes. On campus, shrub, grass land, different tree populations as well a few termite hills can be found (IOV, 2010: 2:04). A field observation by the author revealed that a great portion of the land is still undeveloped with buildings and the university has taken steps to preserve the natural vegetation as much as possible to the extent of maintaining groves very close to its administration block. The University appears green and lively.

4.2 Valley View University (VVU) project background

Valley View University was established in 1979 by the West African Union Mission of Seventh-day Adventists (now Ghana Union Conference). It used to be located in Bekwai-Ashanti in the Ashanti Region of Ghana, but was moved to Adenta–Accra in 1983 where it operated in rented facilities until it found its present site near Oyibi. In 1995 VVU was affiliated with Griggs University in Silver Springs, Maryland, USA and under that affiliation they could offer four year bachelor degree courses in Theology and Religious studies. In 1997 the University was officially accredited by Ghana's National Accreditation Board and granted it official recognition, thereby allowing the university to award its own degrees (VVU, 2010)[45]. At a point in the University's history Water scarcity almost threatened the existence of the University in its present location, "our church welfare office had threatened to close the place down because there was no water" (Vui-6: 1). The university has however since found solutions to many of its problems and a wide range of such problems were addressed in the course of the research project being under study of this thesis.

4.2.1 Initial situation and project evolution

The future increase in population of students which was estimated to rise from 750 to 10,000 between year 2002 and 2015 (IOV, 2010: 2.07; Berger, 2009: 1), automatically demanded an increase in educational infrastructure such as school buildings and other learning facilities. This made it necessary to make provisions for the expected future student populations, in addition to other incumbent problems at

[44]The layer of rock and mineral fragments that rests on bedrock and is produced by the weathering of rocks. Regolith constitutes the surface of most land. Available from: http://www.thefreedictionary.com/regolith (last accessed on 25th July 2011)
[45] See http://www.vvu.edu.gh/about/history.html for more details on Valley View University (last accessed on 19th November 2011)

the university such as shortage of water supply, energy, waste disposal and land degradation which existed prior to the project's initiation. For the purpose of comprehension and clarity of the initial situation, the different problems that existed on the campus before project commencement has been grouped under six different sectors; *Master plan, water, building infrastructure, waste, land degradation and energy.*

Master plan-The first problem situation can be traced as far back as the year 2000, where the university's first master plan was made. The first master plan which intended to guide the efficient development of the university foresaw a rather scattered arrangement of buildings and a "too spacious" traffic route which led to inappropriate infrastructure arrangements and thus hindered the designation of specific areas for agriculture and other special purposes (IOV, 2010: 4.03).

Water-As previously mentioned (see chapter 4: 27), there was and still is an anomaly in the rainfall pattern, which affected the university in terms of water supply, and this is mainly responsible for the problems associated with the supply of water on the VVU campus, as the University was not connected to the National water Grid due to its location away from the Capital Accra (VVU, 2005: 2)[46].

Data published on nearby villages surrounding the VVU area indicate that, the ground water lies at least 30m deep which means it is relatively low (Sebald 2004, cited in IOV, 2010 2.07). In addition to the low ground water table, the so called "groundwater residence" time is very short in this area, it is therefore assumed that this area is probably the recharge area for the groundwater of the Accra plains due to the low average annual precipitation, high evapotranspiration rate and the absence of surface water. As a result, significant groundwater replenishment from local percolation around VVU is unlikely, and this called and still calls for sustainable water solutions (Kortatsi and Jorgensen 2001, cited in IOV, 2010: 2.07).

In the light of these unfavorable water conditions that existed in this zone, mainly three water sources existed at the time of this study, groundwater, surface water and rainwater. In the year 2000, about 8500 cubic meters of drinking water were consumed by VVU, out of this 2960 cubic meters were drawn from the public supply system and 5500 cubic meters came from additional water supply provided by the water tanker by buying from outside sources and transporting directly to the University campus. Comparing the per capita water consumption rate of VVU to European standards, it was found that the rate of consumption was very low and was attributed to the limited supply of drinking water (IOV, 2010: 2.10).

Buildings and other infrastructure-As at 2003, about 831 students were enrolled in the university (IOV, 2010: 2.07), during this time, there were only two lecture/teaching blocks on campus, including administration offices, computer labs and a library. Also in existence at the time were several one family duplex houses and living complex for a so called women's centre. Several buildings were still under construction and commercial buildings on campus were limited to a bakery and a concrete block factory. The building infrastructure before the projects commencement was inadequate to house the students on campus, students had to commute for long hours due to traffic, from Accra to attend lectures, and some students had to find alternative accommodation in the surrounding areas of the University.

What's more, before the project start, open areas around existing buildings as well as the ceremonial grounds were nearly treeless, most of the lawns on campus in these open spaces received occasional irrigation. Whenever there was a school function due to the treeless nature of the ceremonial grounds, sun shades were put up to shelter people from the strong rays of the scorching sun.

The road infrastructure in the university had no traffic restrictions and there were very limited parking areas for cars. The cars were being parked under shady trees and groves before the project took off. This

[46] VVU Brochure on water and nutrient concept

situation reduced the quantity and quality of open spaces needed by the teachers and students during their break and this posed a problem when only about one quarter of the population on campus had access to cars and is most likely to worsen in the near future with the expected increase in the campus population. Also, a well developed network of footpaths and cycling routes did not exist on the campus before the project and the main road was paved, but in a poor condition. The unpaved streets become muddy in heavy downpours of rain (IOV, 2010: 2.08).

Waste-Waste and rubbish disposal on the campus posed a problem, because there were no waste recycling and deposition services available before the establishment of the project, also there was no central sewerage system in VVU. Waste water disposal was decentralized for each building. Grey and black water in different quantities were collected in every building. Most of the grey water and black water was produced in the student hostels since the students showered and did their laundry there. The waste problems on campus took different forms, used batteries, plastic water bags as well as grey and black water. Organic waste and leftovers from the universities kitchen were given away to surrounding villages as animal fodder, whilst other waste like plastic bags and used batteries were either burned or buried (IOV, 2010: 2.10, 11).

Land degradation- As previously mentioned (see chapter 4: 27) the of soil type and land use conditions in the VVU area is generally poor. This facilitates weathering and further erosion in some parts of the campus. Moreover, climate diagrams of Accra reveal that the total annual rainfall at VVU has been recorded at 830mm which is a little higher than in Accra. Precipitation is normally higher between August and January than between February and July with reference to a period of four different years. Some heavy rains have been recorded, causing deep gullies on campus. This provides evidence to explain why most of the rainwater is lost by overland flow (runoff) which is the fastest medium through which water is lost from the ecosystem (IOV, 2010: 2.04).

Energy-VVU is connected to the National Power Grid, which draws power from the Akosombo dam at the Volta lake reservoir. Power failures and strong voltage variations on campus frequently occur and this directly affects the water supply system of the University. This is because the supply and distribution of water from the storage tanks require the use of electric powered water pumps. Thus, water sometimes accumulates in the reservoirs and cannot be pumped out for further use by the university. Electric power cuts can last sometimes for several days making the situation worse and hindering water supply to the different building units of the university (IOV, 2010: 2.11).

Initial project ideas

Since the university projected an increase in its enrolment from 750 to 1000 people from 2002 till 2015 (IOV, 2010: 2.07; Berger, 2009: 1), there was the need for it to meet the infrastructural requirements of a modern university or face the threat of being shut down (Vui-6: 1, 2). So at the start of the project, certain objectives were set to help address the problems mentioned before, and an overall goal was set to become the first ecological university in Africa (Gri-5: 3). To achieve this overall goal a number objectives were defined to serve as stepping stones and measures ranging mainly from the establishment of subsistent water demanding infrastructure in the form of toilet and bathroom facilities with recycle options were planned. Further intentions were to make use of the products generated from these recycling facilities in the University farms (Vui-5: 1; Vui-4: 04). To help build, properly use and facilitate the sustainability of the established systems, it was intended to train workmen and users (students), and to establish an ecological studies program (Gri-5: 03) using the established ecological facilities as a medium for studies to boost acceptance amongst the students and ensure good quality of work from the workmen.

VVU in a search to solve its water problems with projected student number increments and keeping up with the required standards of a private Ghanaian University decided to seek options, in the year 2001 the president of the university through a colleague got to know of interview partner Gri-2 and brought him on

board, who also saw the possibility of a holistic ecological concept as already intended by the Universities President (Vui-6: 1). Thus, various steps were then taken into making Valley View University the first ecological University in Africa. The different stakeholders were brought on board, starting with the BUW from Germany represented by person A, who was a colleague of Gri-2 and formed two partners (BUW and IOV) who started the first project implementation phase in 2002. However, due to the intention of implementing the ecological cycles of the project BBG, Palutec and UHOH were brought on board in 2003 to handle the agriculture and sanitation aspects respectively. BMBF became a part of the project in 2002 when funding was granted. CIM, joined the project at a later stage in the second implementation phase in 2006 (Gri-2: 1; Gri-5: 1; Gri-3: 1; Gri-1; 1).

4.2.2 Involved Stakeholders

The research project "Ecological development at Valley View University in Accra, Ghana" was supported and co-financed by the German Federal Ministry of Research and Education (BMBF) and Valley View University (VVU) located in Oyibi-Accra from 2003 till 2009. Other key stakeholders, of this joint venture were the, University of Hohenheim (UHOH), Ecological Engineering Society (EES), CIM, Palutec GmbH, Bauhaus University Weimar (BUW) and Berger Biotech GmbH

The functions of stakeholders were distributed as follows: the University of Hohenheim was responsible for the work on agriculture, Palutec for grey water treatment and storm water harvesting, Berger Biotechnik for water saving and waterless sanitation and the Ecological Engineering Society (EES/IOEV) to act as project leader (see appendix 3: 80, Annex).

The introduction of Ecosan technologies intended to support the VVU to cope with the effects of the forecasted increasing number of students, which was 1200 at the start of the project in 2003 and was projected to be 10,000 by 2015. The focus of the project was thus set on effectively and efficiently saving water by making use of all water and nutrient inputs to support agriculture as a central and sustainable element in the closed loop recycling management giving the scarcity of water on the campus (Berger et al., 2008). The project consisted of two main phases, the first phase which is the projects "pre-phase" lasted from December 2002 till April 2004 and the main phase also lasted from May 2004 till November 2009 (IOV, 2010: 2.07).

Stakeholder map

To familiarize the reader with the basic interactions that existed between all major stakeholders of the project, in relation to externally involved but important stakeholders, the stakeholder map (See figure 9) helps to define briefly, the various directions in which cooperation in the form of finance, coordination, involvement, conflicts, stakeholder size and power went, based on the different phases of the VVU project.

In the map, for the purpose of explaining the interactions as mentioned before in (chapter 3: 20), four main groups of stakeholders were identified, not directly related to the number of stakeholders for the study thesis. They include Ghanaian project partners, German project partners, project sponsors and other stakeholders.

From the map, on the Project sponsors group, there was BMBF, who sponsored research and technical implementation in the form of paying the German project partners as well as providing funds for logistics and research materials. Also, there was the GTZ (now GIZ) who sponsored a feasibility study in the first phase of the project, prior to sponsorship by BMBF, but did not manage to implement the project even though they recommended it as a potential one at the time in 2001 (Vui-6: 1,2)[47]. Hence, the reason for GIZ overlapping between other stakeholders and project sponsors. Also, CIM usually contributes

[47] See also project timeline p.33

personnel in the form of technical experts, however in the case of the project, CIM provided and sponsored one of two experts for the project, who were brought on board in the second implementation phase of the project and forms the reason for their presence in the category of sponsors. Out of these two experts, one was sponsored financially by CIM and the other was sponsored by the BMBF, hence the reason CIM is in the category of sponsors The CIM experts were responsible for local coordination as well as construction and implementation of some of the ecological systems on the University campus, whenever the German project partners had returned to Germany for a period of time (IOV, 2010: 1.04; Gri-1: 1).

BUW, was responsible for structural planning and architecture and the implementation of the ecological buildings and designed the first and second ecological master plan in the project preparation and implementation phase of 2001 and 2002 respectively.

BBG coordinated the water and sanitation sector and spearheaded the implementation of sanitation installations inside buildings. In close collaboration with the UHOH and the VVU technical and working staff was responsible for both technical implementation, training and research of the ecological systems on campus from the initiation phase till the final implementation phase or project completion.

UHOHs' involvement was mainly agricultural research and the establishment of university farms, making use of the products generated from the water and sanitation sector also conducted training together with Palutec, BBG and some technical staff of VVU. UHOH like BBG and Palutec came on board the project in the third phase, and was responsible for major agricultural research such as the co-composting trials from the different dry toilet sources in the final implementation phase till the end of the project.

Palutec worked mainly in collaboration with BBG and the CIM partners, responsible for technical implementation such as sanitation installations outside buildings like installation of rainwater collection systems. Palutec, like BBG and UHOH was involved in the project in the third and fourth phase.

The conflicts that arose and led to a break in consensus amongst the German project partners were related to activities in the agricultural sector in the last phase of the project when the BMU "climate change" commenced (Gri-2: 2; Gri-5:3 & Gri-3:6):

"In their BMU project there were some things financed that were strictly opposite to what was being done and what was intended to do before and it will be very interesting to know the reasons that led to these decisions… or logic behind that and like I said, also before with the banana because they used the land for other things, Another thing I will like to know is that we planted avocado in a very innovative setup in certain small area catchments implemented when the rains and the water flows to a certain point and there were big holes dug up to increase the water holding capacity of soil and compost were filled in the holes a very nice setup; and the BMU came and they gave up the avocado plantation and started to plant oil palm, now oil palm is a crop of really high water demand, and even needs more water than banana, and that is something really interesting what is the logic behind it, but a documentation on that will be good to know how two ministries from the same government can fund on the same research area different things where one ministry financing what the other ministry has financed before and that will be definitely very interesting to know" (Gri-3:6)

Moreover, there was the BMU sponsored climate change project form 2009-2010, which came in the latter part of the implementation phase of the Ecological Development project, overlapping it. Some of its activities as reported by some members of the Gri-1-5 group mainly caused conflict and a break in consensus among German project partners.

Cooperation, the two way dark and larger dashed line constitutes higher level cooperation and interaction between all stakeholders (both Key and external) of the VVU project system, emphasizing a requisite for

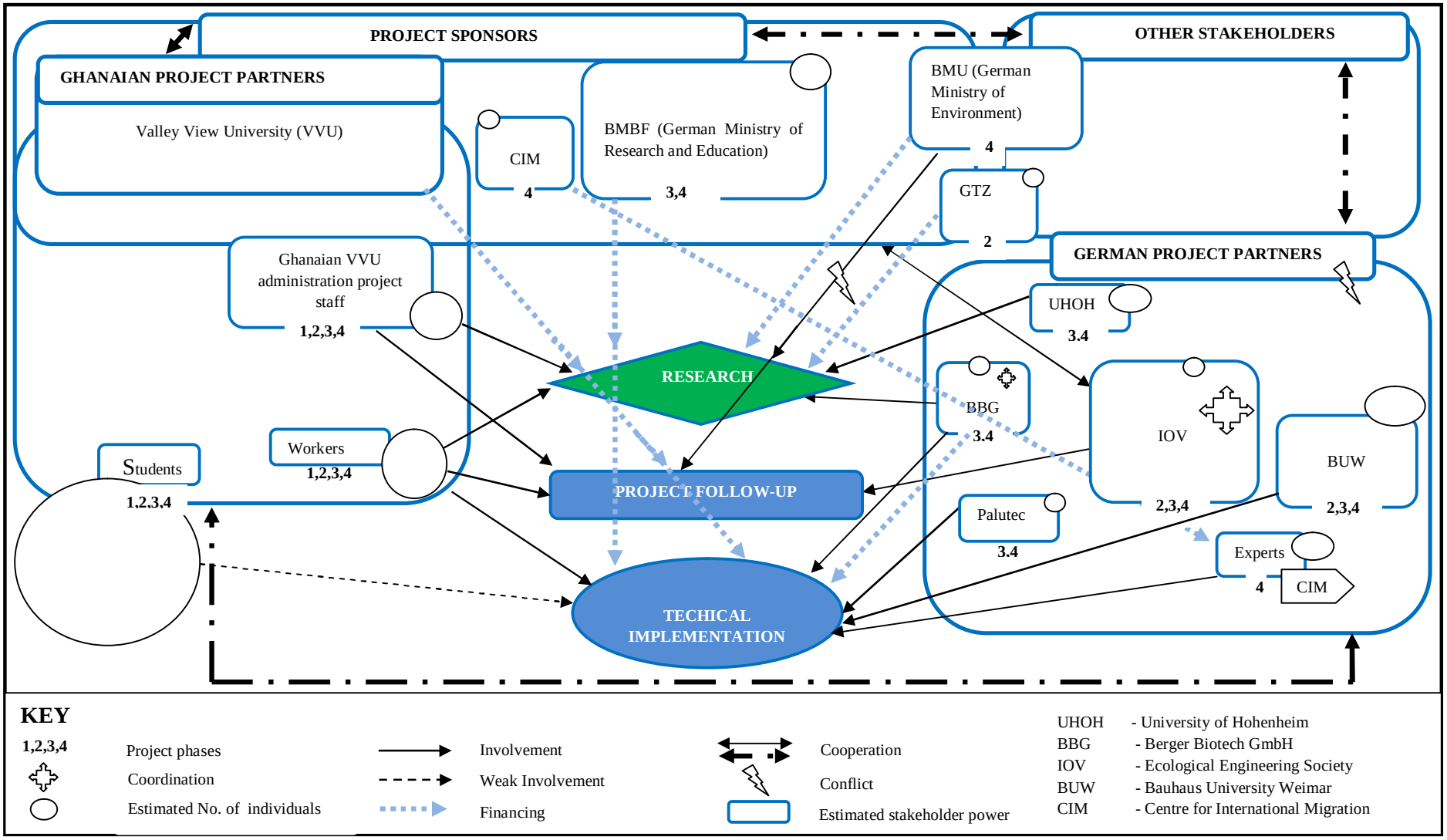
the continuous functioning of the overall project. Second is cooperation with the solid two way arrow head which implies, a much lower level mediation by IOV (responsible for coordination of the entire project), and between the major funding stakeholders such as CIM, BMBF and VVU.

Involvement constituted exchange of technical expectees between the German project partners and VVU. The internal conflict among German project partners is depicted by an involvement arrow with a lightening sign and another lightning sign in the German project partner column.

Project sponsors, referring specifically to the ecological cycle development project (which lasted from 2002-2009) included mainly BMBF and Valley view university administration. VVU served as project partner and at the same time financial sponsor of the project contributing staff and financial support for the establishment of the ecological facilities for research, project follow up and technical implementation, in collaboration with German project partners for all four phases of the project. This is represented by 1,2,3 and 4.This accounts for the overlapping curved rectangle for Ghanaian project partners in the map. They contributed technical and administrative staff and workmen to help build and manage the ecological systems on VVU campus for the project.

VVU based on the size of its curved rectangle including the external donors for VVU depicts the power it possessed in the course of the project a little bigger than the power the German project partners had as they could refuse proposals made to them by the German project partners as will be identified later in the analysis. Students as will be iterated later in chapter 5.3, were not included much in the initial phases of the projects research, follow up and technical implementation even though they were present. Never the less, in the last phase, vui-1-10 groups report of students being part of an eco working group and hence, dashed involvement, implying little involvement in the last phase of the project.

Figure 9: Stakeholder map [48]



Source: Own design, 2011

[48] In the Key,1234 represents the various project phases,**1**-for preparation (year 2000),**2**- initiation phase (2001),**3**- implementation I (2002 till early 2004) and **4**- implementation II (late 2004 till 2009)

4.2.3 Project stages 2000-2009

The project consisted of two main phases, the first phase or "pre-phase" which lasted from 12/2002-04/2004 and then the "main phase" from 5/2004-11/2009. For the purpose of understanding what informed some of the decisions in the different phases and to help the reader follow the different transitions in the project's development, this section attempts to give the reader a short overview of some of the steps and activities that were undertaken in preparation for the main project three years before the projects commencement (see figure 10).

Project preparation phase (year 2000)

Valley View University (VVU) started making plans for further expansion in the year 2000 when the first master plan was created. Forming a master plan committee together with a local Ghanaian Planning firm, the first master plan was established mainly based on the free circulation of people and traffic on the Universities campus. Unfortunately, this master plan was not done with an ecological concept in mind, according to IOV (2010: 03), it had a rather scattered arrangement of the buildings and a "too spacious" traffic route which led to the inappropriate arrangement of infrastructure and thereby hindering the designation of specific areas for agric and other special purposes.

In a quest to fulfill the standard requirements of a private university other buildings had to be constructed, and that same year the university's cafeteria saw its first construction works begin, following the design of drafted master plan (Vui-3: 13). For the year 2000, VVU consumed a total of 8500 cubic meters of water, of which 2960 cubic meters were got from the public supply system and the remaining 5500 cubic meters was transported by the Universities water tanker from other external sources. Estimations made on behalf of the university by experts revealed that each person from Valley View University's faculty consumed an average of 43 liters of water on a daily basis, for student resident on campus and commuting 35 and 8.5 liters of water a day respectively. These consumption figures compared to European standards are very low and indicated a limited supply of water for the University (IOV, 2010: 10). Hence, steps were made to find solutions to the problem and the initiation of the Ecological Development project.

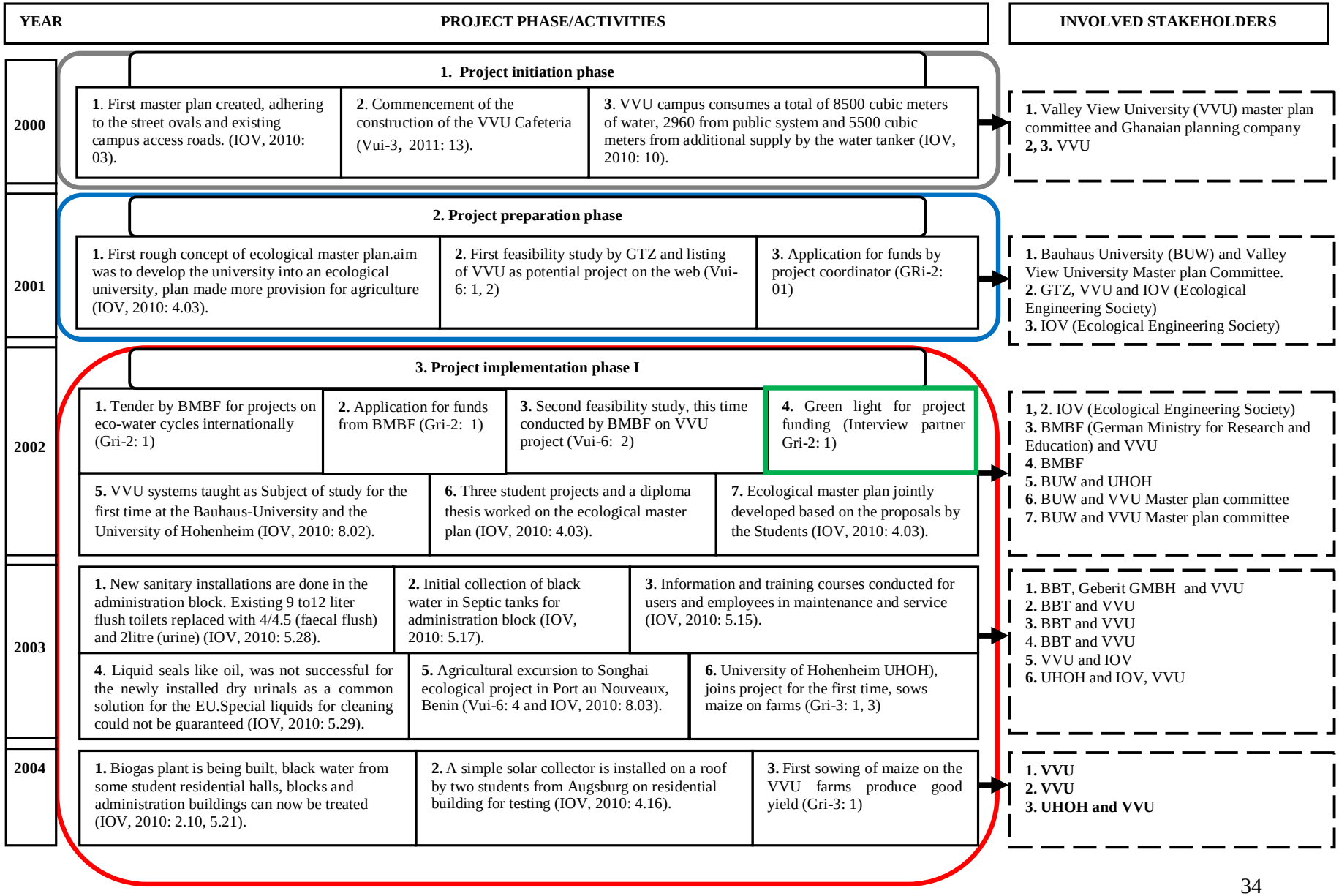
Project initiation phase (year 2001)

As already mentioned (see chapter 4.2.1: 28), the project came to being mainly to solve problems concerning water and sanitation, which triggered several other steps and an ultimate goal of becoming the first university in Africa. The first among such steps was the revision of the old master plan into an ecological master plan with the aim and concept of developing the university into an ecological university by making more provision especially for agriculture along with other diverse ecological functions, this was done by a group of students from the Bauhaus University and VVUs Master plan committee (IOV, 2010: 4.03).

In pursuit of funds to effectively implement the ecological concept on the campus, proposals were sent to different international funding agencies by IOV (Gri-2: 1) including the Gtz (Now GIZ)[49] who had plans on starting an Ecosan project, and thereby funding and conducting the first feasibility study on Valley View University and later listing VVU as a potential ecological project location on their website (Vui-6: 2).

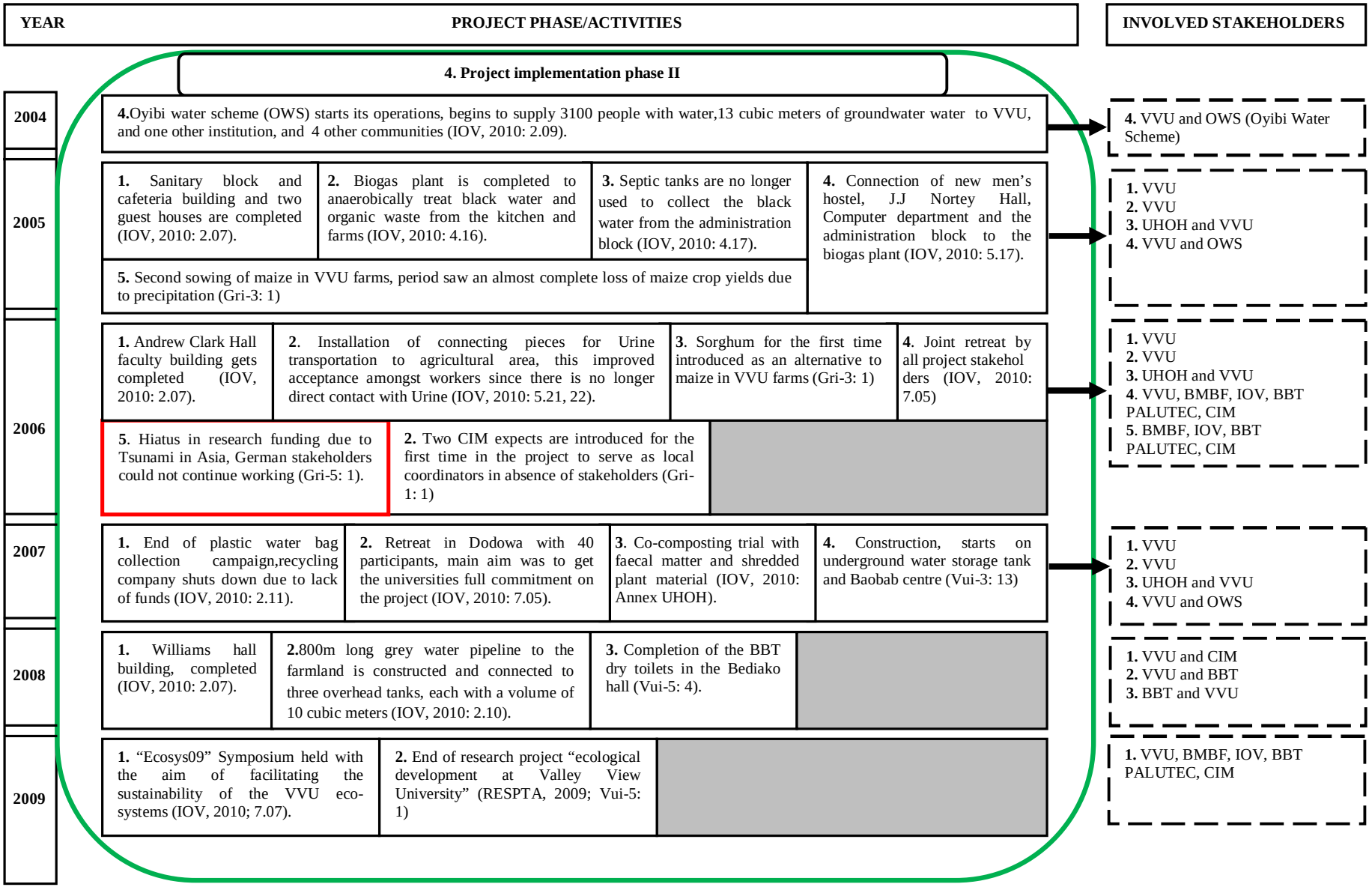
[49] See list of acronyms in page iii

Figure 10: Project timeline and History of significant activities in relation to water, sanitation and Agriculture



Source: own design, 2011

Figure 11: Project timeline and History of significant activities in relation to water, sanitation and Agriculture (Continued)



Source: own design, 2011

Project implementation phase I (year 2002 till early 2004)

The project pre-phase took off around 2002, at the time 750 students were enrolled at Valley View University (IOV, 2010: 2.07). The opportunity for funding the project came as BMBF (German Ministry of Research and Education) put forward a tender for international projects on ecological-water cycles. Immediately interview partner Gri-2 seized the opportunity and applied for funding (Gri-2: 1), the BMBF saw the potential of carrying out such a project and conducted the second feasibility study (Vui-6: 02). After the feasibility study was conducted BMBF finally approved the funding of the project as part of the "Research and environment-Subdivision of water and nutrients" research program (IOV, 2010: 1.03). Thus, Valley View University's ecological systems begun to be taught as a subject of study for the first time at the Bauhaus-University and the University of Hohenheim (IOV, 2010: 8.02), a product of such studies included three student projects and a diploma thesis which focused on the further development of the ecological master plan (IOV, 2010: 4.03), which was further developed and improved into VVUs final ecological Master plan from the proposed structures by the students (IOV, 2010: 4.03).

The following year (2003), some aspects of the ecological systems begun to take place, new sanitary installations were done in the administration block, the old flush toilets were replaced with new ones as part of the efforts to conserve water. The old flush toilets had a water using capacity of 9 to12 liters for each flush, which was rather too much water for a water scarce campus like Valley View University, so the flush toilets had to be replaced with water saving flush toilets and this time with a flush volume of 4/4.5 for fecal flush and 2 liters' for urine, this is to prevent waste of water when one only urinates in the toilet, dry waterless urinals were also installed with different types of seals to facilitate urine collection for further use as fertilizer in the agricultural fields, after two failed attempts for choosing the best seal for the urinals, membrane traps[50] proved more successful and were installed on the dry urinal systems (IOV, 2010: 5.28,29). Since the new sanitation systems demanded special use and maintenance in comparism to the conventional toilet systems, Information and training courses were conducted, spearheaded by Berger Biotechnik GMBH, to inform the users about the new techniques installed and to also train the employees like the cleaners and plumbers on how to maintain and service the toilet systems for sustaining the systems in the future in the absence of the project partners (IOV, 2010: 5.15).

After the toilets and urinals were installed and training was done, the first collection of the black water begun in septic tanks, because the biogas digester had not yet been built (IOV, 2010; p 5.17). To facilitate the up scaling of the Agricultural systems, an Agricultural excursion took the project team and other involved stakeholders to the Songhai ecological project in Port au Nouveaux, Benin where Ecosan systems were being practiced (Vui-6: 4 and IOV, 2010: 8.03).

That same year, the University of Hohenheim got involved in the project by contributing an agronomist who was responsible for the agricultural systems, the first planting and application of urine as fertiliser was done on maize for the VVU farms later yielding a good harvest the next year (Gri-3, 2011: 1, 3).

The next year 2004, saw construction works commence on the biogas plant, even though it was not completed, black water from Valley View Universities J.J. Nortey hall (residential halls), the sanitary block, the administration block, the computer department and the men's dormitory is now treated in the digester (IOV, 2010: 2.10, 5.21). Other ecological options such as solar-energy installations were also explored; a simple solar collector was installed on a roof by two students from Augsburg on residential building for testing (IOV, 2010: 4.16).

[50] See chapter 5.2: 53

Project implementation phase II (late 2004 till 2009)

Later that year (2004), the Oyibi water scheme (OWS) started its operations, It supplied 3100 people with piped groundwater in total,13 cubic meters of groundwater water was also supplied to VVU, one other institution, and 4 other communities (IOV, 2010: 2.09).

In 2005, Construction work on the Universities' Sanitary block, cafeteria building and two guest houses were completed (IOV, 2010: 2.07), the cafeteria building was to make use of the gas generated from the biogas digester for cooking activities and was connected to a fat separator, the sanitary block and guest houses were also installed with urine separation and waterless urinal facilities. The guest houses and the sanitary block were to serve as production points for urine as fertilizer and including the cafeteria, black water for the irrigation of the university farms. The cafeteria and sanitary block were both connected to the biogas digester. This year, the agricultural sector faced a major setback, the Second sowing of maize in VVU farms; saw an almost complete loss of maize crop yields due to precipitation (Gri-3: 1). As a result, the next year (2006), the maize was replaced with sorghum, which performed rather better in comparism to the maize from the previous year (Gri-3: 1).

In 2006, the project came to a standstill, there was a cut in research funding due to the Tsunami in Asia, German stakeholders could not continue working even though they wanted to. According to Gri-5, (1) The local stakeholders lost confidence in them.

The next year 2007 however research funding started to flow again and a retreat was organized under the auspices of the Coordinator, bringing together all involved stakeholders both locally and from Germany. The Retreat was held in Dodowa with about 40 participants and the main aim was to get the universities full commitment on the project once again for work to continue on the project (IOV, 2010: 7.05). In 2007, Construction works started on underground water storage tank and Baobab centre (Vui-3: 13)

The next year (2008) the dry toilets were built and located at the men's Bediako Hall of residence (Vui-5:4). These dry Toilets form the focus of the thesis and will be elaborated further in the next chapters. Another significant development that year was that, an 800m long grey water pipeline to the farmland was constructed; as a result Urine was no longer transported by tractor to the fields, but was simply channeled to three overhead tanks, each with a volume of 10 cubic meters on the University farms. This improved the workers ability to work more effectively and the acceptance also on the part of the workers (IOV, 2010: 2.10).

2009 marked the end of the project and an "Ecosys09" Symposium was held with the aim of facilitating the sustainability of the VVU ecological-systems, during this symposium lessons and experiences were shared from the part of both project partners from Germany and Ghana, the last day served to summarize the findings and included a colorful Ghanaian Closing ceremony, In attempt to obtain some feedback on how to further improve the management of the systems in the future, questionnaires were issued out to participants of the symposium (IOV, 2010: 7.07).

4.3 The VVU project from an ex-post perspective

4.3.1 Current state of the art of the VVU project

At the time of visiting the VVU campus (projects' site) in September 2011, a number of the ecological facilities established at the time of the project were still in place, some of the facilities were still in use, and some modifications were about to be made to some of the originally established ecological building facilities (Vui-4: 2):

> "some of them are not true to real tropical designs, because in the west, they want the sunlight into the buildings to augment the heating, but here we already have too much sunlight and would rather cut out sunlight and believe in sun-shading so that you don't have the direct solar rays into the building because the glare is uncomfortable, but unfortunately they did not take that into consideration so most of the buildings there are not truly tropical designs" (Vui-4: 2)

The university together with the ecological engineering society (EES) and other companies and universities had undertaken a second project known as the "climate change project", which overlapped with the Ecological development project starting from 2009 – 2011 (Vui-5III: 1), in an attempt to upgrade the ecological facilities on campus in the ultimate quest to becoming the first ecological university in Africa.

At local level, VVU stakeholders interviewed expressed their satisfaction on the performance of the ecological sanitation technologies established the university and reported on how beneficial it has served the university, creating a good image and saving them economic costs.

Today, there is still connection between VVU, and the German project partners in the form of random contacts and follow-up, both partners possess a mutual responsibility and ownership of the ecological systems established on the university campus. In the case of serious problems with some of the systems, VVU contacts from time to time their German partners for assistance and vice versa when some information is needed concerning Ghana. Among some of the German partners themselves there is however currently a break in mutual friendship as a result of some conflicts in the course of the ecological project (see chapter 4.2.2: 30).

The VVU administration is currently being managed by new and old staff, some staff in the university was present at the time of establishment of the ecological facilities. Concerning the management of the Ecological systems, the physical plant department mainly handles the management. Two main branches for the ecological systems on campus at the time of this study had been developed, one is for "environment and sanitation" catering for categorized all the ecological systems, farms, grounds, Horticulture and janitorial works (Vui-5I: 6) and the other is for physical plants, conducting architectural and building construction (Vui-4: 1). Both departments together are responsible for the implementation and management of buildings and the other for the ecological sanitation facilities as wells as the agricultural aspects on campus.

4.3.2 Background for evaluation of the project and approach

At the point of conducting this evaluation, there were no major evaluations conducted on the VVU project yet, apart from a student master thesis and the evaluation conducted by the BMBF at the time there was a break in funding for the project.

Both the staff of VVU and the German partners together welcomed the idea of conducting an evaluation and generally provided most of the needed support to assist the realization of the evaluation. This is

because stakeholders of the project were eager to find out the current status quo of the project they implemented.

A logical framework or clear cut project objective outline was not available in the final report of the project, project objectives were sampled into one table from the different sections of the projects final report. A number of project objectives existed, however objectives were collected in relation to water and sanitation and agriculture which is the center of attention of this study.

"The environmental goods and services industry consists of activities which produce goods and services to measure, prevent, limit, minimize or correct environmental damage to water, air and soil, as well as problems related to waste, noise and eco systems. This includes cleaner technologies, products and services that reduce environmental risk and minimize pollution and resource use."(OECD, 2005: 02)

VVUs project was geared at promoting sustainable development, the university's ecological master plan emphasizes the Universities aspiration of becoming the "first ecological University in Africa" (IOV, 2010: 1:03). It made use of new and innovative green technologies such as the closed loop nutrient recycling concept of Ecosan amongst other environmental goods and services of town planning and architecture (Geller and Laryea, 2008: 2).

The entire VVU project therefore presents itself in the category of "activities which produce goods and services to measure, prevent, limit, minimize or correct environmental damage to water, air and soil, as well as problems related to waste, noise and eco systems". Thus, the sampling of project objectives and analysis was done in this direction, since future efforts seek to upgrade the concept of Ecosan technologies in the light of climate change and sustainable development.

5. Evaluation of overarching project objectives

As previously mentioned (chapter 3: 21), ten overarching objectives were sampled with their corresponding activities clustered according to environmental goods such as water, wind, air and man. The main aim of evaluating these overarching objectives is to identify lessons and recommendations in the projects design, set-up, implementation and follow-up clearly laid upon the Water & Sanitation, Agriculture and Capacity building (training/information/managerial) aspects of the VVU ecological research project. To evaluate the achieved results of the various objectives, analysis was based on the RBM approach by checking results differentiated by the output, outcome and possible impact levels[51].

To allow for the effective analysis of project activities, the ten overarching objectives identified for the study, were further summarized into three main objectives. The first objective remained unchanged, whilst 2,3 and 4 were put into one, forming a second overarching objective, which is "To construct and install ecological toilets, and equip them with urine diverting devices and membrane traps to ensure separation for further re-use in Agriculture in conformation with international standards of wastewater re-use (IOV, 2010: 4.13; 5.27; VVU-Brochure[52], 2005: 2, 4)". The following 5, 6, 7, 8, 9 and 10 which comprised mainly managerial activities were further categorized into a third objective which is To promote quality management for the sustainability of the entire ecological system on campus (IOV, 2010: 3.06, 07; 8.04). This was done to facilitate an ease of analysis and incorporation of the pertinent lessons and recommendations of the VVU project. In corresponding chapters they will be presented in the sequence: Objective 1, Objective 2 and Objective 3.

5.1 Objective 1

To generate and treat various dry toilet composts by repeated self-heating and verify the composting process and its hygiene potential by testing finished compost for traces of germs in and around campus (IOV, 2010: 5.27; UHOH, Unknown)[53]

5.1.1 Description of objective

As part of the agricultural sector of the VVU research project, the above project objective sought to generate urine as fertilizer (from UDDTs) and compost from treated human fecal matter and grass clippings (IOV, 2010: 5.27) in order to achieve the core principle of Ecosan which involves "closing the nutrient cycle loop"(GTZ, 2004: 23). Thus, this project objective was meant to discover the most efficient dry toilet compost recycle option in operation and maintenance to save cost, and promote hygiene on the VVU campus and ultimately "determine the duration and most effective treatment processes suitable for the climate of southern Ghana" (IOV, 2010: 5.17).

According to findings of the field study and based on related project reports, compost and urine as fertilizers were meant to be generated with human fecal matter and grass clippings from two different dry toilet trial sources, namely: a previously constructed KVIP (Kumasi Ventilated Improved Pit Latrine) at a men's hostel (J.J Nortey) at the Valley View University campus[54], and finally a Urine Diversion Dehydration Toilet (UDDT) at the Bediako Men's hall (Vui-5; Vcpf-2; IOV, 2010: 5.27; Germer, 2010: 186).

[51] See chapter 2: 18 for the definition of results on the different levels
[52]" Water and nutrient concept" brochure on the Ecological Development of Valley View University, Accra
[53]See https://www.uni-hohenheim.de/respta/poster/UHOH_0001.pdfand https://www.uni-hohenheim.de/respta/poster/UHOH_0003.pdf [last accessed 5th February 2012]
[54] A pseudo-replicate compost trial with a dry ventilated (non-separating) toilet was conducted on the "Orphanage Africa" a Village close to VVU.

In general, human fecal matter for composting and urine as fertilizer, have to be treated before their use in agriculture due to the likely presence of harmful disease producing agents. The treatment of compost and urine from the different dry toilets however did not require any sophisticated methodology, but was meant to be done through storage (urine) and self-heating[55] (compost) correspondingly which is a common process through which most compost is made (IOV, 2010: 5.27, 36; Vcpf-10; Vui-5; RESPTA, 2009).

Hence, the project objective sought also to promote hygiene by verifying the presence of contaminants or any "disease producing agents" in the different finished compost trials and urine-fertilizers before being applied to trees and non-leafy vegetables (IOV, 2010: 4.15, 5.27; Vui-5). Special attention was planned to be given to observing which dry toilet compost trials could generate standard temperatures high enough to kill potentially harmful "disease producing agents" while preserving the nutrient content of the compost at the same time (UHOH-RESPTA, Unknown)[56].

Also, other procedures and activities related to the operation and handling of the different dry toilet compost sources such as collection, storage, and transport, were planned to be tested to ascertain the most suitable source for human fecal matter composting (RESPTA, Unknown: 1)[57].

5.1.2 Results of project objective

In order of what was done sequentially, the results according to the trials conducted with the aforementioned project objective are outlined in ensuing chapters in the order; KVIPs and then UDDTs.

Results of project objective 1 on Output level

Compost trials from KVIP

As part of the trials to determine the most suitable dry toilet urine fertilizer and compost source, the first trials could easily be commenced with a KVIP dry toilet. It was already constructed and in use at the VVU campus, so the first trials were conducted during the rainy season from mid May to early August 2007 with fecal matter from the KVIP (RESPTA-UHOH, Unknown: 1). The KVIP was a one dry toilet unit located at the J.J Nortey students' hostel in VVU (see figure 12 b), constructed before the start of the ecological research project. It had been used for 10 years (Germer et al., 2010: 186), and had six chambers with two pits each (see figure 12a) with the possibility of switching use when one pit was full.

Prior to choosing the KVIP as the first trial collection source, trials were planned to be conducted close to the schools administration block (IOV, 2010: 5.16) which was strongly rejected by the local partners for fear of potential negative health implications and the tarnishment of the universities' image:

> "They were going to shift the raw feces straight to the farms and actually at that time they were not even talking about composting, they wanted to take them there and apply them raw. These were to be applied to mango plantations and not to vegetables or plants that grow lower on the ground, so they felt that it won't harm the plants, but we were considering the people who will be applying them and then also people who may walk in there and find feces all over the place so we didn't accept that…This is a student campus coming from all back grounds, the least misinformation that gets out could have very bad implications, for e.g. if someone goes out to say that; in the VVU campus you see toilet all over the place" (Vui-3: 6).

Nevertheless, trials were conducted on the KVIPs, and not close to the administration as feared. Unlike UDDT dry toilets, in KVIPs there is no immediate diversion of urine from fecal matter and the addition of

[55] According to Gallenkamper et al., 1993 (cited in Brinton et al., Unknown: 2), self heating "drives the compost process".
[56] see https://www.uni-hohenheim.de/respta/poster/UHOH_0002.pdf [last accessed 4th February 2012]
[57] see https://www.uni-hohenheim.de/respta/poster/UHOH_0003.pdf[last accessed 4th February 2012]

saw-dust. Hence, the fecal matter (mixed with urine and toilet paper from the men's hostel KVIP) was collected in its raw form from the KVIP toilets' manhole with the help of VVU workers, Interview partner (Vui-5II: 6), described the collection, application and handling of the KVIP's fecal matter trials as a "big challenge" and the VVU workers also regarded the collection of raw fecal matter as a disgraceful act, so compromising terms with both the local and foreign technicians for trials had to be reached before the trials could be done:

> "So they said they wanted to do it at night so that they are not seen, and they wanted that amount of money and they agreed, we agreed and it was done" (Gri-1: 10)

Protective health measures however were taken such as the use of gloves, masks, boots and boiler suits to prevent any potential health risks. Even so, some problems were still encountered in the collection, handling and preparation of the raw fecal matter for co-composting with reports from the Vcpf-7-10 group, which indicated that even though all necessary protective gear was provided, the odor alone generated during the transportation and preparation of the raw feces could potentially deter farmers from preparing compost from fecal matter:

> "I remember that when it was started a certain man from Germany came and we mixed the fresh fecal matter and that was not easy. I believe it was for his project work, so he employed some people to help him. We chopped some grass and put it on top, so every week we turned the fresh fecal matter. As for that one, no one will like to do that kind of work anymore. As for the BBT, the fecal matter over there is dry, so I don't think we will have any problems" (Vcpf-9)

In spite of the problem mentioned involved groups (Gri-1-5, Vui-1-10 and Vcpf-7-10), reported and confirmed that the compost was generated through *open co-composting*[58]. Fecal matter was combined with grass chippings and the mixture was made into heaps, with different ratios of fecal matter to grass chips at different day intervals (see figure 12c).

Figure 12: KVIP toilet chamber (with toilet pits) at J.J Nortey hall (a), back view of the KVIP (b), co-compost trials with sludge from KVIP(c).

Source: Weselmann, 2007: 44; RESPTA[59]

Periodical temperature records were taken at different times of the day and turning frequencies were tested, to determine the suitable turning frequency for each of the different heaps to finally find out which heap could generate the required temperatures to kill any traces of harmful pathogens (Gri-1: 10).

There was some form of training done for the farm staff on the preparation of compost and its application on crops. This was done by demonstration from the local and foreign technicians of the project, in a "learning by doing" manner jointly done with both local and foreign technicians:

[58] Uncovered composting method which does not involve the use of closed containers but done in the open
[59] See https://www.uni-hohenheim.de/respta/prog.php [last accessed 8th March 2012]

"After doing it, they tell you to also try to see and it was the same for both feces and urine" (Vcpf-8: 1)

A second trial was conducted in 2008 and ended in 2009 for the KVIP but under advanced conditions, this time *closed composting*[60] was done. Four compost chambers were used and food waste and scum from a fat separator was included (Vui-3; 2) for the co-composting process (see figure 13a); two compost chambers were insulated in the inner compost chamber with Styrofoam and the two others were not (Germer et al., 2010: 185).

Once a week, scum was collected from the fat separator which was mixed and co-composted with the fecal matter from the KVIP. It was mixed with grass clippings and sawdust and allowed to decompose for about three months. The compost was then collected into heaps (see figure 13c), on average 5 heaps with each heap estimated to be 1 cubic meter (Vui-5: 1.1).

Figure 13: Second trials with fecal matter from KVIP, with insulated (left) and uninsulated (right) compost chambers (a), solarisation (b), co-compost trial heaps, with sludge from KVIP (c) peak temperature records (d)

Source: RESPTA-UHOH, unknown: 1(a, b, c); IOV: 2010: 4.14(d)

Treatment this time was done first by simple pre-composting and solarisation[61] (see figure 13b), then drying and incineration and further burying in order to monitor the bacteria load and test how efficient the compost could be made hygienic, verification was then made on the compost by lab testing for the presence of bacteria, virus and ascaris eggs (RESPTA-UHOH, unknown: 1).

Results on Outcome level

Average temperature records obtained from the first open compost trials in 2007 was less than 55°c, which is a common international composting temperature requirement (BioAbfV, 2006; cited in Germer et al., 2010: 190), also the duration for which temperatures lasted was not enough to deactivate any harmful bacteria or disease producing agents (RESPTA-UHOH, unknown: 1).

However, the results of the second compost trials in 2008 generated peak temperatures of up to 70°c(see figure 13d) for over two weeks, and temperatures could be maintained (as compared to the first trials) due to the change in composting conditions like the compost chambers and addition of food waste which induced the high temperatures. This duration and temperature obtained were within common international standards (Hogg et al., 2002a; Noble and Roberts, 2004: cited in Germer et al., 2010: 190)

There was the deactivation of *Escherichia coli, Enterococcus faecalis and Salmonella senftenberg,* over 5 log10-units in all cases in "test containment systems placed in the core of the compost" (Germer et al., 2010: 185). Even still, there were some traces of bacterial activity on the cooler outer layers of the

[60] Covered or anaerobic composting method which involves using enclosed containers (Davies, 2011: 77)
[61] A practice aimed at sterilizing seeds and other micro-organisms in top soil commonly used in agriculture

compost, but the extension of the composting period to 4 months was capable of deactivating all traces of E.coli and salmonella.

Also, with experience from the trials, fecal composting should best be done in the wet season instead of the dry season; first due to the deciduous nature of some trees (meaning absence of enough biomass for composting) and second due to the readily available rainwater and sunshine in the wet/rainy season needed for making the compost (Vui-5I: 5; Vcpf-10: 2).

According to the Vcpf group-7-10 and the Vui-1-10 group, the compost was applied to sorghum, maize and plantain, pawpaw, moringa and mangoes; mainly trees but the compost was not applied to vegetables because of still existing health concerns especially about heavy metals that exist even after the treatment of human fecal compost.

What's more, at the time of conducting this evaluation, it was observed that composting with human fecal matter was not being done, Vcpf group-7-10 and Vui-1-10 groups revealed that what is currently used in the farms is what is referred to as "urine compost", urine-water mixture, and cow dung and poultry droppings from nearby farms:

> "We hardly use the toilet compost, what we use is chicken manure, this is what we use to fertilize the farms, we don't use the fecal compost" (Vcpf-7: 1)
> "We normally use all other organic nutrients we have on campus except the fecal matter, because not much research has been done on it and we are still looking into that because the dry toilets were built in 2008, the first experiment we did with fecal compost was in 2007" (Vui-5II: 3)

Furthermore the author also found out that organic food waste from the university kitchens' cafeteria was not being used, due to the improper separation of solid waste from organic wastes in the universities' kitchen and cafeteria:

> "The organic waste shouldn't have been a problem if the composting had been going on very well, and again it requires some sorting out, because they still get the organic waste mixed up with other solid waste and this makes it difficult to get them to the composting sites, but if they can sort them it will be easy to compost" (Vui-3: 3).

The non-utilization of fecal compost cannot be attributed to the lack of know-how with composting work, as practical experience with the composting done from both the first and second trials of the KVIPs could be accounted by Vcpf-7-10 group and local technicians in the Vui-1-10 groups:

> "We went to fetch the fecal matter, chopped pieces of grass and put it down first, and then you fetch the fecal matter onto it and put the grass on it again just like compost… After every two weeks you have to turn it just like you mix a cement/sand mixture, and we left it till everything was decayed-both the grass and feces, and when you see it, it no longer looks like feces anymore, but rather like soil. If you fetch it there is no smell in it. If you are told its faecal matter you won't believe it" (Vcpf-8: 1).

This evidently depicts an effective transfer of knowhow with the KVIP composting trials, since most members of the farmer group (Vcpf-7-10) interviewed as well as local technicians, demonstrate and confirm that they will be able to independently conduct such co-composting on their own without supervision. The fears of some of the farmers were alleviated through practical demonstration by farm technicians who jointly worked with the farmers:

> "Even the last time we did the application our boss used his bare hands to collect the compost material in order to demonstrate to us that there was nothing to be afraid about the fertilizer. So

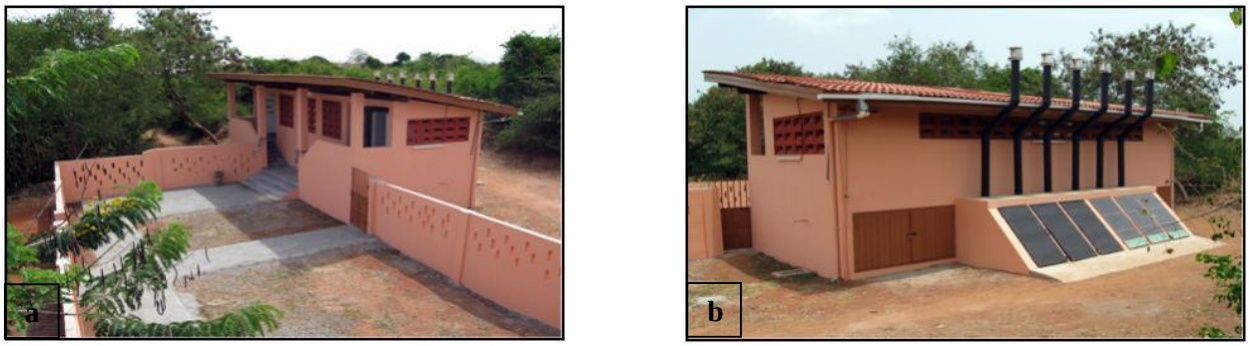
we also realized that it's not something we should be afraid of and since it is not fresh fecal matter but decomposed, one can use it without fear. Also with the urine, it has been stored for a while to kill any germs or harmful materials" (Vcpf-9: 2)

Compost trials from UDDTs

As part of the trials, compost and urine as fertilizers were also generated from one UDDT unit designed by the Berger Biotechnik. It was constructed with joint funding from VVU, BMBF and Berger Biotechnik GMBH (BBT-RESPTA, unknown: 1) at the latter part of the project in 2008 (Vui-5II: 3), however utilization could only begin in 2009.

The UDDT Unit was known as the BBT-Berger Biotechnik Toilet (see figure 14a and b). It contained 6 chambers and was designed specifically to be locally affordable and easy to build and purposely dedicated to high collection, immediate separation and easy removal of dried human fecal matter and urine (UHOH-RESPTA; BBG-RESPTA Unknown: 1) for further composting and application as fertilizer respectively.

Figure 14: Front and back view of 6 chambered BBT located at Bediako Men's hostel in VVU



Source: BBG-RESPTA, Unknown

A caretaker was assigned to manage the BBTs, and on a daily basis was tasked to clean and transport "pre-composted[62] fecal matter to composting chambers (See figure 15c), approximately 100 meters away from the BBTs. To avoid mixing the fecal matter and urine with chemical disinfectants, vinegar with water was used as a cleansing agent for the toilets because it disinfected the toilet units and did not alter the nutrient potency of urine and the pre-composting mixture before co-composting (Vcpf-2; IOV, 2010: 5.29). Vinegar, according to Kocsis (2010: 19) is a "non toxic and completely safe" cleansing agent and unlike many other detergents poses no final threats to the valuable nutrients of the compost. The urine however was diverted with the help of a small vent and membrane trap (see figure 15a), designed to trap odor and finally channeled into 2000 liter volume ($2m^3$) storage tanks for later use.

Moreover, the separated human fecal matter prior to co-composting[63] from the BBTs was applied with saw dust on a daily basis to serve as an "absorbing" material to keep moisture low (WHO, 2006: 83), using large size "pomo tomato" tins and this helped the mixture to desiccate[64]. At the first time of installment of the BBTs, the Vcpf-1-6 group reported that it took about 3 months for the bins to get full even with daily use (Vcpf-2: 1). The mixture was then transported in wheeled bins (see figure 15b), of

[62] As used in this sense refers to fecal matter added with saw-dust which helps absorb liquids and keep the mixture dry, prior to co-composting in the compost chambers, pre-composted because the composting process starts somehow with the addition of saw-dust.
[63] Co-Composting is the controlled aerobic degradation of organics using more than one materials e.g fecal sludge and organic solid waste, open co-composting and In-vessel co-composting are two main methods. see http://www.akvo.org/wiki/index.php/Co-composting [last accessed 15th February 2012]
[64] Preserve by removing all water and liquids

240 liter/0.24m^{3}volumes to the vented brick-compost chambers for further treatment by heating and transformation into compost (Vui-5: 2I; Vcpf-8; IOV, 2010: 5.27).Urine on the other hand, was stored in tanks with volume 2000 liters (see figure 16b) to be treated and sanitized for at least a month, after which it was ready for fertilizing trees and non leafy vegetables.

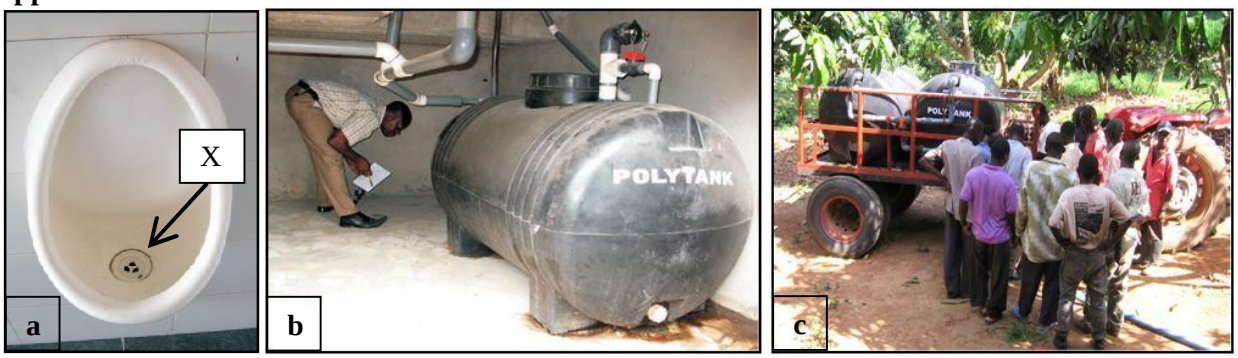
Figure 15: Dry toilet with fecal and urine separation (a) by means of membrane trap (X below), wheeled bins for transport of pre-fecal compost (b) and Chambers for composting(c)

Source: RESPTA

Apart from the Urine diverting toilets[65], dry urinals (see figure 16a) were also installed and connected to the urine tank. Transportation of urine from the BBTs was initially done using tractors (see figure 16c), and the urine was sucked using suction pumps. There were some technical problems related to the use of the pumping machines, however, these problems were resolved by technicians of VVU:

> "Those pumps were designed purposely for water, and the acid content was messing up the pumps, so sometimes we had to wash the pumps and clean them, we had to open the entire system and wash it with water and fix it after that" (Vui-7: 3).

Figure 16: Dry urinals (a) with membrane trap (x) for odor entrapment, storage tank (b) for storing diverted urine, mounted tractor (with tanks) for transporting urine to the farmland for application



Source: IOV, 2010: 5.29, 5.32; BBG-RESPTA, Unknown

[65]Other sources (discussed in overarching objective 2) exist for pure urine and urine-water mixture generated in large quantities from waterless urinals and water saving separation flush (WSSFTs) toilets from the Universities' sanitary block, administration block, Baobab centre, Columbia block and J.J Nortey hall (Vui-5II: 4).

Results on outcome level

After a while, the problem faced was solved even further, as transportation of urine was improved by directly connecting the different urine-sources with pipes to larger storage facilities in the farms, this improved acceptance amongst the workers (IOV, 2010: 5.22).

The application and good performance of urine as fertilizer on the farms could be noted on the part of all the respective groups. Unlike the fecal composts generated from the UDDTs, for most of the individuals interviewed in the farmer groups (Vcpf-7-10) were able to give very vivid accounts of the application (Vcpf-7: 2; Vcpf-8: 1; Vcpf-9: 1) and outcome of urine as fertilizer on the farms:

> "We didn't face any major problems; instead we had very good yields. First we applied to maize and then we applied to sorghum and it came alright" (Vcpf-7: 1)

Therefore, know how transfer on the application of urine can be said to have been very effective, and it can be observed that for urine in particular, application was easily realized and was still being collected for use on the farms at the point of time of this study. Especially for urine, acceptance and appreciation of use could be observed on the part of the farmers due to their practical experiences with the different yields generated at the time of trials with different sources of fertilization:

> "I believe the fecal matter and urine fertilizers generate more yields than the chemical fertilizers. We tried the different fertilizers, and when harvesting we did that observation and realized that the urine and fecal composts generated more yields than the chemical fertilizers. We also used ordinary compost but the urine and fecal matter achieved the best yield" (Vcpf-9: 2)

As for the amount of compost to be produced calculated by the project, it seems that the intended goals couldn't be met for diverse reasons.

> "We were wondering why the toilets were not generating the expected amount of urine and feces, and wondering why it was much less as we expected from making estimates in relation to average number of users"(Gri-2: 3).

Some reasons for this was already found from the interviews made and mainly attributable to the fact that estimations were made without considering possible problems that could arise with operation and maintenance as well as other socio-cultural factors which could directly affect use, maintenance and collection rates in the toilets:

> "The real situation was like this; The cleaning lady in the morning is told "please go to this site and make sure all is proper and people would like to go there, so she's on the way" and then Pastor XYZ meets her and tells her she has a letter for her and sends her on a different errand to give out a letter to a different person at the expense of her task. Again, trying to go to the toilet to work, the next high official does the same and in the end the toilet does not get cleaned and people couldn't use the toilets, hence the low urine and fecesturn up" (Gri-2: 3).

At the time of visiting the project site it could be observed that the compost from the UDDTs was not being used, what was currently used was "urine compost", urine-water mixture, cow dung and poultry droppings from nearby farms:

> "After, we started collection of the fecal matter to compost; they have never used it in the farms so far to my knowledge. They made trials once, and there is another one in another side that they used once but as for this they don't or haven't used them in a long time" (Vcpf-2: 4)

The major reason identified for the non use of fecal matter is due to still existing health concerns especially about heavy metals that exist even after the treatment of human fecal compost, local technicians deem it necessary to clear all health doubts about composting before they will be confident to utilize the human fecal composts from the UDDTs:

> "There is one major area which is of much concern which is the presence of heavy metals and I believe you are aware that in the whole of Europe and also in Germany food that are grown here are not readily accepted as organic foods because of the presence of heavy metals and the possibility of cross contamination and improper treatment is one of concern even though individuals eat these products, the national picture is one that won't be so easy to do. These are some of the challenges" (Vui-5III: 4)

Other reasons were identified from the Vui-1-10 groups and Vcpf 7-10 groups, some especially from the farmer group seem to have the misconception that the fecal composts from the UDDTs need a longer storage period before it can be rendered ready for use:

> "For the fecal matter, when you store it you will have to turn it and mix it up with the grass, so that whiles the grass decomposes the fecal matter will also be decomposing. And the one we have has been stored for about one year, so it takes long to store the fecal matter" (Vcpf-9: 2)

With regards to the composting chambers, at the time of the study, the author found them in a dilapidated situation (see figure 17 a & b), particularly the one located close to the Bediako hall.For the other set of composting chambers located by the cafeteria, even though also This was mainly due to the actions of termites in the area.

Figure 17: Dilapidated compost chambers

Source: Authors field study, September 2011

5.2 Objective 2

To construct and install ecological toilets, and equip them with urine diverting devices and membrane traps to ensure separation for further re-use in Agriculture in conformation with international standards of wastewater re-use (IOV, 2010: 4.13; 5.27; VVU-Brochure[66], 2005: 2, 4)

5.2 Description of Objective

The water and sanitation aspect of the Valley View University (VVU) project sought under the aforementioned objective to install ecological toilets on the VVU campus under a "water and nutrient concept" (VVU-Brochure, 2005); to save water, cost, generate nutrients, and minimize pollution in the process (BBG-RESPTA, Unknown: 1[67]; Vui-7: 1; Vui-2: 1; Vui-3: 1; Vui-5:1;Vui-6: 1;Gri-2: 2; Gri-3: 1)

Prior to project start in 2003, flush toilets with a high water consuming capacity were being used on campus and disposal of toilet waste posed high financial cost, management and environmental problems for the University (Vui-3: 1). Hence, the new ecological toilet installations were intended to ensure sustainable use in line with "closing the water and nutrient cycle loop" (GTZ, 2004: 23); particularly of water due to water supply problems faced in the university, as well as wastewater treatment with an increasing student population (IOV, 2010: 5.02).

Based on related project reports and according to findings of the field study, three main types of ecological toilets[68] were intended for installation on the VVU campus; Water-Saving Separation Flush Toilets (WSSFTs (1)), Water-Saving Flush Toilets (WSFTs (2))[69] and Urine Diversion Dehydration Toilets (UDDTs (3)). Also, waterless (dry) urinals were planned to be installed for the men's toilets (IOV, 2010: 5.27, 5.28).

Out of the water saving flush and separation toilets planned to be installed, different streams of waste-water (blackwater, greywater, yellow water and brown water)[70] were intended to be generated, treated and rendered safe before being released into the environment or used in agriculture (IOV, 2010: 5.10).

5.2.1 Results of project objective

For ease of analysis and comprehension of what was done during the project period, results have been categorized based on what was implemented; first for Water-Saving Flush Toilets and secondly UDDTs.

Results of project objective 2 on Output level-Water-Saving Flush Toilets (WSSFTs and WSFTs)

Spearheaded by Berger Biotechnik GMBH (BBG), the company and project partner responsible for the installation of sanitation systems inside buildings for the entire project (see Appendix 3: 88 in Annex), WSSFTs and WSFTs, according to findings of the study were installed at the following locations on the VVU campus: administration block, sanitary block (by the Cafeteria), faculty building/Columbia hall and NASDAG Hall.

---

[66]" Water and nutrient concept" brochure on the Ecological Development of Valley View University, Accra

[67] See https://www.uni-hohenheim.de/respta/poster/PB_0002.pdf [last accessed 20th March 2012]

[68] Water saving flush toilets were also installed that do not contain source separation and for that matter cannot be considered entirely as Ecological toilets, but in the context of this project, the black water generated was fed into a biogas digester for further re-use and for that matter was considered among the ecological toilets.

[69] Urine separation in WSSFTs is the main difference between WSSFTs and WSFTs, both toilets have the same water saving flush capacity.

[70]Blackwater is a mixture of feces and urine with or without flush water from toilets, yellow water contains urine only or **mixed** with flush water from toilets, brown water is black water with no urine and greywater is generated from domestic water without feces and urine (IOV, 2010: 5.10)

In 2003, when the projects' first phase started, there were delays in the installation of the separation toilets and the construction of building facilities which were needed to generate the different nutrient streams to be applied in agriculture (Gri-3: 2). German project partners were concerned that the ecological systems could not be installed in the planned time frame. The installations required heavily depended on VVU establishing the needed systems to ensure the continuity of the research, however implementation was postponed on several occasions:

> "There was time pressure to achieve that, to make these installations possible, for e.g the faculty buildings had to be built, so 2003, in spring we sat together with VVU asking when exactly the buildings will be installed; can this be done in autumn? They said yes. The time was due but nothing happened" (Gri-2: 3).

According to findings of the study and based on interviews conducted, most of the installations were financed by VVU (Gri-2: 3; Vui-6: 3). It appeared VVU was having difficulties in making finances available at the time due to the cost involved with the WSSFTs and WSFTs to be installed at the administration block to allow the project to continue:

> "The only worry I had was the pricing of the toilets, the cost of the water saving flush toilets were about four times more expensive than the conventional flush toilets" (Vui-3: 11)

Hence, the reason for the delays was mainly a financial one on the part of VVU, and this initially could not be discovered by the German project partners due to a barrier in socio-cultural communication:

> "We expected the Western habit of giving a direct straightforward answer being a yes/no, but in this case their yes meant no and I was wondering why it was so till I realized later on that we were honored guests and they knew in spring that their financial situation would not allow this and for them it was quite clear that they could not do it in autumn. In Germany, the partners would have said no, forget about it and if it's possible we have no money and even if we had the money we will not be able to handle it properly, but that will have been very impolite to these honored guests. Ghanaians cannot deal with honored guests in this way and rough speaking is not the mode of Ghanaian hospitality so they could only say yes. But this is an important thing and there are more Ghanaian ways of doing things which we didn't know but had to learn" (Gri-2: 3)

Administration block

Nevertheless, in 2003 the first toilets' installed were WSSFTs and WSFTs (see figures 18a and 19a) imported mainly from Germany, with lower flush volumes of 4 to 4.5 liters per flush, at the ground floor of the administration block of VVU to replace existing flush toilets with high flush volumes of 9 to 12 liters (IOV, 2010: 5.28). The administration block was selected as it was the biggest point of wastewater generation at the time. Planning and installation work lasted about 5 months from June till November. They were finally ready for use by early January 2004 (IOV, 2010: 5.15; Vcpf-6: 2). Dry urinals were also installed (see figure 18c) to generate pure urine, after other different urinal systems with seals were tried and failed (IOV, 2010: 5.28).

Users were allegedly trained[71] on the rightful use of the newly installed toilets and urinal systems whiles employees (mainly plumbers and cleaners) were also trained by BBG (see figure 18b) on procedures to service and maintain the toilet systems as this was key in helping ensure sustainability and proper functioning of the systems (IOV, 2010: 5.15).

[71] See Chapter 3.1 for more on training (capacity building)

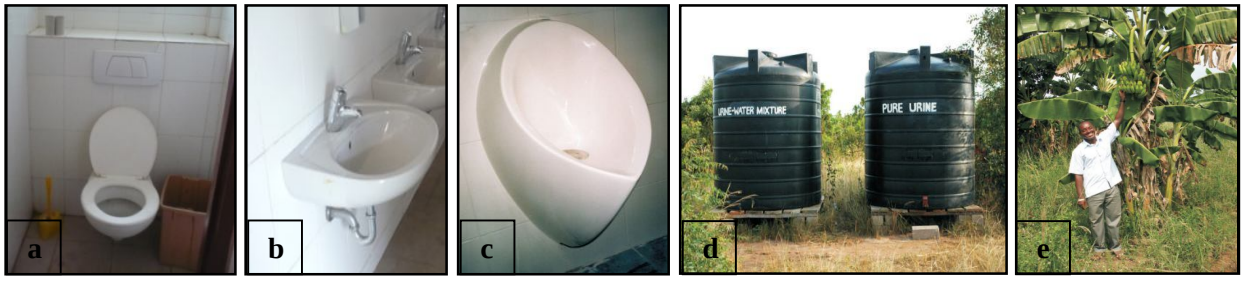
Figure 18: WSSFT with urine separation vents (X) (a), training of plumbers and cleaners (b), polyethylene urine storage tanks (c) and maize field on VVU campus applied with urine from the administration block (d).

Source: IOV, 2010: 5.28, 7.03, 5.15 & 4.14

To prevent the use of potable drinking water for flushing the toilets, rainwater harvesting through rain gutters mounted on the roofs of the administrations' building was constructed by Palutec GmbH, a company mainly responsible for sanitation systems outside buildings for the project (Gri-1: 4). An underground cistern ($32m^3$) was erected to store the harvested rainwater (IOV, 2010: 5.17; 5.28).

To further determine acceptance and functioning of water saving facilities, two types of taps were installed at the male and female toilets of the administration block for hand washing, one was a battery powered photocell tap programmed to open when hand motions were detected which unfortunately did not work due to high power requirements. The second was a self closing pneumatic tap (see figure 19b)[72] with a special function of flowing for 8 seconds when pressed. This was kept as it was much easier to maintain and was accepted more by the cleaning and service personnel (IOV, 2010: 5.29; BBG & Palutec-RESPTA[73], Unknown: 1).Grey water was generated from the hand-washed water from the sinks and was used in the irrigation of bananas on the agricultural fields on campus (see figure 19e).

Figure 19: WSFTs (a), self closing pneumatic tap (b), dry urinals at the administration block (c), larger storage polyethylene urine/urine-water tanks (d) Greywater irrigated bananas at VVU farms (e).



Source: (a &b) authors field study, 2011; IOV, 2010.5.29, 5.34 & 4.12

Blackwater and brown water generated from the water saving-flush toilets were initially connected to a septic tank close to the main administration. However, in 2005 when two biogas digesters (dome-shaped with $36m^3$ volume) were constructed, both blackwater and brown water were further channeled into the biogas plant (IOV, 2010: 5.20).The biogas generated was used in supplying gas to the Kitchen for cooking, and formed 25% of the total gas utilized (Vui-3: 2).

Urine on the other hand was connected to three polyethylene urine tanks (see figure 18c) of $1m^3$ volumes, treated and sanitized through storage for at least a month. For ease of emptying and transportation the

[72] These taps were further installed in all other sanitary establishments on campus (IOV, 2010: 5.29)
[73] See https://www.uni-hohenheim.de/respta/poster/PB_0003.pdf [last accessed 27th March 2012]

tanks were simply placed on ground level. The urine was collected with the help of pumping machines and tractors and later transported to the Agricultural fields to be stored in larger urine storage tanks (see figure 19d) to allow for further use[74].

Results on Outcome level

The urine generated from the administration block was applied to maize in the projects' first phase (2004) and the yield was good, however in the second phase (2005) some major drought related problems were experienced, as the maize was not drought resistant and led to a complete loss of the maize planted. So sorghum was used as an alternative which did rather well in comparison to the maize (Gri-3:3; IOV, 2010: 5.22).The problem encountered with the second maize yields generated with the urine, according to (Gri-3:3) was because no form of assessment was done to determine the suitable crop type for the area:

> "We started to sow maize and that was definitely a mistake which could have been avoided if we had started a little better with evaluation, we had done what everybody else was doing but it was not necessarily the best to do what everybody is doing because everybody was sowing maize but in this region definitely sorghum is much better" (Gri-3:3).

With regards to the toilets installed, according to Vcpf-6 (1), maintenance of the toilets is much difficult to carry out as external contractors were employed to do the installations:

> "Sometimes when there is a new contract for instance and they bring contractors from outside to do the work, the contractor does it any how he/she likes, and leave and after they leave we have to face the problems that they leave behind. Since we were not the ones involved in doing the installations, when they leave it's a bit difficult to do the maintenance" (Vcpf-6: 1).

Conversely, at the point of time this study was conducted, the WSSFTs and WSFTs, urinals and pneumatic taps at the administration block were still in good condition. Plumbers and technical staff however expressed fears that soon maintenance will be a problem as the parts of the installed facilities in the system cannot be generated locally (Vcpf-6: 1; Vui-5III: 3; Vui-4: 1):

> We started using those toilets in 2004 but up till now some are still working and some of them the fittings inside are broken and we have replaced it several times and with that one when it spoils and you work on it doesn't even look like the new one because of the maintenance and after a short while it gets spoilt again, like about last week I went to work on it. I did some maintenance on it, that is the flow valve and filling valve, even though they were good but nothing lasts forever, and when they spoil like that we find it difficult to maintain (Vcpf-6: 2).

The ecological toilets at the administration block are still in use, and the urine/urine-water mixture is being generated and used in the university farms for fertilizing and irrigation purposes. Black water and brown water was observed to be still fed into the biogas digester which generates gas but unfortunately is currently not being used by the kitchen staff as the quantity generated is currently very little:

> "That particular digester was designed principally not for the gas, but for the waste management so the gas that comes out is not much, if we really want more gas, then we have to feed the system, because there is a feeder, and it can be fed with Cow dung, and left over foods, and they haven't been doing that and I think that people have this conception which I don't know how real it is about biogas, that it is not as hot as LPGs and so they prefer the LPGs" (Vui-2: 4)

[74] See also chapter 5.1: 49 for further information.

Sanitary block by Cafeteria

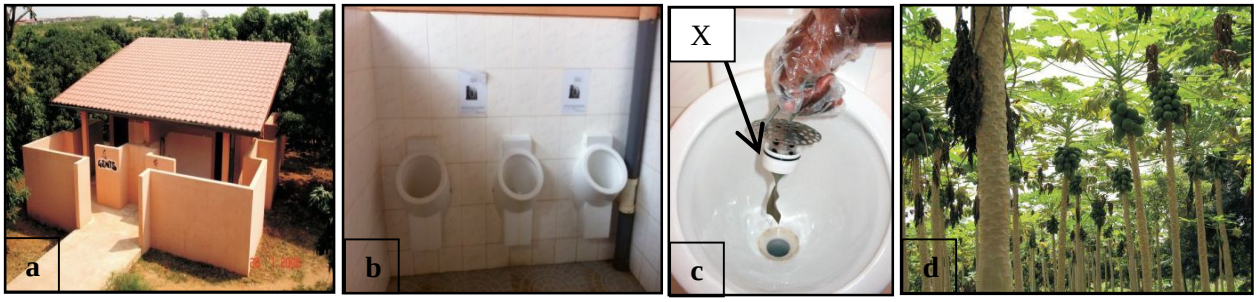
The sanitary block was constructed in 2005 (see figure 20a), it was the second toilet unit installed with Water-Saving Flush Toilets. Based on the experience gained from installing the WSSFTs and WSFTs at the administration block, project partners decided to install, this time, WSSFTs for the female users only and install WSFTs for the male users but with waterless (dry) urinals (see figure 20b). Vinegar was used in cleaning the toilet and urinal systems; especially those with the membrane traps (see figure 20c), to prevent any form of destruction of the membrane traps and contamination of nutrients with other unsure detergents (Vcpf-1: 1). However, some problems with utilization of the WSSFTs could be observed on the part of the female users as a result of the use of vinegar for cleaning the toilets due to health concerns:

> "We were using vinegar in cleaning, some felt they were not clean enough and some of the ladies informed us that some of their colleagues actually squat on the toilets and we had to explain that to them and put up the signs" (Vui-3: 10).

Hence, posters[75] guiding users on the right utilization (sitting and not squatting), indicating further use of nutrients in agriculture and general information about the respective toilets were placed in and around the toilets and also in all the other ecological toilet facilities on campus.

Around the same time the sanitary block was constructed (2005), the biogas plant was also completed and therefore connected to the sanitary block. "Wastewater streams" generated from the sanitary block included blackwater, greywater, pure urine and urine-water. Black water was channeled to the biogas digester and greywater[76] generated from the wash basins of the sanitary block was added to greywater generated from the University kitchen and cafeteria and was initially transported using tractors to the farms and applied to vegetables and fruit trees (see figure 20d) like mangoes and papaw (IOV, 2010: 4.13).

Figure 20: Sanitary block (a), waterless (dry) urinals (b), dry urinals with membrane trap (X) (c), Greywater irrigated Pawpaw at VVU farms (d).

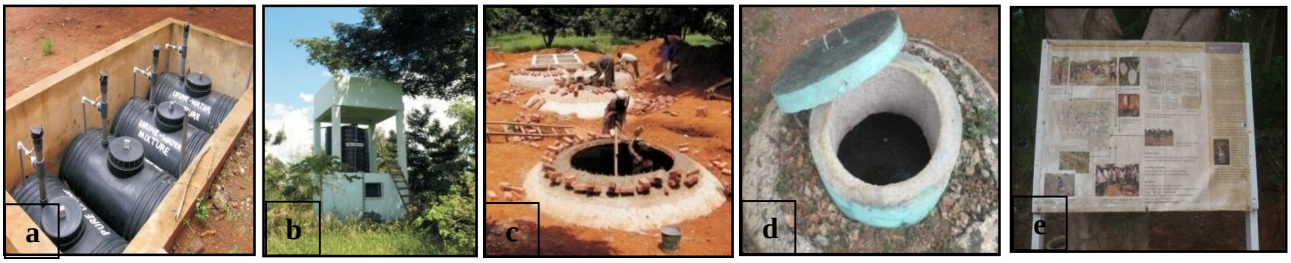


Source: IOV, 2010.5.20 (a); (b) authors' field study, 2011; IOV, 2010.5.30, 4.13 (c & d)

Four urine tanks of $1m^3$ volumes (see figure 21a) were fitted at the backside of the sanitary block mainly to collect pure urine and urine water-mixture from the waterless urinals and separation toilets respectively. Blackwater on the other hand was connected to the biogas digester (see figure 21c & d) to allow further treatment (IOV, 2010: 5.20).

[75] See chapter 5.3 for more information.
[76] Grey water was and is also being generated in large quantities from the NASDAG hall, but the author chose to skip this as it does not form part of the study.

Figure 21: urine storage tanks at sanitary block (a), tank for greywater at the VVU farms (b), biogas digester at time of construction (c), biogas digester at time of field study (d) Sign post (e)



Source: IOV, 2010: 5, 22, 21, 38 (a, b, c); authors' field study, 2011(d, e)

Results on Outcome level

Transportation for both the urine and grey water generated was initially a problem as the tractor, the only transport medium, had to be used also for construction purposes. After a while this problem was solved as the greywater was connected with pipes to the university farms and stored in an elevated tank (see figure 21b) to be pumped directly when needed (Vui-5II: 2).

More so, other cultural related problems[77] were also encountered with the acceptance of greywater transportation and application on the part of the VVU workers due to the diverse tribal backgrounds from which they originated. According to Vui-5I (3), workers were initially reluctant to work with the greywater generated especially from the women's toilet and bathing facilities due to manifest socio-cultural aspects:

> "From the start, the workers handling the greywater from the ladies hostel believed that if women go through their menstrual cycles what they produce are not hygienic to handle, in some cultures even if you menstruate during the month they actually isolate you from the main house. There are so many places in Ghana that still practice this, some places currently in Ghana are in the North and Volta region they still practice this because they think that to them you are not clean"(Vui-5I: 3).

The author observed mainly user-maintenance problems associated with the toilets installed at the sanitary block. The Vcpf 1-4 group reported of problems associated with the incorrect use of the facilities such as failure in flushing due to water shortage[78] and "messing up the place", as described by the cleaners in the local "twi" language "womo asei ho nyinaa" which literally refers to the practice of users defecating indiscriminately in and around the toilet bowl and occasionally on the ground. On such problematic episodes (also observed at the time of the study (see figure 22a)), the cleaners were given the instruction to simply lock up the place till the facility was cleaned properly.

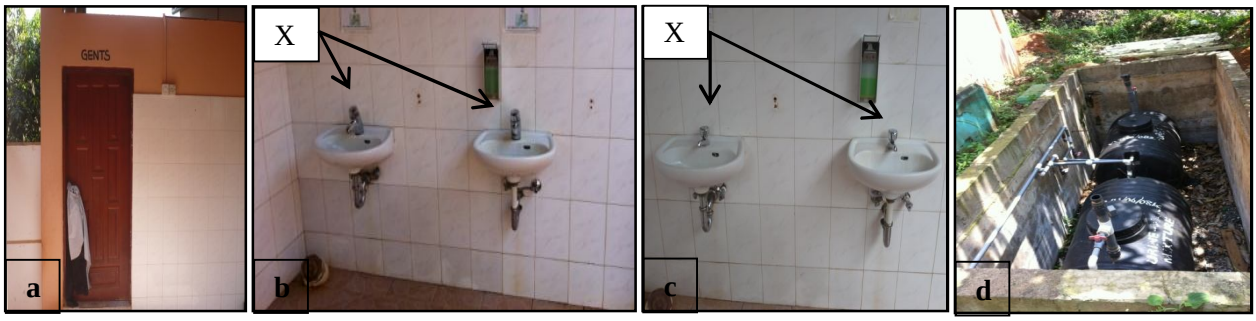
The problems mentioned beforehand were incumbent during and after the projects' period. Hence, in concurrence to the problems mentioned with the use of the toilets, the dry toilets became a necessary measure, and VVU decided to then construct the dry toilets (UDDTs) or BBT at the men's hostel:

> "After a period with no water or low water the flush toilets built started to stink and there had to be a solution to solve this smell in the University, because no one could flush the toilets at the same time water was limited and had to be supplied to the university by water tankers. The University then decided to have the dry toilets instead".

[77] More articulate at the NASDAG women's hall where grey water was generated from the bathrooms
[78] Water shortage is linked to power cuts, as electric pumps are used to pump water to supply the entire university see chapter 4: 28

What's more, the author took notice of some changes made to some of the water saving facilities installed at the sanitary block due to the unavailability of spare parts. The pneumatic taps had been replaced with regular taps and according to some members of the Vcpf-5-6 group one day all the systems will have to be replaced someday if parts are not readily available.

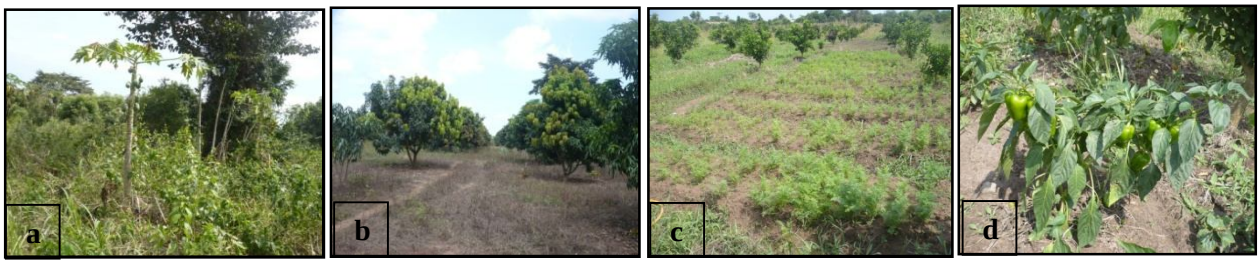
Figure 22: An episode of a locked sanitary block (a), water saving pneumatic taps (x) before (b), replaced "regular" taps (x) after (c), urine tanks reduced to two (d)



Source: authors' field study, 2011

The urine tanks had also been reduced to two (see figure 22d, compare to figure 21a), instead of four, and an extra concrete tank had been built besides it. A tour of the university farms revealed that the pawpaw farms (see figure 23a) were barely existent. . Instead, the mango (see figure 23b) and cashew farms were in very good condition and seemed to be very well maintained Orange and Jatropha trees had also been planted and vegetables of different varieties were being grown such as green pepper, carrots and okro (see figure 23c and d).

Figure 23: Pawpaw farms at the time of study (a), mango farms (b), carrots intercropped with oranges (c) and green pepper (d)



Source: authors' field study, 2011

UDDTs-Berger Biological Toilets (BBTs)

The BBT (see figure 24a) was constructed close to the Bediako Men's' hall in VVU in 2008 (Vui-5: 4). It contained 6 toilet units and was intended to cater for about 200 users from the Bediako hall. It was also meant to serve as a simple, cost effective toilet building design which could facilitate hygienically safe recycling of human organic matter for reuse in agriculture locally. With acceptance of the BBTs, it was intended to replicate the design in public areas of other local communities (BBG-RESPTA, Unknown: 1). The design of the dry toilet (UDDT) was an output of a master thesis, which customized existing dry toilet systems to come up with an archetype, which is the BBT. It was constructed at a cost of €5,759 being €4750 for building materials and €1,009 for workmanship (Weselmann, 2007: 99).

The BBT was specifically built as a standalone toilet facility with very little or no dependence on water supply. The BBT makes use of waterless/dry urinals, urine diversion and dehydration toilets (to facilitate

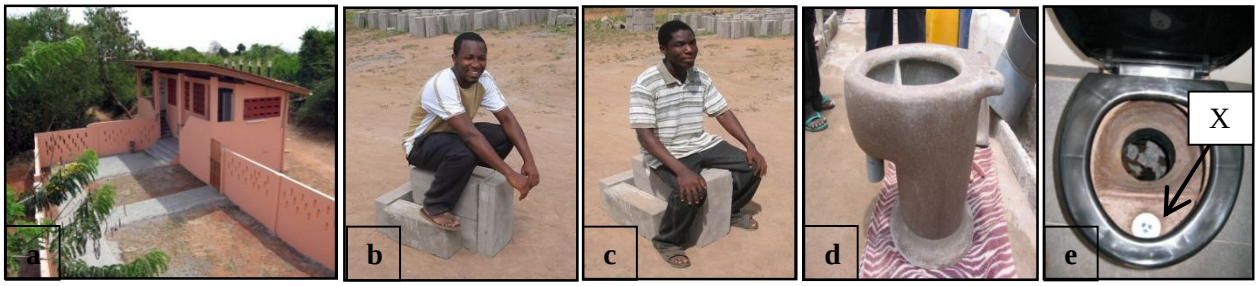
separation of fecal matter from urine for further composting)[79] . It also makes use of rainwater harvesting, storing rainwater mainly for floor cleaning and hand washing to further promote hygiene for users (IOV, 2010: 5.26). The toilet pots (see figure 24d) and hand wash basins were constructed locally together with Berger Biotechnik GmbH and a Ghanaian artisan, purely made from concrete (terrazzo) as the toilets imported from Europe for the administration and sanitary block were too expensive (Gri-5: 2).

According to Gri-5, (1) the proposed construction of the BBT dry toilets was initially rejected by external authorities of VVU from the USA. The UDDTs were regarded to them as outmoded and they wanted to have toilets of alleged higher standards:

> "From the beginning I wanted to have dry toilets in the region because of the lack of rain in this region since it was in the shady area of the mountains, so there was not enough rain...We didn't want to have too much black water from the flush toilets, but at the time the SDA headquarters in the USA said they didn't want dry toilets and that they preferred future toilets" (Gri-5, 2011: 1)

Flush toilets were therefore installed initially for the students at the Bediako hall. Each room had 1 flush toilet facility to 8 students (Gri-5: 6). However, water shortage problems led to strong odor from the toilets as they could not be flushed, and the university finally decided to opt for the dry toilets instead:

Figure 24: front view of BBT (a), hybrid model demonstration squatting (b) and sitting (c) locally made model of separation toilets (d), sitting toilets with membrane traps (x) (e)



Source: BBG-RESPTA Unknown: 1 [a, d, e]; BBG photo archives, Unknown [b, c]

As a result, the UDDTs were constructed towards the latter part of the project in 2008. Hence, operation only started late 2008/early 2009 when the project was almost over (Gri-5: Gri-1: 9; Vui-5: 4). Prior to construction, contributions about user preferences were informally collected from the main users (students from the Bediako hall) and cleaners and incorporated in the design (Gri-1: 11):

> "I went round asking the students for their inputs before the toilet was constructed through this I made my notes and had some orientation which direction was best" (Gri-5: 2)

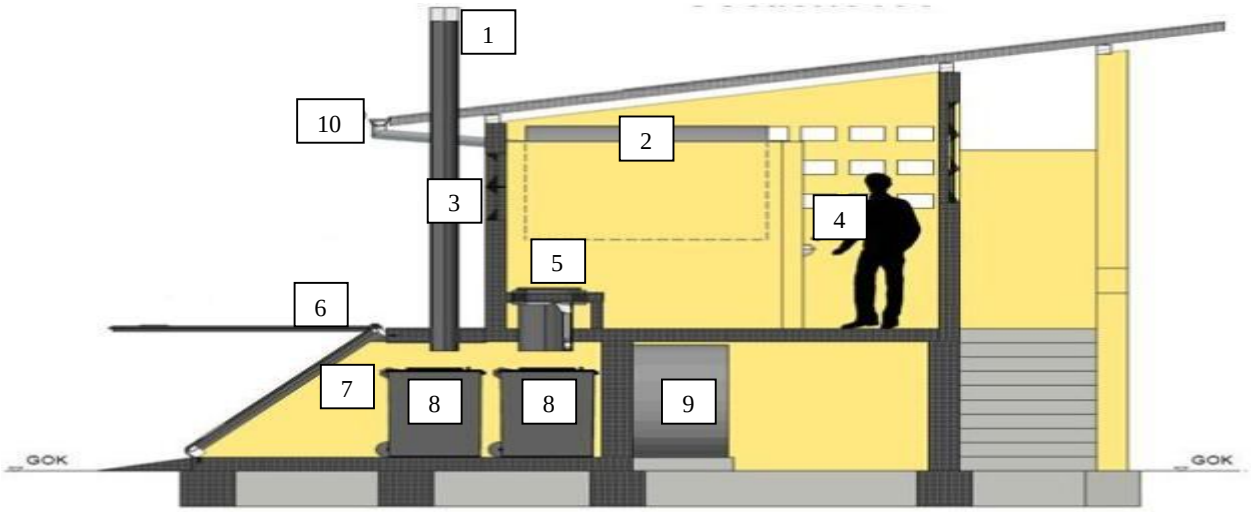
The product of the informal survey was that half of the students wanted sitting dry toilets and the other half preferred squatting dry toilets. Hence, a hybrid model (see figure 24 b & c) was made initially by Gri-5 to allow the usage of both squatting and sitting. However, the university decided the toilets should be sitting toilets instead, so sitting toilets were made (Gri-5:2).

A model of the UDDT dry toilet was placed inside and outside the toilet facility to explain to users and visitors how the toilets work and how it should be used. Users were taught not to squat, but sit upright (to allow the separation of urine from feces) on the toilets and use the dry urinals when they needed to urinate. Mainly students from the Bediako hall and the responsible cleaner were trained on the proper

[79] see chapter 5.1 for more information

utilization, operation and maintenance of the newly constructed toilet systems (Vcpf-2: 3; IOV, 2010: 5.30; 7.05).

Figure 25: Pictorial illustration of the main features installed on the BBT dry toilet UDDT.



Source: IOV, 2010: 5.27

Important features installed on the UDDTs can be identified according to the different numbering from 1-10 (see figure 25); a wind powered ventilator (1), to keep the air circulation fresh in the toilet units to prevent odor. Rain gutters (10), to harvest the rain water into a rainwater tank (2) with 2000 liter volume ($2m^3$) for storing the harvested rainwater which was used as water for the washing of hands through installed hand wash basins (4) after using the toilet facility, also for other cleaning purposes on the facility. A solar heated vent pipe (3) to ensure the escape of excessive heat from the saw-dust fecal matter mixture, sitting toilets (5) with urine/feces separation (see also figures 24e), a chamber flap (6) for closing the substructure chamber (7) unit to prevent the entrance of flies and for housing the exchangeable mobile bins (240 liter volume) (8) and a urine storage tank (9) with 2000 liter volume/$2m^3$ (IOV, 2010: 5.27; BBG-RESPTA[80]).

Results on Outcome level

According to Gri-5, there were some maintenance problems encountered in the course of the project due to the carelessness of the plumbers in dealing with the spare parts imported from Europe for some of the toilets:

> "Because I had a whole store of spare parts which were destroyed by the plumbers who did the maintenance, since they have no feeling for expensive things, they didn't know that the toilets were worth half a year's salary; the value of these spare parts and succeeded in destroying them by mishandling them, and when one part is missing the entire system doesn't work". (Gri-5: 2)

All the same, after the construction of the BBT dry toilets, other students (including female students) from other student residences in the university requested to have such toilets outside their student homes (Gri-5: 7):

[80] see https://www.uni-hohenheim.de/respta/poster/PB_0004.pdf and http://www.berger-biotechnik.com/downloads/-projects/berger-biological-toilet.php [last accessed April 4th 2012]

> "It is very nice compared to the ones we know that is the WCs. At the time they introduced it was very nice to the extent that students from outside were coming here to use it and we were even fighting with them that it's for the hall" (Vsr-2: 16).

A common structural error was made in the design and construction of the BBT which caused male users not to use the dry urinal facility, however upon realization of the mistake, it was quickly corrected:

> "I made a mistake with my dry toilets in Ghana as well. It is due to the construction of the urinal wall orientation some part was exposed and people didn't use those urinals in this exposed parts and we had to solve the situation after observing this" (Gri-5: 9).

In September 2011, it could be observed that the flush toilets installed at the Bediako hall were still in use but in rather bad conditions (see figure 26a). As compared to the BBTs where a cleaner had been assigned to clean the toilets, the students have to clean the toilets themselves and cannot do it as they should (Vcpf-2: 3).

Conversely, the BBTs were still in use and most of the installations were still functioning, but there were still some problems. Upon field observation and based on the interviews conducted from the Vui-1-10, Vcpf-1-10 and Vsr-1-5 groups, the major interconnected problems that exist with the BBTs at the moment have to do with misuse, non-use, maintenance and operation strategies.

Misuse of the toilets could be stated mainly on the part of the students who currently reside in the hall, while the Vcpf-1-4 group complained that the toilets were previously used properly by the students who were present at the toilets initial completion:

> "My problem is, with the way the students use the toilet systems, they always mess up the place. The second thing is that they urinate unto the feces which should not be so, at first when the facility was built, the other students who were here that have graduated and gone used the systems much responsibly, but those that currently live in the Hall misuse the facility and that is one main problem because there is lots of flies and the place stinks nowadays" (Vcpf-2: 1, 2).

Some members of the Vsr-1-5 groups admitted that their colleagues misuse the facility and render them impossible to use for subsequent users:

> "Inappropriate usage makes it difficult for one to use because you can't flush anything, and once someone has soiled it, it means you should find another alternative otherwise you can't use it" (Vsr-2: 15).

Other members of the Vsr-1-5 groups reported that the reason for misuse of the toilets was mainly from construction workers[81], who were working on the hostel facility who hadn't yet received any form of training on the proper use of the toilets (Vsr-2: 18). Instead of sitting on the toilets, the alleged users (whether students or construction workers) tend to squat instead:

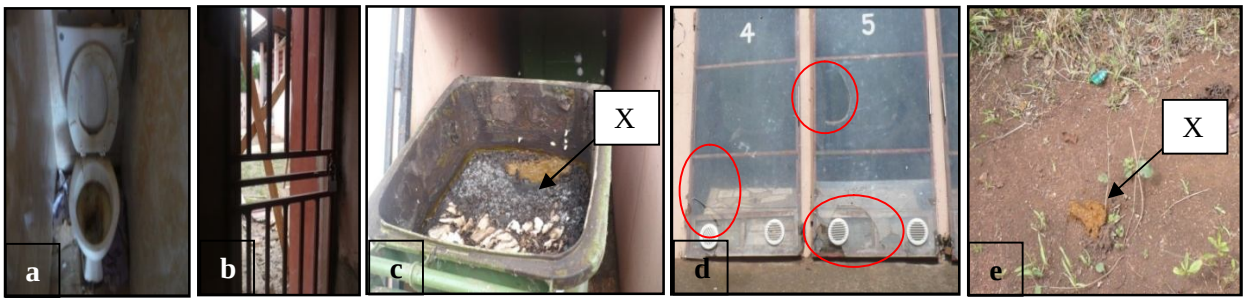
> "At other times it's just out of shear vandalism, and because it's willful, they won't come to report to the administration, but am also inclined to think that some of them just want to squat" (Vui-3: 10,11).
>
> "the workers don't normally drop the tissue inside the bin like they are supposed to and they drop it on the floor, so you go there and the place will be smelling, also people don't sit on it they rather squat on it, because of the heat that comes out" (Vsr-2:)

[81] At the time of this study, construction work was ongoing for the Bediako hall whiles the students were living there.

This further affects also the quality of the saw-dust/fecal (see figure 26c) compost mixture and the rate at which the bins get full, as urine gets mixed up and causes it to stink and heat up:

> "I will recommend every night they should take it away every night because sometimes they leave it and the bin becomes too full. That produces heat and your clothes will begin to stink. So I recommend that every day the place should be cleaned for the next user to feel comfortable" (Vsr-3: 19).

Figure 26: flush toilet in the rooms of Bediako hall (a), locked access to the BBT (b), urine mixed fecal mixture (c), broken transparent chamber flaps (d) and open defecation by Bediako hall (e)



Source: authors' field study, 2011

What is more, some students argued that misuse of the toilets by some students is simply due to the pressure on people who cannot have the time to read instructions before using the toilet facility:

> "Sometimes also due to pressure with visiting the facility I think people just disregard the rules and just do their own thing because if you have to go you don't really consider rules, all you want to do is ease yourself"

The misuse of the toilets leads to non-use as the toilets are simply locked up (see figure 26 b) to prevent the students from further soiling the place and to allow the stench to leave:

> "At the moment it's been messed up, I don't know if you were here about three days ago, it was locked up. The authorities told me to lock it for one week, so that the stench and flies will leave, because at first there were no flies"

As a result some students who prefer to use the BBTs and can't use the flush toilets indoors resort to open defecation, as according to one of the students, the satisfaction generated from the use of the BBTs is like freeing oneself in the open:

> "When it was done initially, using it was like freeing yourself in an outside environment like going to the bush, because you could feel some good breeze from beneath at first, but this time there are some scents" (Vsr-1: 8).

Moreover, other students claim that the BBTs cannot cater for all the students at certain times of the week as high patronage of the facility leads to pressure on the carrying-capacity of the toilets:

> "Sometimes early in the morning, when you go there it will be full. On Fridays till Sundays they don't clean it and they don't open it, the workers don't normally drop the tissue inside the bin like they are supposed to and they drop it on the floor, so you go there and the place will be smelling" (Vsr-2:)

On the operation and maintenance side, there seems tobe a fall out from the careless practices of the plumbers as stated by Gri-5. A problem at the moment is the unavailability of some parts.Specifically the membrane traps, to help curb the smell from the toilets as confirmed by the Vcpf-2:

> "It had to do with parts, like an appliance in the toilet systems, and when things get spoiled, how to replace is a problem so we had to take it out and park it and wait till it was brought from Germany and that was a big problem. But comparatively to the ones on the market from England and China, these ones are more durable" Vui-4: 1, 2

With regards to the physical structure of the BBT, the only problems observed at the time of the study was the broken/ cracked transparent chamber flap[82] (see figure 26d), which allows the inlet of flies.

The operation strategy currently used for all the toilets' is to lock up the place, to allow the stench and flies to leave. Consequently, connected to the problems outlined beforehand is the non-use and misuse of the toilets, which and ultimately generates little quantity of the expected urine fertilizer and fecal composts.

Some members of Vui-1-10 group report of the benefits directly related to agriculture generated from the establishment of the Ecological system through the project:

> "it costs them less with this project, because they don't spend much on certain things like the farm where all the waste water and grey water from the Dormitories which would have been wasted are connected to a reservoir tank to collect all the greywater which can be pumped straight into the farms, and they use it to water the mango, banana, cashew and pawpaw trees and this helps the trees to do very well" (Vui-10: 1)

[82] Refer to part (6) of figure 24: 56

5.3 Objective 3

To promote quality management for the sustainability of the entire ecological systems on campus (IOV, 2010: 3.06, 07; 8.04)

Vital for the realization, continuation and success of development efforts is how the capacity of stakeholders is developed (EC, 2005: 4). To ensure effective consensus building and capacity building, an essential objective of the VVU project was to facilitate the projects' sustainability through its "holistic quality management" approach (IOV, 2010: 3.06, 07; 8.04, 06: RESPTA[83]; VVU[84], Unknown: 2, 3).

According to interviews conducted and based on project documents, the main catalysts later realized to achieve the "holistic quality management" were mainly through *consensus building and circulation of information*, *training ,education* (both inside and outside the university*)* and *monitoring* and *evaluation* (IOV, 2010: 8.04,06 ; RESPTA; Gri-2: 1).

To further ensure sustainability of the ecological facilities established on the VVU campus, the Vcpf-1-10 group, Vsr-1-5 group as well as external organizations were to be trained and educated on the use, application, building, operation, service and maintenance of the ecological facilities established in VVU. In order to strengthen the effectiveness and acceptance of the ecological systems established. An ecological department was planned to be established to carry out an MA graduate course in ecological development (IOV, 2010: 5.10; 5.15 & 5.29; Geller & Laryea, 2008: 4).

Under this project objective, lessons and experiences obtained in the course of the project were to be shared internally and externally, in order to further spread the Ecosan concept and assess acceptance of the Ecosan technologies in closing the nutrient cycle loop (IOV, 2010: 7.05; Geller et.al: 2006: 3).

5.3.1 Results of project objective

The results of this project objective have been grouped in the order: Consensus building, training, education and circulation of information as well as monitoring and evaluation.

Results of project objective 3 on Output level

Consensus building

Based on the information received through project documents and interviews conducted, the only groups which participated in building some form of an initial consensus about the project's concept and contents with the Gri-1-5 group were the Vui-1-10 group. In 2003, discussions were held between the Gri-1-5 group and the Vui-1-10 group (see figure 27a) on how the ecological systems were to take shape on the VVU campus (IOV, 2010: 8.02; RESPTA).

Consensus building among all the other different local groups (Vcpf-1-10 and Vsr-1-5) did not start from the beginning (Gri-2: 2; Gri-5: 6) as it did for the Vui-1-10 group, a few years after most of the ecological installations were constructed, Gri-2 then realized the need to establish consensus also on the part of all the other exempted local partners:

> "After three or four years when most of the things were running I begun to ask myself what the main intention was and how we could ensure that things run for a longer term and then I realized that we completely had to change our approach to promote quality management. I developed a different approach of involving the whole of VVU and the eco-partners; this was not a technical approach but more a holistic process whereby people involved could take part in the decision

[83] See https://www.uni-hohenheim.de/respta/vvu.php [last accessed on 14th April 2012]
[84] Brochure on "Project overview" of the Ecological Development of Valley View University, Accra, Ghana

process to establish a mutual understanding of the Ghanaians to the Germans, and the understanding of the system and the knowledge of the real functioning of the system to be more open and accessible as possible" (Gri-2: 2).

This workshop session undertaken with the Vui-1-10 group was to establish an understanding of the "new" technologies of Ecosan, as it involved the re-use of human waste. Though the reuse of human waste like urine is often practiced unconsciously (Vui-5II: 2; Vui-5I: 9), it is not so favored in the socio-cultural context of Africa in general (Vui-3: 6).

Figure 27: Discussions between Gri-1-5 group and Vui-1-10 group at VVU, 2003 (a), second workshop in 2007 (b), World café rounds in 2009 (c) & other discussions between Vcpf-1-10, Vui-1-10 and Gri-1-5 groups at VVU (d).

Source: IOV, 2010: 8.02, 7.06 & Berger, 2010: 17

Initiated by the Ecological Engineering Society (IOV) and VVU, in February 2007, a 2-day joint retreat was organized (see figure 27b), made up of about 40 people, and represented by all the different groups being Gri-1-5, Vui-1-10, Vcpf-1-10 and representatives of the Vsr-1-5 groups. At this workshop, Appreciative Inquiry (AI) and World café rounds were used (IOV, 2010: 7.05; Gri-5: 1):

"The steps were well developed by Gri-2 who organized the World Café where you sit together on one table and discuss a certain subject and move to another table to discuss ideas on different subjects. He made some good inputs; this brought us closer to the people who were working there, the cleaners, gardeners, builders and also the university staff and students. The president of the school was involved" (Gri-5: 1)

The workshop was aimed at rekindling commitment on the part of the local partners (IOV, 2010: 7.05; RESPTA). Despite the presence of some members of the Vsr-1-5 groups in the second workshops conducted, Gri-5, (3) still reported little involvement of students in the overall consensus building process of the VVU project. According to some members of the Vsr-1 group, sometimes during decision making at VVU, students are usually exempted as it may take longer periods to achieve consensus:

"It is not in all affairs that students are involved, you see when you involve many people it delays decision making, so maybe they thought if they involve student we will show them how it should be done and they will not entertain that. If they involve students and everything to the preference of the students, it's always important but this may delay the work" (Vsr-7: 9).

According to Vui-6, the reason for not having involved the students initially was because they felt students would leave after a period of completing their studies:

"I think we could have created more opportunities for the students to participate more than they did. I think the challenge in our situation was the fact that students were not kind of stationary, because they will come in for a certain number of years and then every time there is a new batch.

> Since every student needs to move out at some point, I wanted us to include a one credit course in the curriculum so that every student who passes through will take that course to understand the reasoning and benefits from it" (Vui-6: 5, 6).

In July 2009, another International symposium was established to mark the end of the Ecological Development project at VVU (Vui-5I: 1). To further build consensus amongst the participants, the Appreciative Inquiry (AI) and world café rounds (see figure 27c) were again employed to harness information from the main stakeholders of the project. The main aim of the 2009 symposium was to share experiences, invite recommendations, display and explain the installed facilities of the ecological systems, to both internal and external participants, with a view to triggering replications and acceptance (IOV, 2010: 7.06). Among the administrational staff of the VVU, not all the staff was on board with the project at the time of implementation of the ecological systems on campus:

> "There was enthusiasm on campus but there wasn't too much willingness to participate, people shrugged it off as my ideas especially in the beginning when the German partners were coming" (Vui-6: 4)

There was no specific financial team in place for solely handling the project, for e.g an accountant responsible for handling the budget and account of the entire project (Vui-7: 4), As a result, this led to some problems with the payment of some workers, which affected the continuation of the project, because some of the financial staff who later came on board of the project felt they had to be responsible for employing and paying workers for the project, and threatened not to pay some of the employed workers at the time:

> "When he came in later he started saying that "the people who have been newly employed, if he is not paying them, then no one should complain" so I realized they were having problems themselves and it means in the administration there are some hindrances and all this hindered the progress of the plumbing side, because if they decide to do something there will be opposition which will say No, so such things will hinder the progress of the project" (Vui-10: 4).

Also, based on interviews the author realized a break in consensus amongst the Gri-1-5 groups, there were some conflicts concerning the establishment of agricultural fields, with the commencement of a BMU[85] sponsored "climate change initiative project" in 2009 (Vui-5I: 1; Vui-6: 2), in which some members of the Gri-1-5 group were excluded and whose activities allegedly conflicted with the "Ecological Development project" sponsored by the BMBF (Gri-5: 6; Gri-3: 7 & Gri-2: 2):

> "However Gri-2 started a new project without informing us and this was a competition nearly. Gri-3 had some fields with different kinds of plants, and part of these fields were planted with oil palm trees by the new project which needs more water. There was no harmony with the oil palm project since they needed more water. These projects were not in harmony with the ongoing projects" (Gri-5: 6).

Results on Outcome level

According to Vui-3, (5) the discussions from 2003 created an understanding of the then to be established Ecosan technologies on the VVU campus:

> "Right from the start, there were a lot of workshops, at the time we did not know so much about ecological sanitation so when Gri-2 and his team started coming they took us through a number of workshops which got us to fall in line with them" (Vui-3: 5).

[85] German Ministry of Environment and Nature Conservation

Without the discussions, proposed activities from the side of the Gri-1-5 groups could have been rejected by the local partners:

> "As a result of the education workshops from the beginning, all surprises were eliminated, if they had not taken us through the workshops the reaction would have been different because even then there were some aspects that we rejected after the workshop" (Vui-3: 5).

In 2007, after the workshop sessions, there was a break in funding from the BMBF due to the Tsunami in Asia, as funds were diverted to help Tsunami victims. This negatively affected the level of trust on the local side being Vui-1-10 and Vcpf-1-10 groups. Also some members of the Gri-1-5 groups were not sure if the project will continue then (Gri-5: 1):

> "After these good sessions, the money from Germany was stopped for one whole year, so what happened was the people were convinced because of these different sessions, but we couldn't take advantage of the situation because the money was gone. We were highly motivated however we couldn't take the chance to work with them during this time as the money was gone. This caused some kind of break and the people somehow didn't believe us anymore" (Gri-5: 1).

Based on interviews conducted, there were positive results from the workshop sessions conducted, which initially enhanced the ease of work and consensus among the different groups in the project, however a break in that consensus triggered conflicts among the Gr-1-5 groups:

> "There was a change in the authoritative manner in which the project coordinator conducted affairs. We were opened for discussions, however he started a new project without informing us and this was a competition nearly…Things like this happened and this was the reason why we more and more split and University of Hohenheim, an engineer from Weimar and me were working together with person F, who dealt with the grey water and rainwater, and the other part was Gri-2 and Person A. But we all had a good connection to Vui-10, and I still feel some friendship with him" (Gri-5: 3).

The activities of the alleged coinciding BMU project, in addition to other managerial problems caused a split among members of the Gri-1-5 group (see also chapter 4: 30):

> " BMU came and they gave up the avocado plantation and started to plant oil palm, now oil palm is a crop of really high water demand, and even needs more water than banana, and that is something really interesting what is the logic behind it, but a documentation on that will be good to know how two ministries from the same government can fund on the same research area different things where one ministry financing what the other ministry has financed before and that will be definitely very interesting to know" (Gri-5: 6).

Training, education and circulation of information

Training and education-From interviews conducted, project reports and documentation; training and education was conducted mainly for Vcpf-1-10 group, Vsr-1-5 groups and Orp-1-2 groups. Training and education in the project mainly covered use, application, building, operation, service and maintenance of the ecological facilities on campus. On the planned MA graduate course in ecological engineering, at the time of visiting the University, it was currently not being done, even though the necessary building infrastructure was in place such as the Baobab Centre[86]. Nevertheless, most of the members of the Vui-1-10 group recognize the urgency in establishing the course as it will facilitate the acceptance and sustainability of the Ecological systems on campus.

[86] The Baobab centre was sponsored by the BMU under the "climate change project" (Vui-6: 2)

To strengthen the training and education, an ecotech centre was established on the VVU campus to serve as a base for carrying out the aforementioned activities in addition to coordinating the building, management and administration of all the ecological activities on the VVU campus (Vui-5I: 2; Vui-2: 3). The ecotech centre was conceived under a joint initiative by Berger Biotechnik GmbH and VVU administration (IOV, 2010: 5.10). There seem to have been inadequate logistical support related to the ecotech centre. This made the transmission of information and feedback between local and foreign partners difficult for some of the local staff:

> "Most of the time when we close I will just go to the cafe and do my work, send my lab reports, write reports because there was no computer in my office and I was doing all those things in the cafe and then get home later so I always arrived home late, now it was not easy for me but with time I became use to it" (Vui-5: 7).

The personnel at the ecotech centre, comprised masons, farmers, plumbers, cleaners and technicians. They were responsible mainly for the construction, operation and maintenance of the ecological facilities on campus and were referred to as the staff of the physical plant department:

> "It was established for the purpose of training in country people or students as sustaining the concept and to also spread the news about Ecosan. It was also set up as a resource centre or consultancy centre which was good. So that whenever people need technical or any other information they could come to the VVU and seek for such information. People always came to visit the university and always wanted to see how the system runs like they ask about challenges and costs of the various systems" (Vui-2: 3).

According to Vui-5, (4) approximately 500 people in all were trained, some were students from the VVU campus, others were students from the partner institutions of Germany, local NGOs and farmers from 6 surrounding communities near VVU:

> "We trained more than 15 students from Germany who came to do their diploma thesis for almost all of them except you. They stayed here for longer periods and were trained. I will say not less than 500 people. A minimum of 500 or more because each year, there are certain instances where you have about 200 people at a time" (Vui-5III: 4).

Vcpf-1-10, groups confirm hands on training (see figure 28d) in the course of the project (Vcpf-6:2; Vcpf-5: 2; Vcpf-7: 1; Vcpf-9: 1 &Vcpf-2: 2), they report that it was done by both members of the Gri-1-5 groups and the Vui-1-10 groups, mainly in the areas of agriculture and sanitation:

> "I learnt it when Gri-5 came. He made a sketch on a paper on how to do it and he will watch you do it yourself, when you do it and he watches, then he will tell you where you are going wrong and when you are right. In fact I learnt a lot from Gri-5, because in Ghana here I don't know if anyone know anything about those toilets I also I don't know anything about those toilets but I learnt everything about those toilets from Gri-5" (Vcpf-6: 2).

Under agriculture, the Vcpf-7-10 groups were trained on the preparation, collection and application of human fecal matter and urine as fertilizer. For the sanitation sector, training was done mostly for Vcpf-1-6 groups on the cleaning, repair, service and maintenance of the facilities installed such as the toilets, pneumatic taps and urinals.

Figure 28: Field education on ecological systems for staff (a), training on cleaning, maintenance and repair of urinals and flush toilets (b, c), training in farms on application of ecological products (d)

Source: BBG-Palutec, Unknown: 1, 2009: IOV, 2010: 7.03; Germer, 2010: 15

For both sanitation and agriculture training (see figure 29d) was done by practical demonstration and the use of modules[87] to guide the trainees (IOV, 2010: 8.04, 5.30 Vcpf-6: 2; Gri-3: 4; Vui-5: 4: Vui-2: 5; Vui-7: 3).

> "As long as you are together with the people and you do the same things as the people do they will accept things very quickly because you are with them and you explain to them and teach them then they will adopt the technology" (Gri-3: 4).

Training modules and toolkits were developed mainly by Berger Biotechnik GmbH in relation to the diverse ecological installations of the project, mainly to guide users and service personnel on building, installation and maintenance (IOV, 2010: 5.10; 5.11; 8.04; 9.01).The users, cleaners, plumbers and farmers were not directly involved in the design of the training modules and posters, they were developed with information received from the users, cleaners, plumbers and farmers (Vui-5:10).

In 2006 and 2007, further training on the application and use of urine as fertilizer (Vui-2: 5) was conducted for some communities and local organizations. It was organized by some members of the Vui-1-10 and Gri-1-5 groups, to help multiply the Ecosan concept. One of them was an orphanage in Ayenyah no.1, a rural community located a few kilometers from the VVU campus. The second was an educational institution (see figure 29a & b) known as PECS educational institute and its contingent NGO, REDF (Rural Entrepreneur Development Foundation) both located in Nsawam (Germer, 2010: 15 (German); Vui-5I: 8; Orp-1; 1 Orp-2: 1). Also farmers from surrounding communities of VVU were also trained (Vui-2: 5).There was some skeptism on the part of the farmers being trained on the use of urine as fertilizer in the beginning. According to Vui-5II (2) an old and still existing local traditional practice of watering and fertilizing crops with greywater and urine facilitated the acceptance of the training in the surrounding communities:

> "Fortunately for us, even in the villages you realize that they normally have their plantains or bananas just behind their bath house and Taro, that's cocoyam and even sugar cane. So we set examples that we all grew up eating those produce and nothing happened to us so it should be ok; so basically by education" (Vui-5II: 2).

According to Vui-5III, (11) the project also invited external government organizations to conduct trainings on health and safety for the different groups (Vcpf-6: 2).

[87] Modules are defined as the dimensions of a structural component, such as the base of a column, used as a unit of measurement or standard for determining the proportions of the rest of the construction. Taken from: http://www.thefreedictionary.com/module [last accessed 17th April 2012]

Figure 29: Ecosan school team (2006 (a)), VVU project field visit of staff and students of PECs' school Nsawam (2007), know-how transfer (urine collection at PECS (c)) Staff training session at VVU (d)

Source: Germer, 2009: 15

These organizations were from the EPA (Environmental Protection Agency), National Fire Service and Health and Sanitation Directorate of the Tema Metropolitan Assembly (TMA).On the part of training done on the use of the ecological toilets for the VVU students in general, the author realized from interviews that no practical training was done with the students on the proper use of the toilets, such as sitting properly and not squatting:

> "Yes, every year, or every semester when we take the new students, we give them orientation but not intensive training but orientation" (Vui-2: 4).

However, upon realizing the misuse of the toilet facilities, signs were made (see figure 30) by a member of the BBG project team to guide the students on how to use the toilets further misuse could compromise the quality of the final product for fertilization purposes (Gri-5: 6; Vui-3: 10).These signs were posted at different locations of sanitary facilities on campus. In conformity to what the Vsr-1, 4, 5 & 6 groups reported, Vui-2 agrees no intensive training was done, but orientation about the ecological systems, as opposed to the planned training reported to have been done for the VVU students in project reports (IOV, 2010, 5. 28). Some members of the Vui-1-10 groups do not recognize the need for such training sessions:

> "I don't think it requires any special training and they just go use it anyway" (Vui-4: 5)

Moreover, further investigation on the training done at the Bediako hall on the use of the BBTs revealed different reports of training. Some members of the Vsr-2 groups report that training was done for the students on the use of the BBT toilets, however majority of the students in the Vsr-3 groups report otherwise.

Figure 30: UDDT of BBT and guiding sign/posters to guide utilization

Source: IOV, 2010: 5.27

Source: Authors field study, September 2011

Circulation of information-An ecological manager was employed in 2007, responsible for coordinating all ecological installations in the university. He was also responsible for the circulation of ecological information both inside and outside the university under the physical plant department (Vui-2: 1: IOV, 2010: 8.04).

Anytime new students were enrolled, at regular school meetings called IDF (Interdisciplinary Forums) and in classroom sessions, students were given a brief orientation of some of the ecological facilities and intentions of the University of becoming the first ecological university in Africa (Vui-5: 9 Vu-2: 4; Vui-4: 5; Vui-6: 6). Gri-5 (6, 7) confirms the relay of project information to students at these IDF meeting sessions:

> When the students met once a week, we had some reports and told them what was going on, I remember there was a small student group that made a sketch in front of about 500 students and some students got the chance then to introduce, ask questions and criticize the toilet systems.. I do not know too much about other West African countries, but my experiences in Ghana has made me believe that it is always good to relay information in a fun way like the sketch and through this you could get the information out quickly and effectively (Gri-5: 6,7).

However, according to some members of the student groups circulation of information about the project using mostly the IDF forums was not really effective:

> " Students don't really go even though its compulsory because they say that when they go there they don't say anything relevant for them so there is no need to go, unless maybe the VC says he's meeting students there then everybody goes because it's the Vice Chancellor"(Vsr-4: 11)

Other the student groups however testified they received some form of information about the ecological facilities on such meetings, they were requested to be the "managers of whatever they see", referring to the Ecological facilities on campus (Vsr-2: 14). Moreover, a green earth club was also established responsible for the education and sharing of information about the ecological facilities for the students, of which the University president was a member. Somewhere in the course of the project however it was stopped (Gri-5: 3; Vui-6: 5).

Monitoring and evaluation

Monitoring and evaluation in the course of the project took different forms. At regular intervals, the physical plant staff comprising Vcpf-1-10, Vui-1-10 and Gri-5 groups took part in "physical plant technical meetings". Discussions were held concerning working progress and general problems being faced on the ground, as well as the finding of workable solutions to allow for the work to continue effectively:

> "Yes, depending on the issues at stake, sometimes once or twice a week to discuss technical issues from each angle, for e.g from the research point of view, what I had done that is the ecological re-use of urine and faecal matter or greywater for e.g people will come with plumbing issues and report on say water collection systems, some could talk about sanitation and waste collection, so there were a lot of issues we were discussing all because we wanted to be sure that we were just up to the task"(Vui-5II: 8).

Other meetings were conducted that didn't involve much technical issues such as the "prescom" (Presidential Committee Meetings) which mainly involved briefing other university administration staff on what was going on with the Ecological systems. There were also "eco working groups" made up of students, technical people and the working staff. The aim was to instill interest in the different groups in order to promote acceptance and further replicate what was being done on campus:

> The "eco-working group" which included technical people, students working staff and etc. we wanted to create their interest for them to carry the message across so we also met and discussed issues affecting the ecological systems" (Vui-5: 8).

In the course of the project there were some proposals to conduct internal evaluations on the work done so far; however this could not be realized for general lack of interest and a concerted effort to carry out such an evaluation:

> "This was actually a suggestion that I made but was not done, I suggested that the project should be evaluated by the research and development team including the German and the people from Ghana to sit together and discuss what we think went wrong because often it's a quite natural thing that for every project that we do in life we see some things didn't not go very well and you probably have a better eye for seeing things that didn't work very well with other people, but your own failures are a little harder to detect. So I suggested that we sit together and reflect a little bit what could have been done in a better or efficient way but unfortunately we never came to that point" (Gri-3: 2,3).

However there were evaluations conducted by the BMBF in 2007 when the funding was stopped, mainly to assess the extent of work done. Unfortunately the results of the evaluations were not made available to any of the related stakeholder groups (Gri-2: 4; Vui-5II: 8; Vui-6: 5).

Results on the Outcome level

At the point of time of this study and based on information from some student groups, it was realized that the education was somehow done initially but was discontinued after a while.

> "When they first opened it for us, they gathered all the students to orient us, by then I was in the first year, for those behind me there wasn't anything like orientation for them, so every semester if we admit new students its better for us to orient them on how to use it (Vsr-2)"

Further education was conducted in the form of field sessions, workshops, training programs and seminars organized for Vcpf-1-10 groups, Vsr-1-5 groups, Vui-1-10 groups, the media, other university staff and visitors of the ecological sanitation systems in the VVU campus (IOV, 2010: 8.04)

> "We have done that several times and for instance we have urine posters and guidelines which have been translated into our local language, and we have given out a number of flyers also. So we train people, each time they come here we take advantage of that to train" (Vui-5III: 8)

Assessing the knowledge of the Vcpf-1-10 group about the ecological systems revealed that, they mainly had knowledge about their area of work and not into all the other sectors of the ecological systems:

> "No, we don't go for any training, ok sometimes we do workshops, how to take good care of the work that we are doing, how to do neat work, that one VVU organized some time ago, but as for now no" (Vcpf-6: 2).

Nevertheless, for all the trainings conducted, most of the members of the Vcpf-1-10 group felt happy about the trainings and indicated how beneficial the trainings were to them:

> "I was very happy about that, it made me know a lot of plumbing, as a result when I go to town any kind of plumbing am faced with am able to do it. There is really no plumbing work I won't be able to do now, whether new technology I have the idea and will be able to do it" (Vcpf-6: 3).

For the training with regards to the Bediako hall, at the point of time of this study, based on information from the students group, it was realized that only orientation was somehow done initially but was discontinued after a while:

> "When they first opened it for us, they gathered all the students to orient us, by then I was in the first year, for those behind me there wasn't anything like orientation for them, so every semester if we admit new students its better for us to orient them on how to use it" (Vsr-2: 17).

According to some members of the Gri-1-5 groups, VVU doesn't seem interested in carrying out a course in Ecological studies (Gri-5: 3) mainly due to its course-study priority areas as a university:

> "Valley view is a system; their main topics are Christian theology, economy accounting etc and computer science, so there is no ecology study, there is no ecological department and lecturers. This is not on their agenda and that's why we wanted to start an ecological study, but this wasn't on their agenda and hence there was no success" (Gri-2: 5).

For almost all the interviews conducted to all the various local stakeholder groups (Vcpf-1-10, Vsr-1-5 and Vui-1-10 groups), interviewees expressed their willingness to eat farm products generated from urine and fecal matter. A general explanation was that it is better than chemical fertilizers as people generally have no knowledge of where or how such chemical fertilizers were produced in the first place. To them, it's better to consume products from what people have knowledge of the production process and not otherwise.

Also, training done on the part of the workers and staff of VVU can be said to have been effective, however, some of the local partners trained felt there should have been a much higher level two way capacity building process not only in the local perspective:

> "Manpower development has always been a problem, we thought that the Germans "cheated" us as it were, because in most cases their people will come to benefit, here but we were not going there. We thought they were not doing much in this direction" (Vui-5III: 8).

Figure 31: Sign boards at the sanitary block (a), Books at the Ecotech centre (b), manual on hand washing(c) poster on how to use the toilets (d)

Source: Authors field survey, September: 2011

Most of the signs (see figure 31a, c, and d) placed at different point of the university giving information about the ecological systems and use of the toilets were still in place at the time of this study. At the Bediako hall BBT toilets, a number of instruction signs on the use of the toilets had been ripped off the inner walls and doors of the UDDT. A visit to the ecotech centre, revealed very little information concerning the ecological systems on campus with some of the literature and documents in the German language, which sets a barrier for people who want to learn more about the ecological systems on campus. Nevertheless there was some more information at the VVU library.

Monitoring & Evaluation – Ecosan technologies' dissemination effect beyond VVU borders

A visit to the Orp-1 groups revealed that they practiced the collection and application of urine on their farms at some point, but had to stop collection (see figure 32a & b) and use of the urine and greywater for fertilizing their crops because they were summoned to court by local health regulatory institutions. The reason was mainly due to the fact that they were not informed before practicing the use of urine as fertilizer and the health authorities regarded it as a threat to the health of the people who will consume such farm produce:

> "There was no problem apart from what I mentioned that the regulatory bodies they couldn't understand why we were collecting urine and storing it. We didn't have any problems with the system itself, because we just had to insert the Cans outside the urinal, and at the end of the day we just collected it and stored it. We were using it for sometimes two weeks or one month, at other times we will take them to a bigger farm and we will pour it around the crops, but the issue with the authorities was the major challenge and at the moment we have totally abandoned the system" (Orp-1: 1).

Fortunately, the case was settled out of court due to an intervention by the legal counsel they employed who by chance happened to be the same counsel for the health authorities and mediated on their behalf (Orp-1: 1,2). Despite the encounter with the health regulatory institutions, they still express plans of using the urine again in the future after authorities get educated about the concept of Ecosan.

Figure 32: Abandoned greywater outlet PECS school, compare with figure 28 c (a), Stationary urine collection containers at PECS (b), Dry toilets abandoned (c) and in use (d) at OrphanAid.

Source: Authors field study, September 2011

A visit to the orphanage at Ayenyah No.1 also revealed that some of their dry toilets were in use, and some had been abandoned (see figure 32c and d), and they were currently not making use of the urine and fecal matter as fertilizer, in the first place because their toilets were not built with separation, as in the case of UDDTs and they had not established procedures for composting the urine-mixed fecal matter yet. Nevertheless, they expressed future plans to do so.

In conclusion, future sustainability of the ecological systems is not ensured, but will depend on the availability of financial structures" to support continuation, however technical know is locally present:

> "Because the Germans actually funded the project, their presence here was always important, because they come with the funds and then we continue the project. Leaving us, we can sustain the project, but it means that we need to make a budget for it, and for that one I cannot tell because the university has got its own priorities and this one being an academic institution the focus will first be on the students before others, and rating it as to where to position the sustainability of the eco project will be very difficult for me to say, but I can assure you that the current VC is highly interested in it as well as the previous president who actually brought the systems to VVU" (Vui-5I: 4).

6. Discussion

Introduction

In this chapter, a summary of findings from literature review and the analysis made is outlined to direct the discussions based on the initial hypothesis and research questions of the study, in direct connection with the selected and summarized overarching objectives outlined for the project understudy, in addition to the limitations and lessons encountered on the part of the author. As mentioned from the beginning, the ultimate goal of this thesis is to learn lessons from Ecological sanitation efforts in Africa and make further recommendations for the design of future projects.

What constitutes a successful and effective project?

UNDP (2009: 6, 7), prescribes four "critical factors" and "areas of weakness" that facilitate the success or failure of development measures. They constantly include: 1.planning and programme and project definition, 2.stakeholder involvement, 3.communication and 4.monitoring and evaluation. A good project is one that succeeds in the effective adoption and management of these critical factors and areas of weakness as they are closely interlinked.

Hence, a working definition of what an effective project is, is a project that significantly considers these critical factors and areas of weakness, commences with an ultimate goal, and combines various inputs and activities to implement tangible outputs, which generate perceived short and medium term outcomes to produce sustainable results in the much longer term, hence achieving the set ultimate goal.

Planning has been defined by UNDP as a "process of setting goals, developing strategies, outlining the implementation arrangements and allocating resources to achieve those goals" (UNDP, 2009: 7). What entails planning, cuts across "(1) identifying the vision, goals or objectives to be achieved, (2) formulation of strategies needed to achieve the vision and goals, (3) determining and allocating the resources required to achieve the vision and goals and (4) Outlining implementation arrangements, which includes the arrangements for monitoring and evaluating progress towards achieving the vision and goals" (UNDP, 2009: 8). Deficiency in planning fogs the clear articulation of intended results, and hence makes monitoring a difficult process. Efficient planning produces a clear result framework which forms the basis for a good monitoring and evaluation process respectively and connectively (UNDP, 2009: 5).

Discussion of project concept, outline and organization

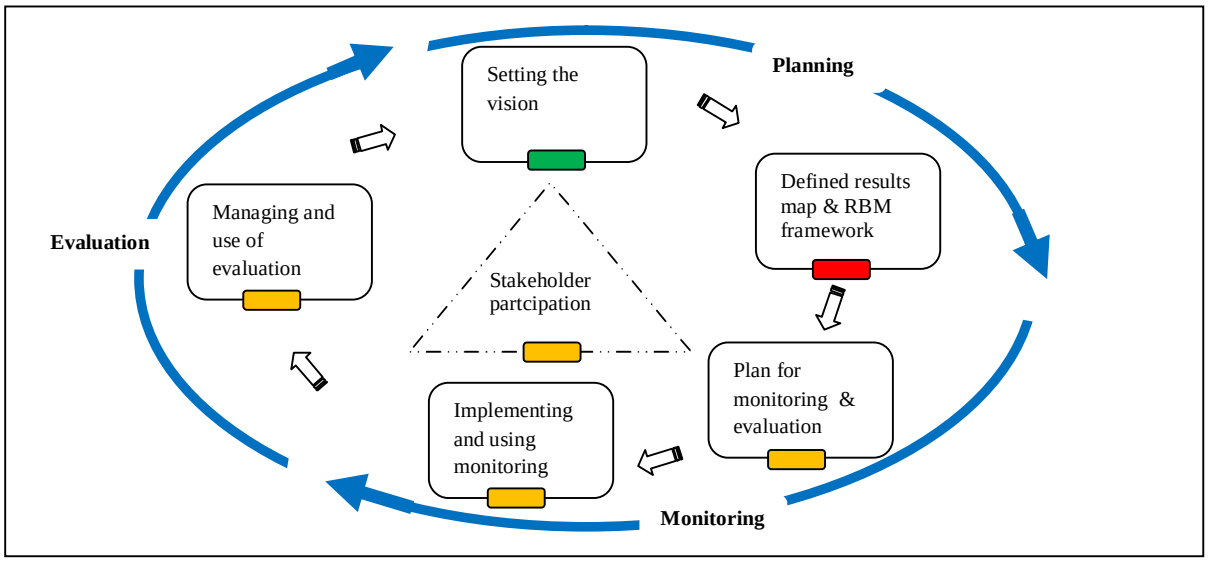
The author chose to compare the project activities of the VVU project against these aforementioned critical areas (which overlap with the different steps of the RBM life-cycle approach), in tandem with the different steps and components of the RBM life cycle approach, to identify to what extent project proceedings were done in conformation. An effective ongoing process and combination of three main sectors makes up the RBM life-cycle approach, not strictly set as a sequential process, but an ongoing or iterative one, and includes planning, monitoring and evaluation (UNDP, 2009: 10, 11).

Figure 33 iterates with colors (green, orange and red), the degree of conformity of the VVU project approach in contrast with the RBM life-cycle approach. Green represents total conformity, orange represents partial conformity and red represents very little or no conformity.

Under the RBM approach, what usually commences every activity is a proper planning phase, which involves ***setting a vision***, followed by a clear definition of the proposed results to be achieved, a product of which is the ***RBM framework or results map***. In comparism to the VVU ecological project, even though an ultimate vision was very well set to becoming the first ecological university in Africa and some sub-objectives were set, the actual activities to achieve these objectives for the establishment of the

project appears not to have been clearly planned and defined from the beginning in a ***results map or RBM framework***. There was no clearly planned strategy for ending the project, which resulted in some of the activities for the ecological systems to be abruptly ended such as the composting of fecal matter from the UDDTs. On the other hand, strategies needed to attain the overall goal were rather well identified, cutting across the Stadtschaft and cell model, the ecological cycles of water and sanitation and agriculture, environmental protection strategies, renewable energy supply etc (see appendix 5).

Figure 33: RBM life-cycle approach vis a vis VVU project approach



Source: Own design 2011, based on UNDP, 2009: 10

Furthermore, a proper stakeholder identification and participation process did not commence the activities of the project, not all stakeholders were well informed of how the project came to being. Even though stakeholder participation was conducted, this was only done after most of the outputs of the project were already implemented. According to the UNDP (2009: 25), non-involvement of all relevant stakeholders in planning, monitoring and evaluation of stakeholders forms the major reason for the failure of many development measures.

In the VVU project, proper involvement of stakeholders can be said to be one of the main causes of most of the projects problems. For example was the site on campus for the conduction of the fecal trials, the first implementation attempt on the first major objective failed, this was mainly due to the location, as issues raised by local partners ranged from the fear of potential negative health implications to the tarnishment of the pride and 'image' of the institution (VVU) where it was to be implemented. This implies that the university or local partners were not properly consulted before or incorporated in planning and selecting the location for the first trials, or even if they were, they didn't fully comprehend exactly the actual direction implementation efforts or activities were going to go. In order words, ***communication*** was not effective enough to facilitate a good understanding of what was going to be implemented. A lesson here is the need to fully consider and confer with local partners on deciding the location of Ecological Sanitation measures in addition to seriously researching and considering all socio-cultural believes, practices and even rumors in the planning and selection of sites for Ecosan projects and development measures in general.

Secondly, as the stakeholder participation was not properly planned, there were differences between the expectations of the different actors. For e.g financing staff that later came on board the project who had different expectations and didn't seem to find their rightful position in the project, or the non involvement of students from the beginning of the project, which didn't create the required ownership and appreciation

of the established ecological facilities which further led to the improper use of some of the ecological systems (toilets) because they didn't really understand the concept. Also, the donor organizations from the USA who overruled proposals made for some aspects of the ecological systems such as the initial construction of the dry toilets.

Besides, a financial structure should have been planned and in place such as project accountants and account that defines payment structures and budgetary allocations for all employees and workmen of the project, so that they could be assured of their remunerations and be motivated to conduct their work without any threats or intimidation as reported in the project.

To criticize the RBM approach, the VVU project outcome (see chapters 4:37; 5.3.1: 64) unearths a disadvantage/disregarded aspect of the RBM approach, which is the difficulties that can be associated with complex co-financed R& D projects like that of VVU. This is because in such co-sponsored cases like VVU, where funding sources can possibly be cut at some point (for e.g in special cases like that of the Tsunami), or not entirely guaranteed till the end, stakeholder participation and consensus maybe lost, which maybe no fault of improper planning.

What's more, even though adopted also in the course of the project, ***plans for monitoring and evaluation*** were not made. The "holistic quality management" process was a change step in the right direction, but occurred in the course of implementation. Monitoring process even though present, were not properly outlined or structured in an initial planning strategy. Nevertheless, the little monitoring processes that existed unearthed some of the problems associated with operation of the ecological systems, such as the misuse of the toilets (sanitary block) on the part of the end-users, due to the sanitary disinfectant for cleaning the toilets. Furthermore, ***Implementing and using monitoring results*** was partially done by the VVU project, through the erection of signs and posters with the realization of misuse of the toilets at the sanitary block. In practice, these signs would have had to be pretested with the students to create ownership and understanding of the reasons for setting them up, but this was not done probably due to the urgency and promptness with which these signs had to be put up.

As reported earlier (see chapter 5.3: 70) proposals for actual evaluations on the project were rejected due to a general lack of interest, as this was not planned and incorporated from the beginning of the project. Some evaluations took the form of master thesis topics, but were done in isolation and not incorporated in the further evolution of the project. Evaluations were conducted by BMBF, the project sponsor but were not made available to the project staff and hence implies that the evaluation results was not geared at helping the project staff learn from the evaluations' results to facilitate its ***management and use***.

Discussion of findings related to sanitation and agriculture efforts' effectiveness (systems' functionality)

Despite some weaknesses in the approach with which the project was planned and managed, the activities of the project still succeeded in the successful implementation of many aspects of the ecological system at VVU. The project conducted many activities, several of them were successful and others were not. Challenges or problems were overcome with innovative measures. Some components of the ecological system established at the time of the project were functioning then, and others were not and likewise at the time of the study some aspects of the ecological system were functioning and others were not (see table 2: 75).

The collection and handling of fecal matter from KVIPs was considered a disgraceful act by the VVU workers, which caused mistrust amongst the VVU workers of the human fecal composting process in the first place and prompted the need to devise a strategy to address the situation by doing the composting at night, in addition to providing protective gear.

Table 2: Functionality table of VVU ecosan project activities (water, sanitation and agriculture), output and outcome levels[88]

VVU ecological system component	Project activities	Output	Outcome
KVIPs and Composting chambers **Overarching objective: 1 (see chapter 5: 41)**	**1.**Good approach for training, education and development of co-composting trials in collaboration with farmers **3.**Protective health measures for composting trials, and done in the wet season 4. Composting chambers well established with various local construction materials 5.Collection & transportation procedures caused mistrust amongst farmers for composting with human fecal matter **6.** First trials failed with Open co-composting	**1.**Hygienized human fecal compost **2.**Four brick composting chambers	**1.** Co-composting of fecal matter 2. Dilapidating compost chambers due to termite action.
UDDTs ,waterless urinals and compost chambers **Overarching objective: 1**	**1.**Development of the toilets in collaboration with end users **2.**Building construction by using mostly local materials except imported pneumatic taps and membrane traps **3.**Experienced "ownership" from the users **4.**Good cleaning and maintenance concept **5.**Good urine collection, storage and treatment concept **6.**Well established urine usage in agriculture **7**.Good fecal collection and transportation concept **8.**Well established education of students on use of toilets **9**.Well established training of responsible cleaner **10.**Greywater generation and transport, rainwater harvesting **11.**Construction of compost chambers with local materials **12.** Not well established fecal co-composting trials **13**.Not well established training of end users on use of UDDTs	**1.**One UDDT building, 6 toilet units **2.**Four composting chambers **3.**Rainwater storage tank **4**.One Urine storage tank	**1**.Good cleaning and maintenance by cleaning personnel **2**.Improvement and adjustments made by the responsible technicians for urine transport system and exposed urinal walls **3.** Improvements by connecting with pipes to university farms **4.**Urine usage in university farms **5**.Pneumatic taps and rainwater harvesting and storage tanks **6**. Dilapidating compost chambers due to termite action **7**.Misuse and non-use by students, due to lack of consistent and continuous training **8**.Open defecation in environs **9.**Deficient operation and maintenance strategy of locking up toilets when misused **10.**Co-composting of fecal matter **11**.Break in education and training of end users **12**.Membrane traps for odor entrapment

Source: Own design, 2012

[88] (Green = functioning, orange = critical, red = not functioning).

Table 2: Functionality table (Continued)

VVU ecological system component	Project activities	Output	Outcome
WSSFTs and WSFTs and waterless (dry) urinals (administration) **Overarching objective: 2 (see chapter 5: 50)**	**Administration block** **1.**Replacement of old high water consuming flush toilets with water saving and separation ones **3.**Toilet components by using mostly imported materials **4**. Good approach for training and education of cleaning and service staff **5.**WSSFTs and waterless urinal systems installed with imported membrane traps **6**.Greywater generation and transport, rainwater harvesting for flushing of toilets **7.** Black and brown water connection to constructed biogas digester, which generated about 25% supplement cooking gas for university cafeteria kitchen **8.** Well established training of responsible cleaners, plumbers on maintenance and building of the systems. **9.**Toilet installation with external contractors for VVU administration **10.**Seldom unavailability of water to flush toilets led to stinking of toilets	**1**.Two each of installed WSSFTs and WSFTs at administration block (total four) **2.**One underground rainwater storage tank **3**.Three urine storage tanks **4**.Two waterless urinals	**1**.WSSFTs,WSFT and waterless urinal systems **2**.Membrane traps for odor entrapment and urine separation **3.**Improvements by connecting with pipes to university farms **4.**Good cleaning and maintenance by cleaning personnel **5**. Underground rainwater storage tank and rain water harvesting systems 6.Biogas system **7.**Difficult toilet maintenance for plumbing staff **8.**Biogas **(25%)** supplement for kitchen cafeteria due to absent feedstock
WSSFTs and WSFTs and waterless (dry) urinals at sanitary block **Overarching objective: 2**	**Sanitary block** **1**.Building construction by using a combination of local materials **2**. Toilet components by using mostly imported materials (pneumatic taps, separation flush toilets) **3.** Black and brown water connection to constructed biogas digester, which generated about 25% supplement cooking gas for university cafeteria kitchen **4**.User-maintenance problems **5**.Equipment availability problems with urine and greywater transportation, due to no fixed medium of transport 6.Cultural problems related to transport of greywater to farms	**1**.Four WSSFTs and WSFTs at the sanitary block **2.**Four urine storage tanks **3**.Three waterless urinals	**1**.WSSFTs and WSFTs at the sanitary block **2.**Urine storage tanks **3.** Waterless urinals **4.** Black and brown water connection to constructed biogas digester **4**.Improper use of toilet facilities (indiscriminate defecation on toilets) **5.**Deficient operation and maintenance strategy of locking up toilets when misused **6**.Replaced water saving pneumatic taps **7.**Biogas **(25%)** supplement for kitchen cafeteria due to absent feedstock

Source: Own design, 2012

Table 2: Functionality table (Continued)

VVU ecological system component	Project activities	Output	Outcome
VVU farms **Overarching objective: 2, 3**	1.Urine and greywater application to planted high ground vegetables and fruit trees (mangoes, pawpaw) 2.Application of urine and fecal matter trials to mango farms, jatropha, pawpaw, banana 3. Good practical training of farmers by learning by doing approach 4. Good concept multiplication strategy	**1**.Total of 14 acres of agricultural land	**1**.Know-how by farmers and local technicians on the maintenance of farms **2**.Urine and greywater application **3**.Increase of total agricultural land to 18acres **4**.Pawpaw farms, banana **5**.Concept multiplication at PECS educational institute

Source: Own design, 2012

This implies that the KVIPs are not a good option for composting of feces, mainly because urine separation was not considered earlier in the KVIPs design unlike the UDDTs, which were constructed with mechanized options that source-separated the urine from fecal matter and easily aided the channeling of urine from source to farms. This implementation (for the UDDTs) was also explained to improve acceptance and adoption amongst the workers. In effect, after the project completion, there was no further composting done with the KVIPs despite the fact that trials were conducted at the time of the project.

With regards to the composting chambers constructed for the KVIP trials, even though local materials were used in the construction, local biological hazards may cause their destruction. This probably maybe because not much attention is being given to their maintenance, as composting with fecal matter from the KVIPs is currently not being done.

Moreover, to achieve acceptable standard treatment (temperatures of 70^{o} C) and durations (4 months) of fecal composts, there is the need to employ additional measures beyond simple co-composting methods as observed from the study. Maybe composting with UDDTs will require different conditions as opposed to the composting method with raw fecal matter from the KVIPs, as some form of treatment is done prior to collection of pre-fecal composts, but that cannot be proved yet for the project as the composting was not well established in the course of the project.

Furthermore, the 'learning by doing' approach was used to train the farm staff on the preparation of human fecal compost form the KVIPs and its application on crops. Farmers mainly reported their satisfaction and approval of the way the training was done, and the fact that they could practically explain quite vividly the process used in carrying out the preparation and application, evidently constitutes an effective way of hands on training for local staff. Felder and Brent (2003: 1) assert this fact, arguing that there is no other effective way to learn. If the same approach was conducted for training the students/users on how to properly use the toilet facilities as well as the utilization and application of products, one can confidently argue that the toilets would have been properly used by the students, unlike the situation at the time of this study.

The focus of the construction of the UDDT toilets were significantly informed from two perspectives, the first being a strategy to address cost and high water consumption problems associated with the use of conventional toilet facilities. The second was to facilitate disposal through the management and application of the human "waste" generated products as fertilizer on VVU farms on campus. Project documentation report of training for users (IOV, 2010: 5.28), however findings from the study revealed that user's (staff and students) were educated, but not trained through posters and school meetings on how to use the systems appropriately.

The reason for misuse of the UDDT toilets is not a technical problem, because everything technical was solved as much as possible in the outcome, for e.g the covering of exposed parts of the BBT urinal. The problem is more on the managerial side, as the training of users, as reported before in chapter 5:70 was either not done, or discontinued after a while, on how to use the toilet systems as stated in project reports (IOV, 2010: 5.15; 5.28). It seems there is a general misuse of the term training which causes confusion on what exactly was done on the training especially of students. The term training seems to be confused with education or orientation, according to Essenhigh, (2000: 1)[89] *know how* and *know* why, constitutes the main difference between training and education. An effective way will be to use both. As noted from the experience with the students at Bediako hall, an integral part of ensuring the proper function, collection and quality of toilets and toilet products would be extensive, continuous conscientization with hands on training and education and not simply education or orientation to re-stimulate a sense of ownership amongst users/students. This is not to imply that there was simply no ownership, there was ownership (as they were protecting their toilets from use by people from other halls of residence) on the part of the students at the Bediako hall in the beginning when the UDDTs were established and students were educated, however the discontinuation of education led to the misuse and non-use of the UDDTs by subsequently enrolled students.

Moreover, although the objective was set out to test the application of both urine and fecal matter as fertilizer options, preference and acceptance was given more to urine fertilizer or compost. Also, despite the significant influence of food waste on achieving the needed temperatures on closed composting, the organic food waste from the university's cafeteria was not being used at the point of time of this study, due to improper solid/organic waste separation. This teaches that, to be able to utilize organic or bio-waste from kitchens for co-composting in institutions like VVU, there is the need for immediate separation, otherwise later attempts to utilize biowaste for co-composts will lead to difficult challenges that can ultimately deter use in composting as learned from the VVU project.

Also, in the context of semi- tropical nations or nations with similar climate conditions, that is wet and dry seasons like that of Ghana, it probably will be more conducive to conduct composting of raw fecal matter in the wet season other than the dry season due to the presence (absence) of adequate biomass for composting and availability of rain water (outcome of KVIP trials).

On the part of the WSSFTs and WSFTs (located at the VVU administration), they were generally working with no reported problems. This may be due to apt response based on the fact that attention is easily drawn to technicians and cleaners whenever problems occur. As the WSSFTs and WSFTs toilets are located close to the office of the administrative staff and that of the vice chancellor of the university. An issue of concern perhaps in the near future will be with the membrane traps (as encountered already by the BBT at the time of the study) as the current reserve stock in store at the time of the study was reported as finished. On the contrary, the WSSFTs and WSFTs located at the sanitary block have started to experience component changes such as the replacement of pneumatic taps, and this strengthens the

[89] See http://www.uamont.edu/facultyweb/gulledge/Articles/Education%20versus%20Training%20.pdf [last accessed 1st May , 2012]

argument that local materials should mainly be used in the construction of local toilet facilities in general as reported by Berger (2009: 19)[90].

For the VVU farms, the fact that local farmers and technicians demonstrated the confidence in being able handle further ecological research on their own denotes great potential for the sustainability of the agricultural farms. There has since been some up-scaling of the agricultural farms even though some of the activities developed at the time of the project were not sustained, such as the pawpaw farms. The multiplication of the technologies to external institutions was a good move also to help spread the concept of ecosan in the form of know-how transfer. As later reported however, the "know-how transfer areas" (PECS) are currently not able to utilize their knowledge of the ecosan technology, which is no error on the part of the VVU project, but teaches an important lesson about the establishment of "new" technologies like ecosan in countries that are not conversant with the technology. That is, the urgent need to conduct some form of education and collaboration also for relevant local regulatory institutions. These regulatory institutions if involved, educated and trained would probably help in the sustainability of such development measures if they fully get to understand the rationale behind.

In conclusion, the actual sustainability of the ecological systems as realized from the functionality of the systems can still not be ensured. Even though there is current maintenance and utilization. A dependant factor however will be if VVU is able to establish the MA course in ecological studies, as this will put the ecological systems on the priority area (education) of the university. As reported (see chapter 5: 72), there will have to be a budget available to cater for the ecological facilities on campus and this can only be made possible if it is embedded in the educational aspects of the university. This task will rest on whether the current administration will see the urgent need of "sustaining the results" of the VVU "ecological cycle development project", by ceasing to regard it still as a research project but as an important component of the functioning and image of the University.

Limitations to the study on the part of the author

The major constraints involved were the delay and difficulties incurred in accessing the most relevant information such as project final reports for the facilitation of the research, most of the available project documentation were in the German language, which served as a big barrier even with some level of knowledge of the language.

The master thesis as a whole developed a great complexity, due to the broad nature of the many different aspects and stakeholder constellations involved and a second contributing factor to the long duration of the study realization was because the author had to type most of the interviews into text transcripts, which caused a long delay before analysis of the transcripts could be analyzed for further evaluation. This method was rather arduous, and the author later realized it was not very necessary, as he could have just listened to the audio recordings and summarized the very relevant lessons, a lesson well learnt by doing and a caution for future researchers.

Also, the initial plan for evaluating the study was to use the environmental goods to analyze the various planned activities together with their overarching objectives, however this could not be done as expected as the focus of the study had to be further narrowed to selected overarching objectives. Analyzing all the activities in the overarching objective analysis framework will demand a study much broader than a master thesis.

[90] See http://www.berger-biotechnik.com/downloads/wtopraesentationtext.pdf [last accessed 16th May, 2012]

7. Conclusions and further recommendations

Water and sanitation go hand in hand, every human being must “respond to nature” when it calls, whether it’s a call for thirst or to do the “number one or two”. The type of toilet or urinal system used in the latter is one of great importance as improper disposal especially of fecal matter (such as open defecation) affects the fore. From the study however, Ecosan technologies, if practiced with caution can ensure the safety of both the latter and the fore.

The hypothesis set from the beginning of this study was to find out whether or not such “new paradigm efforts in sanitation” might in fact play a critical role in helping address the problem of water and sanitation in African cities. As identified from the results of the study, Ecological sanitation technologies such as UDDTs and WSFTs possess measures that allow the safe treatment and disposal of greywater, urine and fecal matter which helps prevent life threatening infectious diseases. However, the Ecosan technologies like many other innovative technologies are not entirely foolproof as identified from the study. There are credible issues of concern on the safe delivery of the products especially of UDDT fecal composts as well as important managerial caution that need to be observed and further developed. That notwithstanding, one will always have to appreciate the fact that in weighing these issues and concerns against the benefits Ecosan produces vis a vis conventional sanitation systems and practices of today, Ecosan technologies are far more profitable, economically and environmentally.

7.1 Conclusions

Firstly, an important lesson is to always commence projects in general (especially ones that involve institutions such as VVU) with participation for consensus building, in order to facilitate commitment and the immediate/future acceptance of measures to be implemented. For Ecosan projects specifically in Africa especially, due to the radical perception and taboo of seeing fecal matter as waste, there is the need for a careful, conscious and constructive way of neutralizing such perceptions, bringing to light all fears and concerns on the part of concerned stakeholders, before projects may seek to take off. In practice, important issues that need to be considered before participation is done, include the tenure of stay of non-stationary stakeholders (for e.g in the case of VVU, students who have to leave after a period of time or financing staff who later came on board the project) in the project for the sake of ensuring project measures in the longer term.

Under the RBM life cycle approach, an integral aspect of planning is the setting of a vision and the clear definition of a results map and RBM framework. The VVU project succeeded in properly doing the former, but didn’t manage to properly achieve the later part. Stakeholder participation posed many problems for the project as observed, which justifies the need to involve all relevant stakeholders and incorporate them in the design of ecological project interventions before conducting projects, as future completed developments maybe hindered by these stakeholders that were left out either intentionally or unknowingly. In co-financing projects especially for donor funded institutions like that of VVU, before project commencement , there is the need to identify all other external financial players who influence the decision making process of the institution in question, in order to enlighten them on the need for setting certain measures in a project yet to be realized. For instance, in the case of VVU, these external organizations appear to have had a big say in the choice of specific facilities to be introduced in the project.

What's more, in the second stage of the RBM approach, which is monitoring, they succeeded in partially planning for monitoring but lacked behind in evaluation. Hence, some of the monitoring results could be used such as the feedback from the female students and cleaners of the sanitary block which led to the formulation of signs on how to use the toilets.

Also, even though calls for rigorous evaluation could not be realized, VVUs adaptation of a "holistic quality management approach", which entailed consensus building, training and education, circulation of information and monitoring and evaluation catered for the success of most of the objectives of the project. Monitoring and evaluation strategies in the form of using regular meetings, the "eco working group" were helpful in realizing the objectives of the project. The control and sharing of troubleshooting experiences among staff of the physical plant department at the ecotech centre and cross information transfer amongst university administration staff and that of the physical plant department can also be attributed to the success and establishment of the agricultural farms ecological building installations on the VVU campus. Unfortunately however, and almost a threat to the further continuation of the project was the fact that funding stopped in 2007 and evidently distorted the planned activities of the research and development project. A further unfortunate issue however, was the fact that the results of the evaluation conducted by the BMBF after that was not made available to any of the project partners before the second phase of the project took off, as this would have enabled project stakeholders to learn from the results in accordance with the RBM approach of ensuring "sustainable results".

Also, another lesson observed from the running and operation of KVIPs compared with UDDTs is that, there is more acceptance with the less handling of ecological toilet products (such as urine and feces) before final application in farms, which implies that, if there are measures that can be employed to avoid less contact with transport of products directly to the farms, this may be a plus for acceptance, especially in situations where socio-cultural and religious factors come into play. In practice this may not be easily achievable as it will mean an extra cost and commitment to constructing these measures which may be a barrier in some cases where project funds may be limited.

Moreover, it is important also to note that in the course of a research project, mainly (if not always) activities or measures that are witnessed and experienced by local or target stakeholders which produce positive results will be adopted by target groups in the longer term. Supporting this argument is the non-use of fecal composts from the UDDTs but urine. Maybe if composting was done also with fecal matter from the UDDTs at the time of the project and produced equal results like the urine, it probably would have been used today even with the mentioned fear of health concerns.

In addition, another lesson learnt from the BBT toilet users of the Bediako hall, is that there was some form of ownership on the part of the students in the beginning when the toilets were constructed for them (as they were protecting their toilets from use by people from other halls of residence), realizing the benefits derived from the BBT dry toilets in comparism to other surrounding sanitary facilities as they regarded the toilets as theirs and sought to defend it against other users. As noted from the experience with the students at Bediako hall, an integral part of ensuring the proper function, collection and quality of Ecosan toilets and toilet products is extensive, continuous conscientization with hands on training and education and not simply education or orientation to stimulate a sense of ownership amongst users. This doesn't seem like an easy task, however the benefits after a longer term can compensate for the efforts or measures to be or implemented.

On the side of the misuse of BBT toilets at the Bediako hall, such as the squatting on sitting toilets, there have been debates by different experts on ecological toilet technologies; whether squatting toilets are better than sitting toilets or vice versa (EcoSanRes, 2011)[91]. From the study at VVU as well as the authors personal use of the BBT toilets, one can conclude that both toilets can be useful, depending on the given situation, that is whether public or private. More suitable for public places (like VVU) however will be both squatting and sitting toilets and sitting toilets for private places. The argument for the first recommendation is that, a public facility could rather exclusively reserve say one or two sitting toilets for the elderly or the disabled and there should be some form of control to strictly reserve those for the elderly and disabled as they cannot squat for long periods. From the VVU experience, the students

[91] Continuous discussion on squatting versus sitting toilets on EcoSanRes internet forum (December, 2011)

decided mainly to squat on the sitting toilets (even though some reported preference for sitting toilets), the author realized that this is mainly because the previous user always left the toilet unit in a bad condition and because they don't want their bodies to come in contact with the toilets seats (mostly there could be old "shit or piss stains" not properly wiped off), for fear of contracting some disease from the previous user and as the previous user can't be guaranteed to have sat like you intend to do, you will be very hesitant to sit on it yourself.

Conversely, on the private side, sitting toilets is rather accepted in a private setting where only one household uses a toilet facility. In that situation one can be assured that your brother, mother, father or sister will not squat on a sitting toilet and since you already share so many other facilities in the household, one will be confident to sit comfortably. Alternatively, there can also be the installation of hybrid toilets, which allow for both sitting and squatting.

On the part of the WSSFTs and WSFTs, from the study it can be concluded that even the choice of cleansing agents in public toilets can cause a misuse of ecological toilets if users have the impression that the cleansing agents are not sanitizing the toilets enough, especially for female users. The usage of the Water Separation Flush Toilet facilities by females was a problem due to the health concerns posed by the type of cleansing agents utilized for treating the facilities.

With regards to the conflicts mentioned among stakeholders, the author cannot judge the real reason for the conflicts that came in the course of the project concerning the activities of the BMU project. It can be concluded however that for Ecosan projects, care has to be taken especially on the side of external foreign aid agencies such as the BMBF and BMU, to try to verify whether new project ideas are not clashing with existing or completed ones. Harmony in development measures is needed, if aid effectiveness is to be made more sustainable. Also, this project has shown that co-sponsored development projects do not necessarily ensure an all inclusive sustainability.

1. Overall status-quo of VVU Ecosan project today (focus: water and sanitation and agriculture)

The current state of the Ecosan technologies on VVU campus can be seen to be in a fair situation, this is because some measures put in place are working even though some others are not. VVU in an ex post project perspective demonstrates potentials and commitments to upgrade ecological facilities on campus, some of the planned objectives such as the establishment of an ecological studies program till date hasn't been realized as it appears the University has other focal areas of study, and Ecological studies does not constitute a very important aspect of the universities' focus and priorities yet even though plans are underway to do so.

2. Extent of use of Ecosan technologies (focus: UDDT units)

With regards to the UDDTs (BBT), the facility generally is in good shape with designed components working fine, Greywater is used, urine is used, but fecal matter is currently not being used. Rainwater is harvested from the roofs, and used for washing and cleaning purposes and for the flushing of WCs. Grey water is used also for the irrigation of farms and urine is also being used as fertilizer on the VVU farms enabling the university to grow crops that are used by the university cafeteria. The biogas digester at the time of the study treated grey water, brown water and blackwater which saves the university cost in terms of having to create expenditure for transporting fecal sludge to waste dump sites. However, gas is currently not being used mainly due to the limited quantity being generated and demands the addition of feedstock's to generate sufficient quantities that can be used by the universities Cafeteria.

Based on the balance of evidence one can conclude that the ecosan technologies at VVU are currently not being closed entirely, there is a break in the loop with regards to the use of fecal composts which are due to legitimate concerns such as heavy metals and pharmaceuticals.

3. Barriers related to the use of Ecosan technologies

Barriers related to the use of Ecosan technologies can be classified under socio-cultural, managerial, and mechanical dimensions.

Mechanical- this constitutes maintenance functions directly related to the type of construction materials and Ecosan toilet components used in the construction of UDDTs. The more local materials and components used, the more easily future maintenance can be done. With regards to the BBTs at VVU, even though local toilet components were used, the barrier in maintenance was mainly due to the only foreign component used in the BBT facility being the membrane trap. This further applies also to the sanitary block where pneumatic water saving taps have been replaced.

Socio-cultural-this involves the attitudinal behavior of local stakeholders to some of the established components of the VVU ecological systems. This is mainly informed by the individual customs, values and beliefs of VVU workers who came from different tribal backgrounds, which did not tally well with the handling of some of the components of the ecosan technologies in VVU, such as greywater generated from the female sanitary facilities. This comprises a barrier that was innovatively overcome by the VVU project staff. Without the innovative way of addressing the issue, in another setting such as a local community, this could have potentially deterred the realization of that aspect of the ecosan technologies.

Managerial- The strategy for solving the problem of smell in the operation of the BBTs and other ecological toilet facilities in the university at the time of the study was to lock up the toilets, anytime they were left in a mess, to allow the flies and stench to leave. This constitutes a barrier to the amount of fecal composts generated and does not constitute a technical problem, but on the management decisions taken to solve the problems encountered with the BBTs. In the long run, the non-use or little use of the technology affects the availability of compost fertilizers that can be used in the farms to close the nutrient cycle loop.

Health- Non- use of the UDDT fecal composts in at VVU farms was mainly due to fears of heavy metals and pharmaceuticals in final fecal composts. This mainly has prevented the use of human fecal composts in the Agricultural farms and constitutes one major barrier to the use of the Ecosan technologies.

4. Success factors and cross-cutting lessons learned concerning the project design, set-up, implementation and follow-up

The body of knowledge from the review of literature stresses the need for conducting more and more evaluation in Ecosan projects as a whole. Right from the start of a project, an ex ante evaluation should precede any planning interventions and in turn pave the way for subsequent formative, summative and ex post evaluations respectively. This makes working for sustainable results a much easy, transparent and accountable process and directly affects future impacts of projects being undertaken.

In the conduct of participation, education and training for consensus building and acceptance for Ecosan projects, a useful tool could be to capitalize on any existing practices or traditions with relation to yet to be implemented project measures. This was one of the strategies used by the VVU project partners in conducting training for local farmers in the environs of VVU which facilitated the acceptance of the Ecosan technologies according to some of the project partners.

Furthermore, learning by doing is an effective way of training for acceptance and ensuring trust among local stakeholders or target groups. The ‘learning by doing’ approach was used to train the farm staff on the preparation of compost and its application on crops. Farmers mainly reported their satisfaction and approval of the way the training was done, and the fact that they could practically explain quite vividly

the process used in carrying out the preparation and application, evidently constitutes an effective way of hands on training for local staff.

Moreover, from the findings of the study, even though composting was not done with fecal matter from the UDDTs, the most suitable in terms of maintenance and operation as observed from the study is the UDDTs, in terms of collection and ease of transportation of urine and fecal matter. Important conditions for its operation however is the constant training of users and workers who will use and run the facility, in order to ensure a more secured source

Another issue of concern is the future availability of spare parts and components, which will assist in future maintenance, This teaches us that in co-financing projects such as the VVU project, there is urgent need to investigate and research local prices of existing ecological facilities and together with local partners decide if it's a feasible option before resorting to a particular alternative.

Recommendations from the author for the VVU project and Ecosan projects in general

For VVU, Currently the treated greywater from the biogas plant has been channeled into the mango plantation for irrigation, but with time will accumulate into a pool, which may potentially be a haven for the breeding of mosquitoes, the author recommends collection of the treated water into a reservoir for storage and re-use for the flushing of Water saving toilets from where they were mainly generated.

At the BBT in Bediako hall, the author experienced that during the outpour of rain, students cannot access the facility as the path that leads to the UDDT facility is no roofed, a recommendation will be to create a protection roofed walkway attached with rainwater harvesting gutters to the BBT toilet facility to assist the students to access the facility and at the same time harness the potential of rainwater to assist in the overall water supply of the University.

To help address the problem of squatting on the sitting toilets at the Bediako hall, VVU can take steps to replace about half of the sitting toilets with squatting UDDT toilets, to test and see whether this might help solve the issue of indiscriminate defecation by students or external workers in VVU. This will give the option to those who are willing to squat to do so and vice versa. Concerning the membrane traps however the University could contact the German project partners and together research ways of locally producing the component, as it constitutes an integral part of most of the ecological urine and toilet systems on the VVU campus. Alternatively the university could contact local plastic manufacturing companies to experiment and try to produce the component locally in order to have a secured source for generating these parts, maybe in collaboration with the companies in Germany from where these membrane traps were produced.

For Ecosan future projects, important and not to be taken likely for future projects is the sensitization of workmen on the cost of materials, specifically of toilet components, so that they can have a feel and a sense of the actual value of such materials which probably will help them keep, preserve and handle such components properly and more carefully. Also, in future projects for institutions like VVU, there is the need to utilize or directly involve permanent technicians and workmen, and not contracted ones in undertaking the installation of ecological facilities as future maintenance will in the long run involve permanent staff, and there may be difficulties in maintenance as identified from the project in VVU.

In future projects for institutions like VVU, there is the need to utilize or directly involve permanent technicians and workmen, and not contracted ones in undertaking the installation of ecological facilities as future maintenance will in the long run involve permanent staff, and there may be difficulties in maintenance as identified from the project in VVU.

A lot has to be done in relation to capacity building. The administrative hierarchy of VVU obviously affects the mode and quality of work and management of Ecosan facilities, as learned from the field study. Referring specifically to the usurpation of duties mainly by the higher level staff, for e.g the cleaning lady who cannot work because she has to go around on errands for some pastor, or the workman who is threatened not to be paid because of one financial staffs' disagreement on people employed. Evidently, issues like this need consideration if ecological systems established in a university have to be considered.

In the construction of UDDT toilets in general, the elderly and physically challenged need to be considered and factored in the construction and design of the toilet units. The BBT toilet design constitutes an efficient UDDT structure in terms of collection and transportation of fecal composts. However, an addition to the design of the structure could be a slope for wheel chairs, and one or two physically challenged customized units (for e.g handle bars for helping the challenged to hold themselves off a wheel chair in the absence of other people to help).

To the further up scaling of Ecosan UDDT toilets especially in public places, there is the need especially for UDDT sitting toilet systems to establish some sought of control mechanism (perhaps electronically) known as the "Adjeteysan control principle", that cautions or controls how users use a toilet facility properly, for e.g an electronic device that beeps, or lights red when sitting and not squatting on sitting toilets. Alternatively, there could always be a toilet referee to first tell people how the toilets work, receive a small deposit of money as collateral before users use a toilet facility and goes to control to make sure the toilet is in good condition as before, before releasing the collateral to users, to ensure a good condition for the next user and hence avoiding vandalism or any other form of misuse of the toilet facility by others.

The VVU administration (Physical Plant department) should take steps to conduct actual training, education and sensitization of students on the ecological facilities installed on campus, such as the correct use collection and application of toilet fertilizer generated composts. This no doubt will demand some extra dedication and commitment but will help ensure an appreciation and acceptance of the ecological facilities installed on campus.

Recommendations for further research

The VVU project conducted a know-how transfer on the collection and application of urine to surrounding villages near the VVU vicinity. Due to the author's limited scope, he could not effectively reach out to these areas. A recommendation for further study will be to conduct a similar qualitative research study that will unearth the lessons, recommendations and problems from these communities and to find out if the ecosan technologies are still being practiced.

There should be more R&D projects on the use of hybrid (that is toilets that allow the both squatting and sitting) separation toilets in both public and private places to identify the benefits and challenges to allow for further up scaling of the Ecosan technologies.

Conclusion

In conclusion, in a global community where many issues of common concern are circulated across continents, facilitated particularly with the advent of the world wide web, issues of concern in one part of the globe will resonate to other parts. As unearthed from the VVU project, a major concern for why the UDDT composts were not used was because of international concerns about the presence of heavy metals and pharmaceutical remains, to summarize the situation in a sentence, one may pose a simple question to that effect such as: if it is not allowed or done in Europe why then should it be done in Africa? For many R& D projects in Africa, such questions may well answer the reason why certain development measures may not be sustained in the long-run.

References

A. U. (1981, June). The African Charter of human and peoples rights . Banjul, The Gambia: OAU.

AAA. (2008). Accra Agenda for Action. *3rd high level forum on aid effectiveness* (p. 7). Accra: Unknown-http://siteresources.worldbank.org/ACCRAEXT/Resources/4700790-1217425866038/AAA-4-SEPTEMBER-FINAL-16h00.pdf.

Agodzo, S., Huibers, F., Chenini, F., J.B, V. L., & Duran, A. (2003). *Use of wastewater in irrigated agriculture: Country studies from Bolivia, Ghana and Tunisia (Volume 2: Ghana)*. Wgenigen ISBN 90-6754-704-2: Wgenigen University.

akvo.org. (2011). *index.php*. Retrieved February 15, 2012, from http://www.akvo.org: http://www.akvo.org/wiki/index.php/Co-composting

BBC. (2011, June 12). *Business News*. Retrieved October 13, 2011, from BBC-News: http://www.bbc.co.uk/news/business-13742217

BBG. (Unknown). Retrieved April 4, 2012, from http://www.berger-biotechnik.com: http://www.berger-biotechnik.com/downloads/-projects/berger-biologicaltoilet

BBG, Palutec. (Unknown). *Wastewater treatment.* https://www.uni-hohenheim.de/respta/poster/PB_0003.pdf: Palutec & BBG.

BBG-RESPTA. (Unknown). *poster*. Retrieved April 4th, 2012, from www.uni-hohenheim.de: https://www.uni-hohenheim.de/respta/poster/PB_0004.pdf

BBG-RESPTA. (Unknown). *respta (Recycling the resource)*. Retrieved February 5, 2012, from www.uni-hohenheim.de: https://www.uni-hohenheim.de/respta/poster/PB_0002.pdf

Berger, W. (2009). From pit latrine to nutrient conservation – Design and construction of an optimised public dehydration toilet in Ghana. *3rd International DryToilet Conference in Tampere, Finland, 2009* (p. 4). Tampere

Berger, W. (2008). Results on the Use and Practice of Composting Toilets in Multi Story Houses in Bielefeld and Rostock, Germany. *Dry Toilet 2003, 20th "ecosan - closing the loop" proceedings of the 2nd International Symposium, 7th-11th April 2003, Lübeck,Germany GTZ , Division 44, Germany* (p. 5). Eschborn : GTZ.

Berger, W. (2010). *Schlussbericht BMBF- Verbundvorhaben „Ökologische Kreislaufwirtschaft an der Valley View University Accra (Ghana)"Teilprojekt 2: „Sanitärtechnik innerhalb von Gebäuden"*. Hamburg.

Bourguignon, F. a. (Unknown). *Aid Effectiveness – Opening the Black Box.* Retrieved April 2012, from worldbank.org : http://siteresources.worldbank.org/DEC/Resources/Aid-Effectiveness-MS-FB.pdf

Brinton, W. F., Evans, E., Droffner, M. L., & Brinton, R. B. (Unknown). Retrieved March 28, 2012, from Solvita.com: http://solvita.com/pdf-files/dewar.pdf

Bryman, A. (2004). Triangulation and Measurement. Leicestershire 5.

Camara, F. A. (2009). Ecological Sanitation (ECOSAN): A New Sanitation approach in Senegal. *WEST AFRICA REGIONAL SANITATION AND HYGIENE SYMPOSIUM* (p. 7). Accra, Ghana, 10-12 November 2009: Unknown.

CIA. (2010). *CIA*. Retrieved April 10, 2011, from The world factbook: https://www.cia.gov/library/publications/the-world-factbook/fields/2212.html The World Factbook ISSN 1553-8133

CIDA. (2004). *CIDA evaluation guide.* Ottawa, Canada: CIDA.

Cofie, O., Kranjac-Berisavljevic, G., Drechsel, & Pay. (2004). The use of human waste for peri-urban agriculture in Northern Ghana. *Renewable Agriculture and Food Systems* , 8 DOI: 10.1079/RAF200491.

Cross, P., & Salifu, L. (2002). Retrieved April 9, 2012, from EcoSanRes: http://www.ecosanres.org/pdf_files/Nanning_PDFs/Eng/Piers%20Cross%202%2049_E06Bok.pdf

Dagerskog, L., Kenfack, S., & Jönsson, H. (2008). *ECOSAN fertilizers with potential to increase yields in West Africa.* Urban Agriculture magazine.

EC. (2005). *Aid Delivery Methods C o n c e p t Pa p e r: Institutional Assessment and Capacity Development Why, what and how?* European Comission.

EC. (2011). *Supporting Environmentally Sound Decisions for Bio-Waste Management:A practical guide to Life Cycle Thinking (LCT) and Life Cycle Assessment (LCA).* Italy: European Commission.

EcoSan-Club. (2011). *Sustainable sanitation Practice.* Vienna: EcoSan-Club.

EcoSan-Club. (2009). *Sustainable Sanitation practice-greywater treatment and use.* Vienna: Medieninhaber, Herausgeber und Verleger, Ecosan-Club.

EU. (2006). COUNCIL REGULATION (EC) No 1083/2006-laying down general provisions on the European Regional Development Fund, the European Social,Fund and the Cohesion Fund and repealing Regulation (EC) No 1260/1999. *Official Journal of the European Union* , 54.

EU. (2001). *EX ANTE EVALUATION A PRACTICAL GUIDE FOR PREPARING PROPOSALS FOR EXPENDITURE PROGRAMMES.* 10th December, 2001: European Commission (EC).

FAO. (2010). *Growing Greener Cities.* Rome, Italy: FAO.

FELDER, R. M., & BRENT, R. (2003). *LEARNING BY DOING.* North Carolina State University,Raleigh, NC 27695.

FOE. (2004, May). *resources.* Retrieved April 20, 2012, from FOE.co.uk: http://www.foe.co.uk/resource/briefings/biowaste_guide.pdf

Geller, G., & Laryea, S. (2008). Cycles in the ecological development of Valley View University, Accra, Ghana. *33rd WEDC International Conference, Accra, Ghana, ACCESS TO SANITATION AND SAFE WATER GLOBAL PARTNERSHIPS AND LOCAL ACTIONS* (p. 9). Accra: WEDC.

Germer. (2011). Effect of transparent covers for collection chambers of urine-diverting dry toilets on dehydration of faecal waste. *IWA* , 11.

Germer, J. (2009). *Schlussbericht BMBF Verbundvorhaben „Valley View University: Ökologische Kreislaufwirtschaft“ Teilprojekt 5 „Landwirtschaft“*. UHOH.

Germer, J., & Joachim, A. S. (2011). Response of grain sorghum to fertilisation with human urine. *Elsevier* , 8.

Germer, J., Yongha Boh, M., Shoeffler, M., & Amoah, P. (2010). Temperature and deactivation of microbial faecal indicators during small scale co-composting of faecal matter. *Elsevier* , 7.

Ghanaweb. (2011, March 25). *Ghanaweb(Article No. 205713)*. Retrieved April 20, 2011, from Ghanaweb: http://www.ghanaweb.com/GhanaHomePage/NewsArchive/artikel.php?ID=205713

GIZ. (2008). *Ecological sanitation projects from around the world and their links with the solid waste sector* . (Presentation by Christian Olt).

GIZ. (2008). *Guidelines on the Project Progress Review.* Unknown: GIZ.

GIZ. (2010). *Results.* Power point presentation.

GIZ. (2011). *Technology review of constructed wetlands Subsurface flow constructed wetlands for greywater and domestic wastewater treatment.* Eschborn: GIZ.

GTZ. (2005, June 2). *dokumente.* Retrieved April 20, 2011, from Gtz.de: http://www.gtz.de/en/dokumente/en-ecosan-pds-006-germany-waldmichelbacherhof-2005.pdf

GTZ. (2004). ecosan – closing the loop Division 44 Environment and Infrastructure. *ecosan – closing the loop, Proceedings of the 2nd international symposium,7th –11th April 2003, Lübeck, Germany* (p. 263). Eschborn : GTZ.

GTZ-ECOSAN. (2009). *Library.* Retrieved May 4, 2011, from SuSanA: http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=99

Hao, X., Novotný, V. &., & Valerie. (2010). *Water Infrastructure for Sustainable Communities: China and the World - Page 274.* London: IWA.

Holden, M. T., & Lynch, P. (2004). Choosing the Appropriate Methodology:Understanding Research Philosophy. 18.

IIED. (2005). Stakeholder influence mapping. *prepared by James Mayers and Sonja Vermeulen* , 15.

IOV. (2010). *VALLEY, ECOLOGICAL CYCLE MANAGEMENT AT VIEW UNIVERSITY IN ACCRA, GHANA (Final Report).* Augsburg: Ingenieurökologische Vereinigung e.V. (ed).

lgam. (n.d.). *trunk-infrastructure* . Retrieved May 6, 2012, from lgam.wikidot.com: http://lgam.wikidot.com/trunk-infrastructure

Keraita, B., Danso, G., & Obuobie, E. (2004). *Extending the "ecosan loop" to address health concerns from wastewater irrigation in urban and peri-urban areas.* Kumasi: Unpublished article.

Kocsis, A. (2010). *The Complete Guide to Eco-Friendly House Cleaning: Everything You need to know.* Atlantic publishing company.

Morgan, P. &. (2004). *The Aborloo book.* Harare: SEI.

Muijs, D. (2011). *Second Edition, Doing quantitative research in Education with SPSS.* London: Sage Publications Ltd.

ODA. (2009, February). *ODA EVALUATION GUIDELINE 5th edition -International Cooperation Bureau/Ministry of Foreign Affairs of Japan.* Retrieved April 30, 2012, from http://www.mofa.go.jp: http://www.mofa.go.jp/policy/oda/evaluation/guideline.pdf

OECD. (2010). *dataoecd.* Retrieved April 12, 2012, from http://www.oecd.org: http://www.oecd.org/dataoecd/55/0/44798177.pdf

OECD. (2005). *Policy brief: Opening Markets for Environmental Goods and Services.* Paris: OECD.

Olsen, W. (2004). Triangulation in social research: Qualitative and Quantitative methods can really be mixed (Draft). *Developments in sociology* , 30.

Orb, A., Eisenhauer, L., & Wynaden, D. (2001). Ethics in Qualitative Research. *Journal of Nursing Scholarship First Quarter* , 4.

Ospina, S. (2004). Qualitative Research. *Encyclopedia of Leadership* , 13.

RESPTA. (2009). *respta*. Retrieved April 12, 2012, from www.uni-hohenheim.de: https://www.uni-hohenheim.de/respta/prog.php

Ridderstolpe, P. (2004). *Introduction to greywater management.* Stockholm,Sweden: SEI.

Schmeer, K. (1999). Stakeholder analysis guidelines: section 2. 48.

SEI. (2008). Sanitation now. *A magazine on the global sanitaion crisis,Special edition UN international year of sanitation* . Stokholm, Sweden: SEI.

Shannon, H. a. (2005). Three Approaches to Qualitative Content Analysis. *SAGE-October, 2005* , 13.

Smith, K. (2011). *How to Build, Maintain, and Use a Compost System: Secrets and techniques you need to know to grow the best vegetables.* Florida: Atlantic publishing group,inc.

SROI. (2004). Measuring Social Impact: the foundation of social returns on investment (SROI). *SROI Primer ©2004 nef* , 12.

Streubert, H., & Carpenter, D. R. (2011). *Qualitative research in Nursing: advancing the humanistic imperative: Fifth edition.* Wolters Kluwer health/Lippincott williams and Wilkins.

SuSanA. (2011). *Compilation of 13 factsheets on key sustainable sanitation topics.* Eschborn: GIZ/BMZ.p.115.

SusAnA. (2012, April 21). *Select by region and country*. Retrieved April 21, 2012, from SusAnA: http://www.susana.org/lang-en/case-studies?showby=yeardesc&vbls=2&vbl_2=9&vbl_0=0

Sc Department of archives and history, S. h. (n.d.). Retrieved May 10, 2012, from palmettohistory.org: http://palmettohistory.org/archaeology/ReconnaissanceSurvey.htm

Thrift, C. (2007). *Sanitation Policy in Ghana: Key Factors and the Potential for Ecological Sanitation Solutions.* Stockholm: EcoSanRes/SEI.

Tsiboe, I.A and Marbell E. (2004) A look at urban waste disposal problems in Accra-Case study in Accra, Ghana [online] MSc thesis, Roskilde Universit http://rudar.ruc.dk/bitstream/1800/322/1/A_Look_at.pdf [accessed 8th April 2011], Accra, Ghana.

UHOH-RESPTA. (n.d.). Retrieved February 5, 2012, from www.uni-hohenheim.de: https://www.uni-hohenheim.de/respta/poster/UHOH_0003.pdf

UHOH-RESPTA. (Unknown). Retrieved February 5, 2012, from www.uni-hohenheim.de: https://www.uni-hohenheim.de/respta/poster/UHOH_0001.pdfa

UNEP. (Unknown). *Regional overview*. Retrieved April 10, 2011, from UNEP: http://www.unep.org/dewa/africa/publications/aeo-1/203.htm

UNESCO/IHP, & GIZ. (2006). *Capacity building for ecological sanitation. Concepts for ecologically sustainable sanitation in formal and continuing education.* Eschborn/Paris: UNESCO/IHP and Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH.

UNESCO. (2007). *Internal Oversight Service Evaluation Section-EVALUATION HANDBOOK*. Unknown: UNESCO-IOS/EVS/PI/63.

UNFPA. (2004). *Programme Manager's Planning Monitoring & Evaluation Toolkit.* Unknown: UNFPA.

UNWATER. (2008). *10 Things You Need to Know About Sanitation.* Retrieved November 5, 2011, from www.unwater.org: http://www.unwater.org/wwd08/docs/10Things.pdf

USAID. (1996). Performance Monitoring and Evaluation tips. *USAID Center for Development Information and Evaluation* , 4.

USDA-NRCS. (1995). *A guide on constructed wetlands Volume 1.* Washington, ISBN 0-16-052999-9: U.S. Goverment Printing Office.

VVU. (2005). Water and nutrient concept. *Brochure on the Ecological Development of Valley View University, Accra* . Ghana: VVU.

Weber, R. P. (1990). *Basic Content analysis: Volume 49.* SAGE.

Westat, J. F. (2002). *The 2002 User- Friendly Handbook for Project Evaluation.* Arlington: National Science Foundation.

WHO. (2009). *HIV triangulation resource guide-Synthesis of results from multiple data sources for evaluation and decision-making.* 28th february: WHO.

WHO. (2006). *WHO guidelines on the safe use of wastewater,excreta and greywater. Volume IV.* France: WHO.

WHO/UNICEF. (2008). A Snapshot of Sanitation in Africa. *A Snapshot of Sanitation in Africa, AfricaSan: Second African Conference on Sanitation and Hygiene* (p. 22). Durban, South Africa: WHO/UNICEF.

Wong, T. H., & Breen, P. F. (1999). Ponds versus Wetlands-Performance considerations in storm water quality management. *1st South Pacific Conference on Comprehensive Stormwater and Aquatic Ecosystem Management* (p. 9). Auckland: Unknown.

WSMP. (2010). *Directory of Ghana's water and sanitation sector.* Retrieved November 27, 2011, from WSMP: http://www.wsmp.org/downloads/4d4bce9d3227c.pd

WSP. (2005, January). *Library.* Retrieved May 4, 2011, from SuSanA: http://www.susana.org/docs_ccbk/susana_download/2-295-jackson-2005-ecosan-experience-in-eastern-southern-africa-wspes.pdf

WWF. (2005). Logical Framework Analysis. Resources for Implementing the WWF Standards. *Written by: Meg Gawler, ARTEMIS Services* , 10 September.

WWF. (2002). *WWF.* Retrieved January 8, 2011, from Living waters, conserving the sources of life, facts on water in Africa: http://wwf.panda.org/index.cfm?uGlobalSearch=assets.panda.org%2Fdownloads%2Fwaterinafricaeng.pdf+&x=0&y=0

Appendix 1: Framework for Semi-structured interview design

Overarching Objective	Interviewee Person/group	Guideline questions			Sector
		Output level	Outcome level	Impact level[92]	
1.To generate and treat various dry toilet composts by repeated self-heating and verify the composting process and its hygiene potential by testing finished compost for traces of germs in and around campus (IOV, 2010: 5.27; UHOH, Unknown)[93]	1.Vui-10 2.Field Observation 3.Vcpf 1-10	1. What quantity of compost is currently being treated? 2. What methods exist for compost treatment? 3. Why was self heating chosen? 4. How much of compost was treated by self heating? 5. How many times was self –heating repeated on the compost? 6. What processes were used in testing for traces of germs?	1. What kind of "products" were the compost applied to? 2. How much traces of Germs can be found in finished products (yields)? 3. Does composting with self heating generate enough amounts of fertilizer for the farms?	1. Does the composting process produce higher or lower yields (quantity and quality of products)? 2. How much is being saved in relation to the price of fertilizer? 3. Does the duration for treatment of compost conform to local farmers demand for application? 4. How many local farmers are still using self treated-fertilizer after being introduced? 5. What perception surrounds products from fecal composted products? 6. To what extent has it reduced the use of chemical fertilizers in farming activities in surrounding areas?	Agriculture
2. To determine the duration and most effective treatment processes suitable for the climate of southern Ghana	1. Vui-10 2.Farmers 3.Cleaners 4.Field Observation 5. GRi-3	1. How long did each self heating process take? 2. What period of the year was it most effective? 3. What period was it least effective?	1. Is the compost generated adequate enough to supply the farms within the duration in which they are generated? 2. What makes self-heating suitable for Southern Ghana?	1.In comparism to chemical fertilizers does it yield enough quantities for application when required 2. Can you say if it has contributed to the health of consumers of the products? 3. What indicators exist to prove this? 4. Does the compost produce fewer odors? 5. Are they scaling up the self-heating composting method, what have been done to upscale?	**Water & Sanitation**
3. To equip toilets with urine diverting devices and membrane traps to ensure separation for further use in Agriculture (IOV, 2010: 5.27)	1.Field Observation 2.Plumbers 3. Vui-10 4. GRi-5	1. How many toilets are equipped with urine diverting devices and membrane traps? 2. How many toilets are not equipped? 3. How many membrane traps are in stock?	1. How many of the installed devices and traps are functioning? 2. How available are the membrane traps for replacement?	1. What is the effect of the toilet installation system on the composting process? 2. What happens when the membrane traps don't work? 3. How feasible is it to replace a membrane trap (cost and process)?	**Water & Sanitation**

Source: Own design, 2011

[92] The impacts is measured based on user-acceptance, feasibility, sustainability and environmental friendliness.

[93] See https://www.uni-hohenheim.de/respta/poster/UHOH_0001.pdf and https://www.uni-hohenheim.de/respta/poster/UHOH_0003.pdf [last accessed 5th February 2012]

Appendix 1: Framework for Semi-structured interview design (continued)

Overarching Objective	Interviewee Person/group	Guideline questions			Sector
		Output level	Outcome level	Impact level	
4. Application of the Multi-barrier Concept by the WHO for waste water-reuse (IOV, 2010: 4.13).	1. Vui-10 2.Field Observation 3.Vcpf 1-10	1. Please tell me about the Multi/barrier concept 2. In what ways are the multi-barrier concept applied?	1. Could you please tell me if the concept is still being practiced today and how? 2. Please describe to me how you apply the faecal matter and urine in your daily work?	1. What are some of the benefits derived from application of the concept?	**Water & Sanitation**
5. To develop an *ecotech* centre responsible for Consensus building (IOV, 2010: 8.4).	1. Vui-10 2.Field Observation	1. What happens in the ecotechnic centre? 2. Who and how many people access the centre? 3. What kind of information are they normally looking out for?	1. What are some of the problems/challenges being faced at the ecotechnic centre? 2. What has been done or is being done to address such problems or Challenges? 3. What are some of the success stories? 4. Can you please share some of your management strategies?	1. How has it helped the University and the people who visit? 2. What can be done to improve the centre?	Consensus Building
6. To develop training modules for users, farmers or service enterprises (IOV, 2010: 5.10).	1. Vui-10 2. Vui-8 3. Vcpf 1-10 4. Vsr-1-5	1. How many users have been trained so far? 2. How were the training modules developed? 3. What parameters were used to develop them and what problems were encountered during training sessions? 5. What success stories could be shared from users?	1. How many users have been trained so far? 2. What success stories could be shared from users? 3. What problems can be shared by users?	1. How did the problems/success affect the continuity of the project if any? 2. What has been done or is being done to address such problems?	Consensus Building
7. To develop a toolkit for ecological water management and cycling to serve as a guide for users (IOV, 2010: 5.11).	1. Vui-10 2. Vui-8 3. Vcpf 1-10 4. Vsr-1-5	1. What was considered in the development of the tool kits? 2. Did users participate in the development of the tool kit?	1. What ways has the toolkit contributed to the Ecological management of water? 2. What problems or successes can be shared? If any problems, then What has been done or is being done to address such problems?	1. How has the toolkit helped the university and the users and operators? 2. What success stories could be shared from users?	Consensus Building

Source: Own design, 2011

Appendix 1: Framework for Semi-structured interview design (continued)

Overarching Objective	Interviewee Person/group	Guideline questions			Sector
		Output level	Outcome level	Impact level	
8. To hold information and training courses to inform users and employees about new techniques, as well as maintenance& service (IOV, 2010: 5.15).	1. Vui-10 2. Vui-7 3. Vcpf 1-10 4. Vsr-1-5	1. What kind of information or training courses is being taught? 2. What kinds of people were trained? How many people have been trained so far? 3. What were some of the problems or success? If problems, then what was done to address them?	1. Do you feel these courses have really informed users and employees as expected? 2. What new techniques have been found so far?	1. How has the courses affected maintenance and service? 2. What problems or successes can be found on the part of users and employees?	Cost Effectiveness
9. To train personnel who will build and run the Installations for the entire system (IOV, 2010: 8.4)	1. Vui-10 2.Field Observation 3.Vcpf 1-10 4.Vui-7	1. How was the training done? 2. How many personnel have been or are being trained so far? 3. What were some of the problems encountered in the course of training?	1. How many of the personnel trained are still available to run the system? 2. What is the attrition[94] rate? 3. What structures exist to ensure the continuity of the training sessions?	1. How has training improved technical support? 2. What problems exist and what are some of the success stories?	Cost Effectiveness
10. To promote reliability and safety by training and instruction of staff, craftsmen and users for the sustainability of the entire system (IOV, 2010: 5.28).	1. Vui-10 2.Field Observation 3.Vcpf 1-10 4.Vui-7	1. How many safety training Sessions have taken place so far? 2. Which parties were involved?	1. What structures exist to ensure the continuity of the training sessions?	1. How has it improved the usage of the facilities on campus? 2. What problems exist and what are the success stories?	Monitoring

Source: Own design, 2011

[94] The rate at which trained employees leave their trained positions in the university since new people will have to be trained to fill in such vacant positions.

Appendix 1B: Contingent interview guidelines

List of Interview guidelines for farm staff and cleaners

- Please tell me what your duties are on campus in your line of work?
- What are some of the success stories in the course of work you will like to share?
- What are some of the problems being faced with your work?
- Future ideas, what will you change to improve things over here?
- Information flow and participation or training, how was the training done?
- How did you feel about the training and the method used?
- Would you buy or eat products that have been produced with fertiliser from treated fecal matter? Yes/No and Why?
- What can be done to improve your mode of work on a general level?

List of Interview guideline for student groups (student representative and Bediako hall students)

- What Hostel do you live in? If (Bediako hall) did you undergo any form of education or training on how to use the toilets?
- Information flow and participation or training, how was the training done?
- Have you heard about the BBTs or Ecosan water saving flush toilets before?
- Have you used the BBT before? Yes/No if yes did you enjoy using it? And why? If No why?
- Which country are you from?
- How long have you been in the school?
- What kind of toilet/Urinal facility do you use on campus?
- Have you heard about Ecosan? Yes/No if yes can you briefly tell me what you know or have heard about it?
- What do you know about Agricultural system on campus?
- Would you buy or eat products that have been produced with fertiliser from treated fecal matter? Yes/No and Why?

List of other Interview guidelines

- When and how did the whole idea about the project start?
- Why was the project started in General? (What was the main objective)?
  Which objectives could be achieved at your level?
- How did the project start? What were the initial Goals? Were they changed along the line?
- What was surprising to you in the beginning when the project started? (Negative and positive experiences)
- Please tell me a little about your experiences with work during the period of the project. What was done?
- Did you have problems doing it? What were the success stories?
- Can you name other similar projects you have undertaken both in Ghana and other parts of the world?
- In comparism to the valley view project which projects were the best for you?

- Would you say you have had bad experiences with some of these projects? If yes, where and why?
- Have there been any evaluations done on this project or any of your other projects? If yes, when? And who were involved? And is it possible to have access to any reports or any related material/documents.
- If you were a second time in this same project, what would you do differently?
- At which points were local people involved in the project? That is, at the planning stage or implementation (information campaign)
- Acceptance was a crucial point for this project; do you have any idea who worked on the info Campaign? If yes were they pretested if yes, with whom? Was it with the Students?
- Where will you rate the valley view University project if you had to do so from 1-10? and why? What do you think about the Ecosan toilets and maybe the entire Ecosan system in General? Is the performance of the toilets satisfactory from the view of the university?
- In your opinion do you think the VVU project has multiplied the Ecosan concept in Accra and beyond? If yes/No why?
- If yes, what in your opinion do you think will be the best way to further promote the concept in Accra.
  If No, what do you think should be changed to achieve this?

About the future

Did the entire ecological idea market Valley View University? What makes you think so? Did you receive requests from other universities elsewhere?
Did the acceptance affect work? Yes/No why didn't it work?

- Could you please give me advice on things that you feel could be done differently to help make improvements in a new project. The idea behind is to learn from this project for future design of similar projects.

Other relevant guidelines

- If they don't know explain to them and ask them what they think about the toilets for e.g.
- What was done here?
- Ask for whatever he can tell you if he was not there at the time, ask other people.
- Or how is it today now? How do you feel about the utilisation?
- Is it satisfactory from the view of the university?
- Information flow and participation and how they felt about the trainings?
- What was done with regards to the training?
- Did you have problems doing it?
- Please describe to me your function and duties at work? In the future what would you change to work better?
- Do you have any measure for Xyz, can you measure XYZ?
- Make a time list then, if they don't know figures, later you can calculate.

Appendix 2: List of coded interviewee groups

Group 1: German research interviewee group (Gri-1-5)				
Pos.	Interviewee Group / Type/ Cluster	Name	Time of interview	Date
1	German Project implementation staff (engineer)	Gri-1	10:22 (2h,37mins)	18/07/2011
2	German Project implementation staff (engineer)	Gri-2	10:10 (53mins)	26/05/2011
3	German Project implementation staff (technician)	Gri-3	15:30 (55 mins)	28/07/2011
4	Resource person others (Monitoring & Evaluation)	Gri-4	14:19 (1h,19 mins)	21/04/2011
5	German Project implementation staff (engineer)	Gri-5	14:31(1h,43mins)	12/05/2011
Group 2: Ghanaian VVU project staff interviewee group (Vui-1-10)				
6	VVU managerial staff	Vui-1	13:59 (07mins,7sec)	03/10/2011
7	VVU engineering staff	Vui-2	8:12 (49mins)	30/09/2011
8	VVU managerial staff	Vui-3	10:19(2h,20 mins)	09/09/2011
9	VVU managerial staff	Vui-4	13:47(29mins:41sec)	26/09/2011
10	VVU engineering staff	Vui-5	11:56(1h,25mins)	23/09/2011
11	VVU managerial staff	Vui-6	09:02(1h:27:mins)	26/09/2011
12	VVU managerial staff	Vui-7	09:22(37mins:05)	27/09/2011
13	VVU managerial staff	Vui-8	15:39(24mins:05)	27/09/2011
14	VVU technical staff	Vui-9	11:03(15mins:46s)	27/09/2011
15	VVU technical staff	Vui-10	08:30(31mins,7s)	03/10/2011
Group 3: Ghanaian VVU cleaning, plumbing and farm maintenance staff group (Vcpf-1-10)				
16	VVU cleaning staff	Vcpf-1	08:52(15mins)	22/09/2011
17	VVU cleaning staff	Vcpf-2	09:27(21mins)	22/09/2011
18	VVU cleaning staff	Vcpf-3	10:54(6mins)	22/09/2011
19	VVU cleaningstaff	Vcpf-4	11:01(3mins)	22/09/2011
20	VVU plumbing staff	Vcpf-5	11:30(17mins,49s)	27/09/2011
21	VVU plumbing staff	Vcpf-6	12:01(16mins,37s)	27/09/2011
22	VVU farmmaintenancestaff	Vcpf-7	12:17(10mins,25s)	22/09/2011
23	VVU farmmaintenancestaff	Vcpf-8	12:31(16mins,23s)	22/09/2011
24	VVU farmmaintenancestaff	Vcpf-9	12:49(13mins,44s)	22/09/2011
25	VVU farmmaintenancestaff	Vcpf-10	13:07(12mins,10s)	22/09/2011

Source: Own design, 2011

Appendix 2: List of Interviewee groups (continued)

Group 4: Ghanaian VVU Student representatives interviewee group[95] (Vsr-1-5)				
Pos.	Interviewee Group / Type/ Cluster size	Name	Time of interview	Date
26	Student group (10)	Vsr-1		22//09/11 and 29/09/11
27	Student group (2)	Vsr -2		29/09/11
28	Student group[96] (65)	Vsr -3		05/09/11, 20/09/11 ,22/09/11 and 29/09/11
29	Student group (4)	Vsr -4		29/09/11
30	Student group (3)	Vsr -5		29/09/11
31	Student group (3)	Vsr -6		29/09/11
Group 5: Other resource persons group (Orp-1-2)				
32	Pecs Educational Centre	Orp-1	15:58 (28min,58s)	25/09/11
33	Orphan aid Ghana	Orp-2	15:52 (25mins 44s)	21/09/11
34	Orphan aid Ghana	Orp-3	16:42 (18mins 24s)	21/09/11

Source: Own design, 2011

[95]Individual interview times for students cannot be given due to number of students at the same time some students declined to have their sessions recorded, points were recorded in a written manner in field notes.

[96] Focus group discussions were used randomly from one Student dormitory to the other collecting the inputs of the students at some points and audio taping with their permission at other times.

Appendix 3: List of Involved Stakeholders of Valley View University ecological development Project

No.	Stakeholder name	Position in project	Role	Involved time frame
German Project Stakeholders				
1.	German Ministry of Research and Development (BMBF) Bonn-Germany		Provision of funds for project research as part of the "Research and environment-subdivision of water and nutrients" research program, in addition to supporting and guiding the development of the entire project. (IOV, 2010 p.1.03)	Pre-Phase 12/2002 - 04/2004 and Main-phase 05/2004 – 11/2009
2.	Bauhaus-University Weimar. (BUW) Weimar-Germany		Ecological master plan, building design and decentralized sanitary systems.	Pre-Phase 12/2002 - 04/2004 and Main-phase 05/2004 – 11/2009
	Prof.Dr.-Ing.Detlef Glücklich	Architect, Head of "new" Master plan and buildings designs.		
3.	Centre for international Migration and Development (CIM) Frankfurt-Germany		CIM contributed two experts who were responsible for construction and implementation	Main-phase 05/2005– 04/2009
	Mr. Anton Mitterer	Project Building Contractor (construction supervisor, consultancy, realization)		
	Dipl.-Ing. Luis Addy	Expert in charge of landscape and outdoor water installations		
4.	Berger-Biotechnik GmbH. Hamburg-Germany		Company responsible for installation of sanitation systems inside the buildings.	Pre-Phase 12/2002 - 04/2004 and Main-phase 05/2004 – 11/2009
	Dipl.-Ing.Wolfgang Berger	Project leader for concept and design, final realization of sanitation installations.		

Source: Own design, 2011

Appendix 3: List of Involved Stakeholders of Valley View University ecological development Project (continued)

No.	STAKEHOLDER NAME	POSITION IN PROJECT	ROLE	INVOLVED TIME FRAME
German Project Stakeholders				
5.	University of Hohenheim (UHOH): Hohenheim-Germany		Agriculture and nutrient cycling, Also responsible for utilization of the harvested Ecosan products in the VVU farmland. They developed a plant system to use it under different conditions	Pre-Phase 12/2002 - 04/2004 and Main-phase 05/2004 – 11/2009
	Prof.-Ing. Joachim Sauerborn	Head of the Agricultural research of the project		
	Dr. Jörn Germer	Test supervisor for secondary research		
6.	Ingenieurökologische Vereinigung (IÖV). Augsburg-Germany		Project coordination and quality management for entire project.	Pre-Phase 12/2002 - 04/2004 and Main-phase 05/2004 – 11/2009
	Dipl.-Ing. Gunther Geller	Project coordinator for entire project sponsored by BMBF.		
7.	Palutec GmbH: Augsburg-Germany		Company responsible for sanitary installations outside buildings rain water harvesting.	Pre-Phase 12/2002 - 04/2004 and Main-phase 05/2004 – 11/2009
	Dipl.-Ing. Gunhild Höner	Project leader for sanitary installations outside buildings and Rain water harvesting.		
Ghanaian Project Stakeholders				
8.	Valley View University (VVU) Accra-Ghana		Provision of land, manpower and buildings as part of the "Research and environment-subdivision of water and nutrients" research program, in addition to supporting and guiding the development of the entire project.	Pre-Phase 12/2002 - 04/2004 and Main-phase 05/2004-11/2009
	Prof. Seth Laryea	Local partner, initiator and former President of Valley View University at time of project.		
	Mr. Emmanuel Kwandahor	Formerly Director of Physical Plant at VVU, second local partner at the time of project.		

Source: Own design, 2011

Appendix 4: List of Interviewees

German interviewee group			
Pos.	Interviewee Group / Type/ Cluster	Name	Institution/Position
1	German Project implementation staff (engineer)	Mr. Anton Mitterer	CIM expert-Building Contractor (construction supervisor, consultancy, realization)
2	German Project implementation staff (engineer)	Mr. Gunther Geller	Ecological Engineering Society (IÖV) (VVU Ecosan project coordinator)
3	German Project implementation staff (technician)	Dr.Jorn Germer	University of Hohenheim, Test supervisor for secondary research
4	Resource person others (Monitoring & Evaluation)	Mr. Michael Gajo	Senior Advisor GIZ Dept. For Monitoring and Evaluation.
5	German Project implementation staff (technician / engineer)	Mr. Wolfgang Berger	Director of Berger Biotechnik GmbH (Ecological sanitation project director-VVU Ecosan project)

Source: Own design, 2011

Appendix 4: List of Interviewees (continued)

Ghanaian interviewee Group			
Pos.	Interviewee Group / Type/ Cluster	Name	Institution/Position
6	VVU managerial staff	Prof. Daniel Buor	Current Vice Chancellor of Valley View University.
7	VVU managerial staff (Engineer)	Mr. Daniel Sarpong	Former manager in charge of ecological water and sanitation of Valley View University
8	VVU managerial staff	Mr. Emmanuel Kwandahor	Former Director of Physical Plant at VVU, (Currently retired)
9	VVU managerial staff	Mr. Isaac Osei Kwaku	Current works and physical development director

Source: Own design, 2011

Appendix 4: List of Interviewees (continued)

Ghanaian interviewee group			
Pos.	Interviewee Group / Type/ Cluster	Name	Institution/Position
10	VVU managerial staff (Engineer)	Mr. Solomon Addae	Currently Acting as director of Environment and Sanitation (Former Farms Systems manager)
11.	VVU managerial staff	Prof. Seth A. Laryea	President of Data Link University, Tema. Ghana (Former President of VVU)
12.	VVU managerial staff	Mr. Sonny Davis Arthur	Current director in charge of transport and at the time of project
13	VVU managerial staff	Pastor. Patrick Arkoh	"Work-study" student at the time of project, Current Supervisor of cleaners and other physical plant duties.

Source: Own design, 2011

Appendix 4: List of Interviewees (continued)

Ghanaian interviewee group			
Pos.	Interviewee Group / Type/ Cluster	Name	Institution/Position
14.	VVU Technical staff	Mr. Frank Ampofo	The Current Chief Plumber in charge of Sanitation systems.
15.	VVU former technical staff	Mr. Raymond	Former Chief Plumber of Valley View University
Ghanaian Cleaning and maintenance staff group			
16	VVU Cleaning staff	Cleaner A	Valley View University , Ghana, cleaner for Toilets and Urinals
17	VVU Cleaning staff	Cleaner B	Valley View University , Ghana, cleaner for Toilets and Urinals
18	VVU Cleaning staff	Cleaner C	Valley View University , Ghana, cleaner for Toilets and Urinals

Source: Own design, 2011

Appendix 4: List of Interviewees (continued)

Ghanaian Cleaning and maintenance staff group			
Pos.	Interviewee Group / Type/ Cluster	Name	Institution/Position
19	VVU Cleaning staff	Cleaner D	Valley View University , Ghana, cleaner for Toilets and Urinals
20	VVU Maintenance Staff	Plumber A	Valley View University , Ghana, cleaner for Toilets and Urinals
21	VVU Maintenance Staff	Plumber B	Valley View University , Ghana, cleaner for Toilets and Urinals
Ghanaian farm maintenance staff group			
22	VVU farm maintenance Staff	Farmer A	Valley View University , Ghana, farm workers
23	VVU farm maintenance Staff	Farmer B	Valley View University , Ghana, farm workers

Source: Own design, 2011

Appendix 4: List of Interviewees (continued)

Ghanaian farm maintenance staff group			
Pos.	Interviewee Group / Type/ Cluster	Name	Institution/Position
24	VVU farm maintenance Staff	Farmer C	Valley View University , Ghana, farm workers
25	VVU farm maintenance Staff	Farmer D	Valley View University , Ghana, farm workers
Ghanaian Student interviewee group[97]			
26	Student group	Student Representative Council (SRC)	Valley View University, Ghana.SRC, executives
27	Student group	Bediako hall, location for Berger Biological Toilet (BBT), Students group 1(Total of 2 students interviewed)	Valley View University, Ghana. Bediako hall executives (Current Hall President and Deputy)
28.	Student group	Bediako hall Students group 2 (Total of 65 students interviewed in focal group discussion style, from dormitory to dormitory)	Valley View University, Ghana.
29	Student group	Computer Science Students Association (COSSA) executives (Total of 4 students interviewed)	Valley View University, Ghana.
30	Student group	Theology and missionary students Association (Themsa) executives (Total of 3 students interviewed)	Valley View University, Ghana.

Source: Own design, 2011

[97] Individual interview times for students cannot be given due to number of students .Some students declined to have their sessions recorded, points were recorded in a written manner

Appendix 4: List of Interviewees (continued)

Ghanaian Student interviewee group (Continued)			
Pos.	Interviewee Group / Type/ Cluster	Name	Institution/Position
31.	Student group	Business Administration Student Association (BASA) executives (Total of 3 students interviewed)	Valley View University, Ghana.
Other interview Groups			
33	Others	Mr.Emannuel Aheto	Pecs Educational Centre, proprietor Adoagyiri-Owuraku Nsawam

Source: Own design, 2011