
33rd WEDC International Conference, Accra, Ghana, 2008**ACCESS TO SANITATION AND SAFE WATER:
GLOBAL PARTNERSHIPS AND LOCAL ACTIONS****Cycles in the ecological development of
Valley View University, Accra, Ghana**

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Valley View University (VUU), a private Ghanaian institution, has adopted a holistic approach in developing a sustainable eco-university. Ecological cycles, ecological settling and buildings and encompassing quality management are included in the concept. The cycles are closed locally, bringing collected urine and grey-water to the eco-farming area for use as fertilizer. Intensive training of staff and students is part of the endeavours. An ecological engineering study is proposed as part of the plans to intensify education of communities and interested individuals. As a preliminary result it can be stated, that the holistic approach is essential for the sustainability of such projects and in the case of Valley View University the approach is largely accountable for the success attained so far.

Introduction**Initial situation**

The Valley View University (VUU) is situated 30 km north of the capital Accra within Ghana's coastal savannah zone. The university campus which covers over 120 hectares, hosts 2.000 people - most of these being students. About forty-percent of the students live off-campus. Facing the projected number of about 5.000 people on campus in 2010 the university in co-operation with supporting partners decided to expand the institution based on a holistic ecological concept. The design and implementation of the ecological development concept started 2003. It was financed by the German Ministry of Research and Education (BMBF) within a programme for decentralised water and wastewater systems.

In 2001 when the initial visit was made to VUU, water was delivered to the campus by truck. Rainwater harvesting was restricted to a few buildings. The limited water supply was aggravated by lavish use. Conventional water closets with a flushing volume of about 20 litres and pit latrines have been the main toilet types on campus. There was no central sewage system at VUU and wastewater disposal took place in septic tanks decentralised for each building. Domestic refuse was incinerated and the remains buried on-site.

Waste separation and recycling is underway now. Urine, grey-water, faeces and wastewater are treated and utilised on campus, bio-waste and leftovers from the kitchen are used by surrounding villagers as animal feed, plastic-bags of drinking water are collected and delivered to a recycling plant. Since 2004 about 13 m³ of tap water is supplied daily from the water works in the neighbouring village of Oyibi.

Partners

The ecological development of Valley View University is accomplished with support from four main partners, namely - the Bauhaus University Weimar (BUW), responsible for architecture and town-planning; the University of Hohenheim (UHOH), which is in charge of agriculture and nutrient cycling at VUU; the Ecological Engineering Society (IÖV), coordinating the project and responsible for quality management; Berger-Biotechnik as well as Palutec - two companies responsible for the sanitary installations and systems inside and outside the buildings. Over the course of the project-time other partners joined, including the universities of Augsburg, Giessen, Magdeburg and Wiesbaden, the Centre for International Migration and Development (CIM) and Support Africa International (SAI), an NGO.

The programme**The holistic concept**

The holistic concept aims at fostering long-term sustainable development of VUU. Part of the initial ecologi-

cal holistic development process was the development of a physical master-plan. The plan was designed to cater for a projected student enrolment of 5,000 people on campus. This master plan is closely linked with the design of the mass flows for the project expansion. In addition, additional measures in the area of information dissemination, organisation and quality management were introduced.

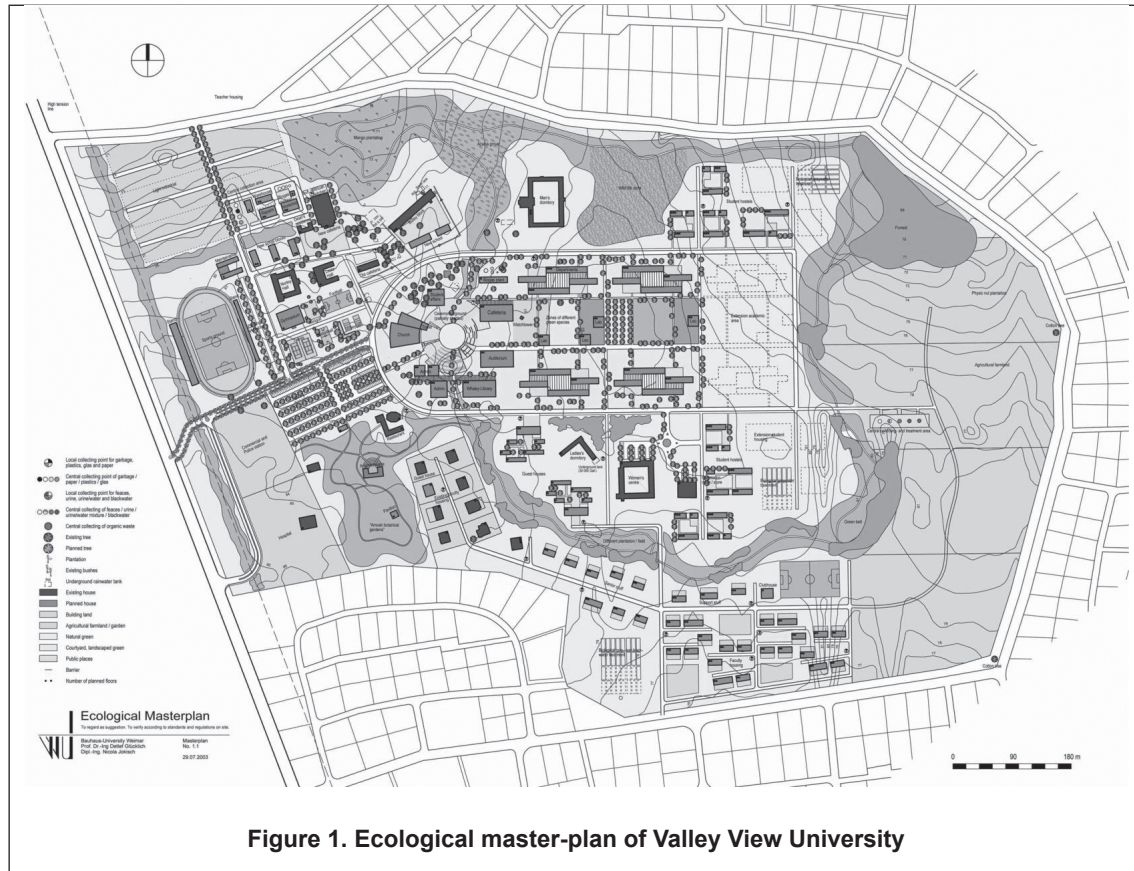


Figure 1. Ecological master-plan of Valley View University

Physical measures

Physical facilities included in the BMBF-project are - the existing main multi-purpose building, a new faculty building, a guesthouse, the cafeteria with its new sanitary building, and a women's dormitory. These buildings are positive examples of newly implemented installations for treatment and management of black water, grey water, rainwater, urine and biogas. The biogas plant consists of two simple domes connected in line, without any electric mixer.

The main goal of the agricultural part of the ecological sanitation project is evaluating and understanding the agricultural requirements as well as the necessary technological solutions for cost-effective treatment of human excreta and their environmentally friendly use.

Within the ecological development of VVU, the eco-farm is intended to produce crops for the supply of the cafeteria and the local market, while offering environmentally sound and hygienically safe solutions for the ecosan-products, thus closing the nutrient loop. VVU has zoned a 20-hectare piece of land for farming on campus. The poor nutrient status and the low water holding capacity of the soils along with low rainfall make efficient use of resources enhancing soil fertility an absolute necessity. The products collected by the ecological sanitary installations are utilised on the VVU own farmland for growing various crops like cashew (*Anacardium occidentale*), mango (*Mangifera indica*), avocado pear, etc.

A green corridor, a naturally shaded footpath, will lead around the inner campus offering an area for agricultural and environmental education as well as recreation. Passing through the farming section, the path is dominated by avocado trees (*Persea americana*) planted in a loose pattern. Sections of the green are used for the cultivation of endemic and introduced plant species well adapted to the local environment. Depending on the species, grey water, urine and compost will be used for irrigation and soil amelioration.

Informational measures

A free flow of information is necessary for the success of any project dealing with sustainability. In the BMBF-project the information goes various ways. These include close personal contacts, regular meetings of the project-team, many bilateral meetings of the partners in Ghana and Germany, an FTP-Server for the internal exchange in the project and the homepages of IÖV (www.ioev.de) and UHOH (www.uni-hohenheim.de/respta) and VVU (www.vvu.edu.gh). Publications like a booklet about the entire project (Bauhaus University Weimar 2006) and flyers for the various topics are other ways of communication.

In the early phase of the joint project-endeavours a mission statement was worked out: "VVU, the First Eco-University of Africa".

Measures of quality management

The long-term function of the installations established in the frame of the BMBF-project is ensured by an encompassing quality management (QM). Acceptance is a crucial point in such a project, therefore all measures which assure that inside and outside the project are essential (for example: information campaigns, info-boards, public relations, retreats, a permanent eco-group looking for the ecological development etc.). Apart from raising awareness concerning the ecological approach, detailed information and education is provided on various levels, including instructions for workers and craftsmen, along with guidelines and standards for hygienic and environmental safe handling and usage of the sanitary products. Important to the sustainability and management of the project, is the creating permanent posts at VVU (e.g. of an ecological director, farm manager, especially trained plumbers, cleaning staff and caretakers). In addition to the personnel of the partner organizations, two CIM-experts (a master brick layer/construction manager and a landscape architect) provide on-the-spot support for two years.

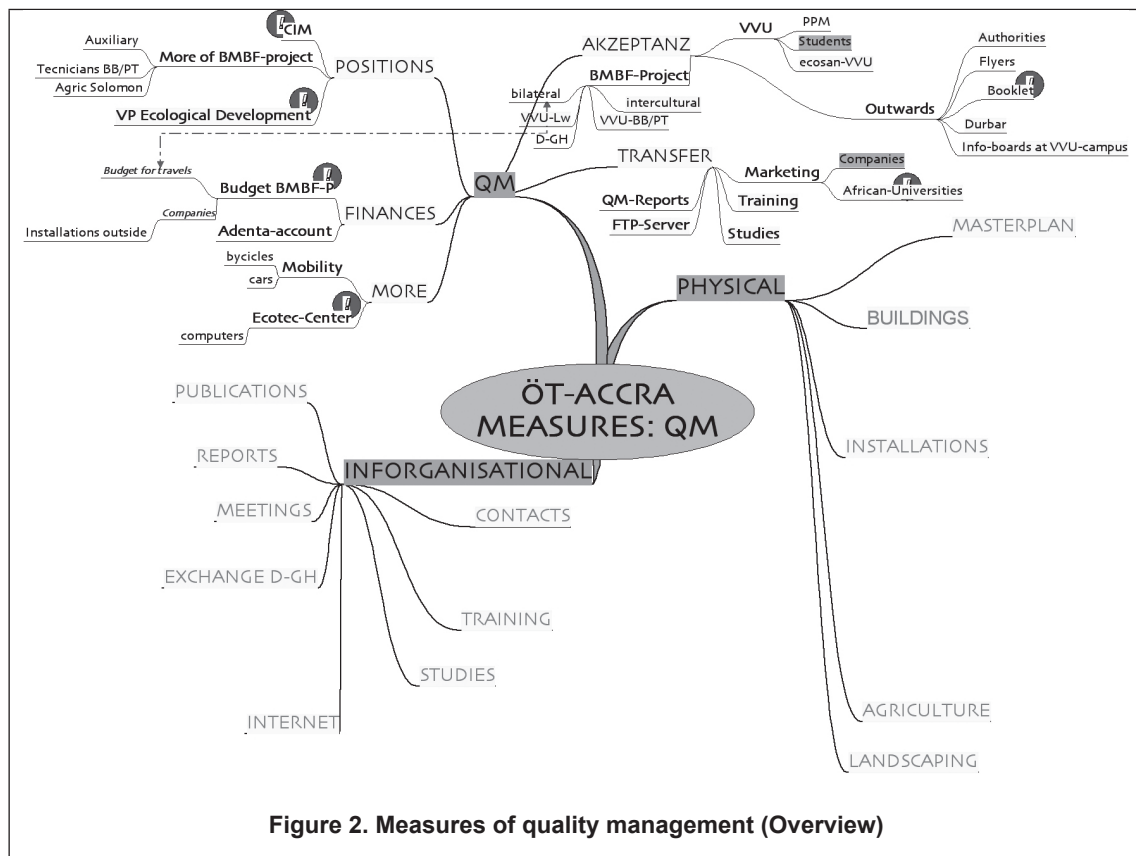


Figure 2. Measures of quality management (Overview)

Special care is given to the socio-cultural environment, the intercultural communication (see: Gyekye 2002) and it's special consideration in the holistic development. A graduate school program on ecological engineering, which is to be implemented in the near future, will help to strengthen in the implement of the eco-development of VVU. This will also promote teaching and research.

Methods

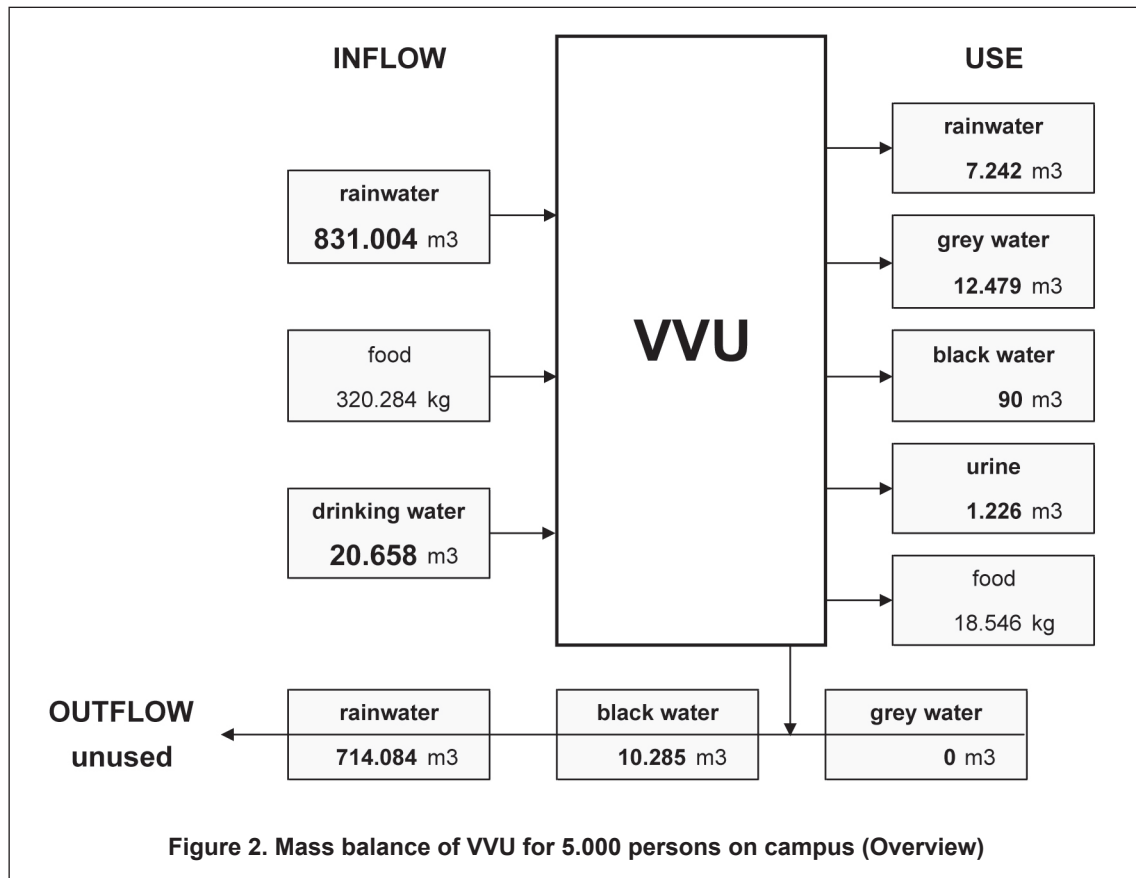
Methods concerning town planning/architecture

Concerning town planning the approach of “Stadtschaft“ (literally “townscape” in contrast to “land-scape”) integrates the single concepts like water, traffic, open space, energy, buildings and socio-cultural infrastructure into a holistic whole (see: Glücklich 2006 and Bauhaus-University Weimar 2006). This approach for the first time will be implemented and tested at VVU in a practical case of town planning. The term of landscape, which means a space with cycles and relations between the involved creatures will be applied by “Stadtschaft” for human settlements dominated by human beings. In such a “Stadtschaft” the human influence is dominating, but nevertheless ecological principals are given a special consideration (see: McDonough & Braungart 2003).

For designing purposes the cell-model is being applied, which allows for a very flexible approach under maybe fast changing conditions. Cells are entities, similar in their function or their fluxes of matter. For ecological town-planning it is necessary to combine these various and different cells in a synergetic way.

Methods concerning ecological cycles

For the ecological cycles a model has been developed and applied which shows the most important streams of water and nutrients between the single cells and between the whole campus and the surrounding environment. In this model, for example agriculture, student hostels and faculty buildings are cells, each of them having a very specific characteristic of mass flow.



The mass flow analysis has been worked out for the initial state and for the final stage (1.000 versus 5.000 persons on campus). Various scenarios have been elaborated for this final stage with various central or decentralised solutions for the mass flow (and the accompanying different arrangement of buildings and open spaces). This then allows for adjustment with other requirements in the development of settlements. The various flows of matter are registered better and better in the course of time by analyses done for the ecological sanitation products, by the measuring devices installed, by tests of the installations and by interviewing the users.

The feasibility investigation focusing on the ecological sanitary products as a water and nutrient source for agricultural production includes assessment of nutrient content, nutrient efficiency, pathogen control and producer as well as consumer acceptability.

Methods concerning agriculture and greens

The division of the farm land into productive sections enables a continuous supply of a variety of produce and at the same time offers a range of options for application of the various sanitary products. A micro-level study is carried out, to assess the type and quantity of water and organic materials generated at the campus and its present mode of management. This will help to identify the appropriate technologies to enhance the value of the material produced and re-use it in agriculture. For example cultivation of trees enables the productive use of water supplied by intermittent rain and constitutes a persistent sink for urine-based fertiliser and compost. Hence drought resistant tree species, e.g. cashew, mango, starfruit (*Averrhoa carambola*), guava (*Psidium guajava*) and oranges (*Citrus* spp.) were planted and meanwhile occupy the major portion of farm land available on campus. Staple food crops (maize, sorghum (*Sorghum bicolor*), cassava (*Manihot esculenta*), cowpea (*Vigna unguiculata*)) are cultivated in rain-fed field trials during both rainy seasons (March to July and September to October). Urine is employed as fertiliser and compost to improve soil quality. In especially designed fruit orchards, more water-demanding species, e.g. papaya (*Carica papaya*) and banana (*Musa x paradisiaca*) are irrigated with grey water and biogas effluent and intercropped with species such as pineapple (*Ananas comosus*) and passion fruit (*Passiflora edulis*).



Photograph 1. Agricultural trial: Maize fertilised with urine in comparison with different combinations of mineral fertilisers

Preliminary results

Preliminary results concerning physical measures and ecological cycling

The water saving and separating sanitary installations are most successful outcomes of the initial stages of the project. Outside the buildings rainwater is collected, purified and stored, black water treated (in septic tanks, sand filter and biogas plant) and grey water and urine are collected and used effectively. Good experiences have been achieved with water saving toilets, dry urinals and grey water collection in their implementation, operation and acceptance. The functioning of the devices proved to be not so much a matter of technology, but of proper training and responsibilities.

The evaluation and optimisation of the biogas plant and the rain water installations are still in progress. At the moment there is too much black-water going to the biogas plant, not enough organic material, not enough caloric value in the biomass (e.g. no fat and oil of the cafeteria). Therefore the biogas process does not work very well and the reduction of hygienic germs in the runoff is poor. That's why the biogas plant is not fully utilised yet. Generally, however, it could be proved that the ecological sanitation products at VVU (urine, urine-water-mixture, grey water) can be applied simply, usefully and the acceptance inside and outside of VVU is very high for that.

It is noteworthy that even under the prevailing environmental conditions with scarce rain and poor soils it is possible to produce food, when the available resources of the ecological cycles are used effectively like at VVU. Preliminary results show that the nutrient content of the collected urine is lower than in comparable studies conducted in Europe. One of the reasons contributing to the found difference in nitrogen content may probably be the lower protein intake as a result of the exclusively vegetarian food served at the cafeteria. The high temperature may contribute to a very fast phosphorous fixation (struvite formation) in the collected urine. This is assumed to be, apart from intake, the cause for the very low phosphorous concentrations measured. Published studies demonstrate that there is a high correlation between potassium intake and excretion in urine. Therefore, similar to nitrogen, the low potassium concentration is possibly primarily related to the alimentation. Nutrient assessment of grey water, black water and compost are not yet concluded.

In a maize field trial that investigates the nutrient efficiency of urine in comparison with manure and mineral fertilisers (Fig. 4) it has been shown that the application of sanitary products led to a considerable increase in the production. The results indicate that under the local conditions maize yields can be increased with fertilisation at least 5-fold. No significant difference between the urine and the other nutrient treatments has been found. This suggests that urine can substitute mineral fertilisers without adverse effects on yield. The storage of urine for two weeks under Ghanaian climate is enough to reduce pathogens and make usage safe, as the analyses shows.

The advantages of grey water irrigation are impressively demonstrated with the successful establishment of a banana and papaya orchard as well as an avocado plantation. All of these crops do under natural circumstances not thrive at VVU, but grow very well if grey water supplies water and nutrients. Due to the large quantities produced and applied it became necessary to optimise the grey water transport from the various buildings to the agricultural area. The transport by a tractor drawn trailer is now substituted by an underground pipeline from the women's dormitory to the agricultural site.

First composting trials to treat septic tank sludge and scum from the cafeteria's fat separator have been successful. A shredder is used to produce structuring material to allow air circulation within the compost pile. This is to enhance the microbiological activity through which the process temperature is increased and maximum temperatures of 60 degrees Celsius and more are achieved. Further effort will aim to maintain this temperature over a 10-day period for a satisfactory reduction of the pathogen load.

A more precise analysis of the mass flow from single cells in 2006 revealed, that the values for the whole campus are well in accordance with the pre-estimations. For individual cells the case is, however, different. For example the new sanitary block was expected to be the main producer of urine and wastewater, but is less utilised than expected. The reasons are being evaluated. One is most probably the sometimes poor caretaking in the early stages of the project (cleanliness, lack of toilet paper and towels etc.). The general acceptance of the building is also of importance (e.g. from the local point of view it's direct situation near the cafeteria possibly does not guarantee sufficient intimacy). A further problem is the still insecure supply of water to the campus and consequently to the water toilets. As a conclusion the plan for the further development of the campus includes therefore additional sanitary blocks with dry toilets, one new dry toilet building, combining squatting and sitting toilets, being nearly finished.

A crucial question is finding the optimum rate of decentralisation and positive synergetic effects between the various cells. Therefore a decision model is under development, which allows for a simple arbitration concerning the various streams of urine, rain water, grey water and black water.

Preliminary results concerning quality management and information

The success of the physical measures was very much depending on the attention, that was given to the aspects of an encompassing quality management and to the wide field of information flows and their structure in an ecosystem (represented by the hierarchical organisation of the university by example).

Training, education and briefing of the workers and members of VVU and their intensive involvement are of crucial importance. To ensure the long-term sustainability of the measures however, more than speaking to the mind is necessary - the heart and spirit of the involved people has to be won. This can be done by ways of holistic social engineering (Scharmer 2007) which has been tested and applied successfully at VVU, for example by retreat-workshops with essential stakeholders, applying methods like Presencing, Appreciative Inquiry, world-cafe, circle etc.

The exchange of information between the project partners in Ghana and on site is also essential. The top ranking given to the activities in the field of information in the BMBF-project has shown a very positive effect and is central for the success of such a project.

One of the compulsory measures of quality management is the inclusion of essential positions for the ecological development into the organisational scheme of VVU. It could be achieved for the cleaning staff and for the most important craftsmen (electrician, plumber). An ecological director acting directly under the president is now employed.

By the help of the good contacts with the president of VVU it was possible to change and expand the use of an existing building for the so-called ecotec-centre. This structure now provides the workspace for CIM-experts, the German project partners and the German exchange students, in addition to the members of the physical plant.

The experience in our project shows that close supervision of the construction process by a qualified and experienced project manager is extremely important. This person has to co-operate very closely with all partners. Equally important is the existence of a on-site person who takes care of the communication between the Ghanaian and German partners. The responsibility of such a person includes the coordination of project-related communication in the local and regional environment (e.g. with developmental organisations like GTZ, state authorities of Ghana and so on). In our project these important functions realised by appointing two CIM-experts. These additional personnel were appointed at the appropriate time at the early stages of the project.

The installation and use of the new sanitary equipment provided research opportunities for several undergraduate as well as under graduate projects. Key among these was an investigation conducted by a student working on his MSc thesis. Among other things, the study also investigated the acceptability by the local population. Personnel responsible for the collection, transportation, and use of human wastes showed an initial reservation. With education, creation of team spirit and the enforcement of safe and hygienic practices these objections and inhibitions were overcome. The initial negative attitude towards the handling of various types of waste differed. While for urine the collection to the application on the field was easily implemented, the reuse of grey water and composting of septic tank sludge and scum from the cafeteria's fat separator was more difficult. The introduction of all nutrient and water cycles has in all cases been much easier when the workers were not left by themselves. Education, participation and support of superiors, and insistence on hygienic handling practices tended to eliminate the initial inhibitions. A questionnaire survey in the nearby villages revealed that most of the farmers showed interested in receiving human urine derived fertiliser on their field and willing to pay for the service.

Transfer of approach and methodology

What can be applied from the lessons learned and the approaches, methods and technologies developed so far?

The integration of architecture, town planning, cycle management and the use of simple/appropriate technologies as achieved in the VVU-project is essential for the establishment of human settlements, including campuses of universities generally. It is evident that these results and practices can be easily replicated in other settings. This explains why three other African universities want to adopt this approach in the near future.

The encompassing quality management, as practiced at VVU, is crucial for the long-term ecological functioning of settlements and campuses, too. As was the case VVU, participation of local personnel at all the various levels in the organisational hierarchy, training and education, external support during the initial stages of the project, and carefully plan processes for gaining the acceptance inside and outside, will be very helpful for the success of the project. These factors make the project relatively inexpensive and easy to implement. It is further recommended that strategies that aim at gaining the heart and spirit of all stakeholders should be adopted. These include retreats featuring such techniques as Presencing / U-process from MIT (Scharmer 2007), Circle, Worldcafe, Appreciative Inquiry which proved effective in the case of this project.

The application of urine and grey-water in agro-forestry and landscaping proved to be relatively simple, increasing self-sufficiency, and effective under the bad natural conditions at VVU. The range of experiences gained at VVU in terms of managing collection, sterilisation, storage and application of ecological sanitation products, together with lessons learned in the fertilisation of a wide range of crops with these products should be easy to transmit to similar projects elsewhere.

Summary

The unique approach in the ecological development of Valley View University in Accra, Ghana, is one of an encompassing ecological concept where technological and other measures are embedded. Ecological cycles can be established in such a framework successfully. For tropical areas the use of grey water and urine proved

to be simple and very helpful. The long-term development of the campus and the long-term success of the technological measures are ensured by an encompassing quality management. This approach has proved to be successful to a large extent. There are good prospects for using this approach for other ecological developmental areas in town and regional planning, even for city quarters in megacities.

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References

- Bauhaus University (Ed.) (2006) *Ecological cycle management at Valley View University in Accra, Ghana*. IOEV-Press: Augsburg pp.58.
- Glücklich, D. (Ed.) (2005) *Ökologisches Bauen. Von Grundlagen zum Gesamtkonzept*. Deutsche Verlags-Anstalt: München pp.246.
- Gyekye, K. (2002) *African Cultural Values. An introduction*. Sankofa Publishing Company: Accra pp194.
- McDonough, W. and Braungart, M. (2003). *The Hannover Principles. Design for Sustainability*. Tenth Anniversary Edition, William McDonough and Partners: New York, Hamburg pp101.
- Scharmer, O. (2007): *Theory U. Leading from the Future as it emerges. The social technology of Presence*. The Society of Organisational Learning (SOL). Cambridge, MA pp 533.
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