I) The joint German-South African young scientists workshop in Potchefstroom – *Sano* in South Africa

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1 Introduction

In order to achieve global challenges in the field of environmental protection and sustainability, strict goals where set by international agreements. These goals can only be reached by intensive research and cooperative exchange and development between different countries. In this context the German Federal

Ministry of Education and Research (BMBF) proclaimed the German-South African Year of Science 2012/2013.

International agreements and national standards concerning water quality and waste management put increasing pressure on the South African environmental management systems. In order to face these challenges, German Bauhaus-Universität Weimar (BUW) and South African North-West University Potchefstroom (NWU) decided on a cooperation project concerned with the development and imparting of a concept for sanitation and organic waste utilization that is sustainable and based on an economic management of resources. At the same time, this project is to consolidate the relationship that already exists between both sides.

The joint German-South African workshop for young scientists on “Sustainable resource based sanitation and organic waste utilization (Sano)” was designed to enable the exchange of experiences in different key aspects of research and research needs, the building of new networks, the strengthening of existing networks, and the promoting of the mobility of young scientists. The workshop focussed on the development of new approaches and ideas against the background of the social, economic, ecological and legal conditions in South Africa, which can contribute to a paradigm shift in the academic and public sector as well as in politics, administration and in practice.

BUW and NWU seek to further develop their existing cooperation in research. This cooperation between BUW and NWU is based on the shared approach to research of “sustainable resource based sanitation and organic waste utilisation”. Both universities aim at intensifying their exchange of experience in this field by exchanging scientists. In addition, research projects in South Africa are planned but had to be put on hold due to problems in the CLIENT programme funded by the German Federal Ministry of Education and Research (BMBF).

This is why the workshop for young scientists was used to promote the project in South Africa and to improve the willingness to participate on the South African side. A goldmine near NWU, for instance, has already made considerable promises of funding joint research.

2 Planning and conduction of the project

BUW and NWU's plans for conducting the project have been clarified during a joint planning and preparation workshop between December 16 and 19, 2012 in Weimar. The workshop's participants are listed in Table 1.

Table 1: Participants of the planning and preparation workshop in Weimar

Germany		South Africa	
2	Professors (BUW)	3	Young scientists (NWU)
2	Young scientists (BUW)	1	Business representative (Sasol)
1	Journalist (radio)		

The planning and preparation workshop addressed the following issues:

- presentation of the academic background of the different young scientists (YS) and the selection of the participants of the Young-Scientist-Workshop,
- decision on the guests to be invited from South Africa (experts, politicians, decision-makers),
- content structure of the media relations work in South Africa and
- specification of the main research areas of the Young-Scientist-Workshop.

The Young-Scientist-Workshop took place at the NWU in Potchefstroom, South Africa, from March 3 to 13. The participants are listed in Table 2, the workshop schedule is found in Table 3.

Table 2: Participants of the Young-Scientist-Workshop

Germany		South Africa	
2	Professors (BUW)	1	Professor (NWU)
13	Young scientists (BUW) including 1 Post-Doc	13	Young scientists (NWU) including 1 Post-Doc
1	Journalist (radio)		
1	Expert		

The workshop used various different methods to develop and combine ideas. For instance, the workshop opened with a public joint event that set the frame for the following workshop days through a panel discussion (participants: Ingrid Dennis (NWU), Liandi Bothma (Tlokwe Municipality), Piet van der Merwe (Tecroveer), Sundhir Pillay (WRC); moderator: Stephan Pretorius (Ages)). During several workshop sessions, researchers of BUW and NWU analysed the current situation in South Africa regarding “Treatment technologies”, “Collection and transport systems”, “Urban resources – products made of organic materials” and “Systems – overall system: management, regulation, connections between society and technology”, and identified necessities and options of implementing the Sano concept. Field trips provided case studies (sewage plant and composting project of Tlokwe Local

Municipality, the mine post-closure care project Lancaster Site, the townships Ikageng and Serafina, and the informal settlement around Serafina).

Table 3: Schematic illustration of the YS workshop's schedule

	Plenary session	Work-shop session	Field trip	Working on publications	Final pre-parations	Final event	Out-look
Mo, 04.03.	■						
Tu, 05.03.		■					
We, 06.03.		■	■				
Th, 07.03.		■					
Fr, 08.03.	■						
Sa, 09.03.			■	■			
Su, 10.03.			■	■			
Mo, 11.03.				■			
Tu, 12.03.				■	■		
We, 13.03.						■	
Th, 14.03.							■

The working groups' results were summarized and made accessible to all participants of the workshop through the World Café method. Additionally, the workshop focussed on compiling research questions for future joint projects and on developing a "Sano vision" using the example of Tlokwe Local Municipality.

The research questions were grouped, weighed and subsumed under the generic terms of "anaerobic digestion", "rainwater management", "decision support systems", "promotion of knowledge and know-how" and "waste and wastewater management systems".

A final event, that addressed actors from business, public administration and politics, completed the workshop.

Prior to the workshop in Potchefstroom, various government agencies and non-governmental organisations in South Africa had been informed about the goals and contents of the workshop and had been invited to it. Representatives of these organisations were presented with the results of the events in the form of a summary (Executive Summary of the SANO workshop) at the end of the workshop and were asked to give comments and suggestions.

The following governmental organisations participated in this:

- the German Embassy in Pretoria,
- the Department of Agriculture and Forestry (regional and national level),
- the Department of Water Affairs (different sections on the regional and national level),
- the Department of Environment and Tourism (regional and national level),
- the Department of Sciences and Technology (national level), and
- Tlokwe Local Municipality (Potchefstroom).

The following non-governmental organisations participated:

- Water Research Commission – research institute
- CSIR – research institute,
- Rand Water – water supplier,
- Mvula Trust – foundation,
- Tecroveer – engineering company: sewage plants/ water constructions,
- Sasol – chemicals group,
- Ages – engineering company: development in rural areas, and
- the University of KwaZulu-Natal.

3 Underlying scientific and technical status

South Africa, like many other countries, is faced with the problem of managing complex challenges in the fields of water resource management and sanitation and organic waste utilization. Germany has already collected experience with lots of these challenges, for example the recycling of organic waste material, the rehabilitation of mine sites, the implementation of sustainable sanitary systems in various forms of settlement, all of these could be incorporated in corresponding projects in South Africa. At the same time, there are a number of identical research interests that could be developed further by joint research.

Only little information on and publications about challenges in South Africa can be found, and most of these are not up to date anymore. Systems that are successful in Germany cannot simply be transferred to South Africa without any knowledge of the local conditions. The research project builds on these two issues and will contribute to their improvement.

4 The joint German-South African young scientists workshop in Potchefstroom

The structure of the YS workshop had already been determined during the preparation meeting in December in Weimar (see Table 2). This structure served to discuss the following content-related questions:

1. How sustainable is the South African system of sanitation and organic waste utilization and what weak spots do exist?
2. What tools are necessary to achieve sustainable solutions and which do already exist?
3. What gaps does the system have?
4. What proposals for action and research questions can be inferred?

Furthermore, the workshop itself and its results were used to discover joint practical research topics, to discuss a joint PhD programme of both universities and to exchange opinions with the other young scientists on various research questions.

The opening event laid the foundation for the joint work. During its panel discussion (see Figure 1) the participants were able to gain interesting insights into current affairs of South African business, science and politics, and to discuss these.

Stephan Pretorius (Ages Group), Ingrid Dennis (NWU), Liandi Bothma (Tlokwe Municipality), Jay Bhagwarn (WRC) and Piet van der Merwe (Tecroveer) had been won for the panel discussion.

The second part of the opening event already presented a first opportunity to the German and South African exchange scientists to introduce themselves and their respective research projects and to discover mutual research interests.

Figure 1: Panel discussion at the opening event of the YS workshop

Figure 2: Young scientists presenting their research projects

The opening event was completed by an accompanying display of posters. Here, German and South African young scientists presented the projects that they were working on and the theses they intended to do their doctorates on (see Figure 3, left side). The display of posters offered much opportunity for discussion and talks. The displayed resumes of all workshop participants (see Figure 3, right side) gave a starting point for conversation as well. The Young-Scientist-Workshop was thematically divided into two parts. In the first part the participants, split up in several teams, addressed the topics of "treatment", "collection", "municipal resources – consequences and risk assessment" and "systems". The individual teams were moderated and led by a German and a South African young scientist who had been intensely engaged with the respective topic before. Afterwards the results of the teams were presented and discussed in a plenary session. These activities were complemented by visiting different local practical examples. These included the sewage plant in Potchefstroom, the various forms of settlement in South Africa (township, informal settlement, urban area) as well as the rehabilitation area of a former gold mine.

Figure 3: Poster display and presentation of the young scientists

In the second part of the workshop the findings of the first part were revisited and scrutinized with regard to possible solutions. The solution proposals, in turn, were edited, presented, and discussed and evaluated in another plenary session. In a further step, a comprehensive model for transferring the solutions to the South African situation was developed and illustrated using the example of a specific model region. At the same time, further questions were inferred, that are to be continued by future research and projects.

At the end of the Young-Scientist-Workshop the results were edited, recorded in a strategy paper and put up for public discussion in a panel discussion as part of the closing event (see Figure 4).

Figure 4: Panel discussion at the closing event of the YS workshop

For this panel discussion, too, representatives of science, administration and business, such as Johan Nel (CEM-NWU), Sudhir Pillay (WRC) and Martin Ginster (Sasol), had been won with whom two young scientists discussed the workshop results.

5 *Sano* in South Africa – the *status quo*

South African sanitation shows basic deficits. In particular, there is no guarantee that the poorer classes always have an appropriate access to sanitary facilities.

Even if the country has a number of sewage plants in the urban areas, 60% of these do not fulfil the requirements of the South African Green Drop Certification, which is awarded to wastewater systems that achieve a certain quality in wastewater treatment. As a consequence, surface waters and ground water are polluted by sewage water but especially by untreated mine wastewater (see Figure 12). Defects in the quantity and quality of the water supply are the results.

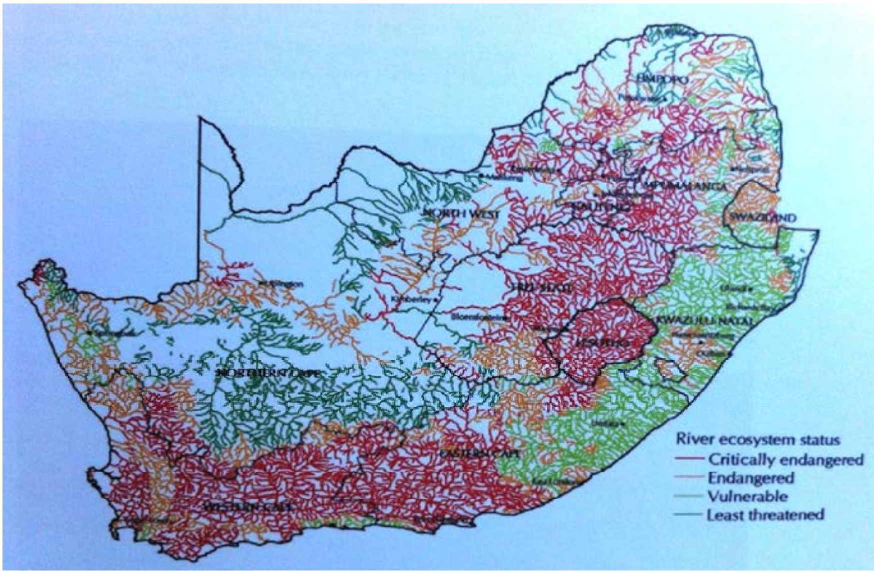

Figure 5: State of South African waters [Source: SA Env. Outlook, Dept. Env. Affairs and Tourism, 2007]

Figure 6: Water crisis in Potchefstroom (March 2013)

Germany, too, has struggled with problems of water quality in the past (see Figure 7). The technologies developed to counteract these problems have been created out of the respective predicament and address the aspect of emissions. For instance, sewage systems for rainwater and wastewater (usually collective transport) have been built. The wastewater is usually treated end-of-pipe in sewage plants. Further treatment steps to eliminate carbon, nutrients or micro elements have been implemented. Today, the required standards are defined in, among others, the Urban Waste Water Treatment Directive (91/271/EEC) and the Water Framework Directive (2000/60/EC) of the European Union.

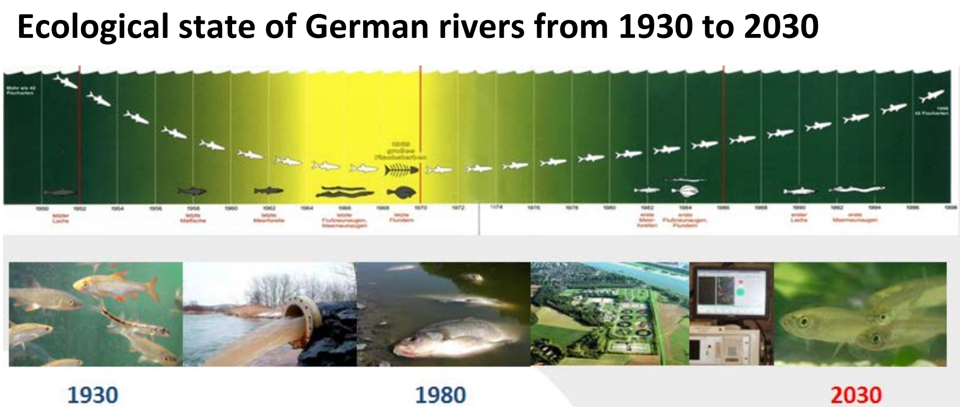

Figure 7: State of German rivers 1930 – 2030 [Source: S. von Keitz]

Today almost 99% of the German population is connected to the drinking water system. The quality of the drinking water completely fulfils the requirements as defined by the Drinking Water Directive (98/83/EC).

About 95% of the population is connected to a biological wastewater treatment. Almost every treatment facility provides a treatment step for nutrients reduction. Thus, degradation rates of 82% for nitrogen and 91% for phosphate can be achieved. The annual (re)investment costs are € 4.6 billion (56.40 € / E*a).

But at the same time, the German sanitary system shows a number of disadvantages. It is mainly based on the principles of “mix and dilute”, “transport together with drinking water” and “end-of-pipe treatment”. Each of these principles leads to the fact that the system is expensive. Also, the system is not closed, neither in theory nor in practice, making it very inflexible as well. Furthermore, this sanitary system does not use the wastewater stream in its entirety or its substances (nutrients, energy potential).

South Africa is in the situation that it has to improve its waste and sanitary system but is able to draw on experiences already gained in other countries like, for example, Germany. In this, not only the current sanitary system becomes the focal point of interest but also the alternative systems that are tested and proven but cannot be applied nation-wide in Germany because of the existing inflexible system. The new sanitation systems can be named as an example. By using these new sanitation systems, it is sought to re-use wastewater and recover wastewater substances like nutrients or organic substances. The basic idea of these resource-oriented sanitary systems is the separate collection and specific treatment of partial flows of domestic wastewater.

But it is important to always remember that these infrastructures cannot be planned on the drawing board only without also taking the existing infrastructures into consideration and integrating the various structures of settlement.

Beside its cities with their residential and industrial areas, South Africa also has so-called informal settlements and townships.

Townships are understood as residential areas planned on a drawing board, usually erected outside the city boundaries in an environment with no infrastructure, to give the poorest of the black population houses to live in. The houses are built, paid for and given to the citizens by the government. At the same time, these houses are supplied with electricity and drinking water on public expenses. The following pictures show an example of a township.

Figure 8: Township near Krugersdorp

In most townships the wastewater system is badly planned and built. Due to a steady population growth, the wastewater system struggles with the consequences of permanent capacity overload as these systems have not been designed for being used by an increasing population. The consequences are dysfunction, overload, overflow and wastewater floods in the streets. In many parts of the townships are often only a few public toilets which are overused and mistreated to such a degree that they quickly become a health risk to the society.

When building the townships with its close-standing houses it has been overlooked that the maintenance of the wastewater system is necessary to ensure its functionality and that this requires having access to the pipes. Each instance of maintenance of the system is complicated and often causes a number of new problems. The houses on the outskirts of the townships or near the river banks usually do not have access to sanitary facilities as they are not connected to the wastewater system.

The supply with drinking water is one more problem in the townships. Due to the increasing population the installed pumps cannot maintain the necessary pressure anymore. Having such a low system pressure, it becomes increasingly difficult to provide the households with the amount of water they need every day.

Rapid population growth, especially due to immigration from neighbouring African countries, and the impossibility to master the increasing need for living space have led to the formation of informal settlements. These are dwelling units that have been erected without any permission or planning in illegally occupied areas. The following pictures give an impression:

Figure 9: Informal Settlement near Serafina

These residential areas are mostly located at the periphery of cities. The dwelling units are mostly built of plywood, corrugated metal sheets or plastic and have no water supply, wastewater disposal, electricity or telephone. At the same time the population density is very high.

5.1 Challenges and opportunities of sanitation and organic waste utilization in South Africa

As already mentioned, the challenges posed to sanitation and organic waste utilization are multifarious. Nevertheless, a holistic solution is sought after that especially takes into account the specific user behaviour, the amount of waste and the space requirements of treatment plants with different technologies.

During the workshop and the panel discussions with the participation of experts and the interested public, further relevant aspects were worked out. These individual aspects were subsumed under the generic terms of technical, environmental, economic, governmental and social aspects and challenges. Field trips during the workshop provided opportunities to inspect many of these individual aspects.

5.1.1 Technical and environmental aspects and challenges

Drinking water

The constitution of the Republic of South Africa guarantees that every citizen has access to 5 litres of water a day. This, however, should not be confused with the citizen's right to consume 5 litres a day. South Africa could not even afford even this little amount of water per head.

Urban areas

South African urban areas have central sewage treatment plants, most of which eliminate carbon as well as nutrients, like in most parts of Europe. In most cases this is followed by chlorination in order to disinfect the sewage water.

But these sewage treatment plants often face financial restrictions leading to the fact that, for instance, maintenance work, especially that of the preventive kind, is often not carried out. Adding to this situation is the deficit of well-trained specialists.

What makes it even more difficult is the fact that the load situation of the individual sewage plants is not sufficiently known because, for instance, it is not documented what industrial discharges are led in. In addition, there are operating problems due to blood and fat in the input materials of the plants.

Facilities to remove micro-pollutants do not exist in South African sewage plants.

(Organic) Waste

Furthermore, it should be noted that sewage sludge is only used in isolated cases. In general, it was noticed that urban organic residuals are not used sufficiently. For example, huge amounts of organic waste materials are deposited on landfills without any pre-treatment.

The upcoming enormous increase in energy costs could be an incentive for changing this practice and the understanding of waste as a resource.

Townships / RDP-Houses

The townships are usually supplied with drinking water and electricity. The disposal of waste, too, is centrally regulated. But there is often no functioning sewage system. Because most residents have a low income, the considered systems have to be implementable in this environment, easy to handle and, above all, inexpensive.

Informal Settlements

Because of the missing infrastructure the supply with drinking water is realised with the help of public tapping points. The following Figure 10 shows an example of these.

Figure 10: Drinking water supply in informal settlement

A sewage infrastructure does not exist either. Experiences with dry toilets have already been gained but the disposal of the sludge has proved to be problematic.

Due to the non-existing waste disposal, there are uncontrolled waste dumps to be found almost everywhere (see Figure 11), that serve not least as playgrounds for children.

Figure 11: Waste dumps in an informal settlement

<u>Mines</u>

Because of its high mine density, South Africa has to struggle not only with municipal sewage but also with wastewater from diamond, gold and copper mines. These wastewaters are highly acidic (pH value = 2) and are led from the mines into reservoir lakes (see Figure 12).

Figure 12: Reservoir lake with mine wastewater

The wastewater is collected here, and a sludge layer forms that is also highly contaminated (see Figure 13). Sludge and wastewater are not treated in any way.

Figure 13: Highly contaminated sludge from mine wastewater

Beside the problems mentioned above, the operation of mines also affects the groundwater, its quality and the options of its extraction.

The mine areas themselves are completely dried-up areas, mostly without any vegetation, and need rehabilitation measures after being abandoned. Many research projects at NWU are concerned with this problem. The following Figure 14, left side, shows a typical mine area. On the right side a research area of NWU is seen where possible ways of reintroducing plants on mine areas are studied.

Figure 14: Mine rehabilitation area

5.1.2 Economic aspects and challenges

With regard to the above mentioned water shortage in South Africa it could be assumed that water is a good that especially financially less well-off people cannot afford. But in reality people only have to be able to afford water when a household consumes more than a certain, not insubstantial, annual amount of water. Only if this threshold value is exceeded the consumers are hold liable for financing the water and the related infrastructure. This practice applies to all households in South Africa, not only to those that could not afford water otherwise.

The sewage water infrastructure is financed by funds of the respective municipality; there is no allocation of expenses to the causers. Accordingly, the financial options for maintenance and personnel are very limited.

5.1.3 Governmental aspects and challenges

South African environment law sets, most notably in the water sector, include the strictest possible requirements that can in part only be fulfilled by using the most modern technologies. Examples of these regulations are The Constitution of the Republic of South Africa Act 108, Chapter 2, Section 27, Water Service Act, 108 (1997) and the National Water Act, 36 (1998). But it is obvious that these standards cannot be achieved in reality.

One reason for this might be the organisation of the executive branch. The hierarchy of the individual water institutions can be seen in the following Figure 15.

During the panel discussion it was criticized, above all, that although there is a number of different regulations the controlling instances are not defined. In addition, there is always more than one institution involved but the cooperation between the individual institutions is often not coordinated.

One obstacle to using organic materials for energy recovery is seen in the fact that the legal basis for the production of energy from waste is not yet defined and that this has to be done before a nation-wide implementation.

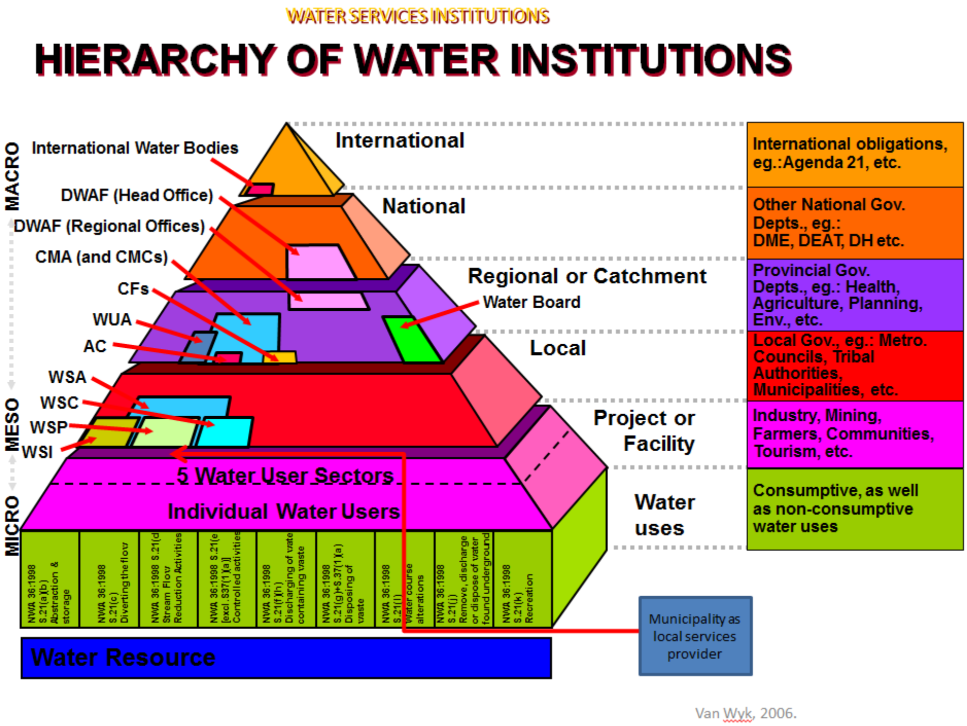

Figure 15: Hierarchy of water institutions in South Africa

5.1.4 Social aspects and challenges

The social aspects, justified by the fact alone that five million people have no access to an appropriate sanitary system, are obvious. Nevertheless, it is at the same time-questionable to what extent a large proportion of the population would accept new technologies. What is seen as especially problematic is the removal of flush toilets. A large proportion of the population regards the existence of flush toilets as synonymous with wealth, which could make it difficult to make people abandon them.

Furthermore, two more aspects have to be taken into consideration that might not be seen at once from a European perspective. First, large parts of the population do not accept the existence of informal settlements. That is why there is no intention to lastingly change and improve the situation as it exists there. Rather, the temporary character of the unauthorized settlement is maintained and is not wished to be retroactively legitimized by implementing appropriate sanitary systems.

Second, South Africa fights the effects of the widespread infection with the HI-virus on a large scale. The design of the sanitary and waste systems has to consider especially the needs and necessities of AIDS patients.

The very low education level of a large portion of the population must also be considered, a fact that might make an appropriately comprehensive information campaign necessary. And in order to realise this task of informing and educating, the scientists need partner – not at least to recognize further social aspects and to incorporate them into their research and measures.

5.1.5 Challenges inherent to the system

Beside the different forms of settlement, the characteristics of each municipality have to be considered individually in order to find a solution for each challenge.

This basically focuses on realistic and cost-efficient solutions. A lot of research on this is conducted but often remains isolated. Cooperation is necessary to avoid multiple unrelated studies on the same issues. Similarly, an improved cooperation between the research institutes and the municipalities is required, which might also improve the implementation of research results.

The current system and the resulting problems lead to the fact that "green energy" and an environmentally more sustainable water management have not yet become part of the country's mentality. A comprehensive education on this matter is necessary, too.

5.2 Options for resource based sanitation and for the usage of organic residuals

Against the background of the challenges described above and the impressions gained on site, it was attempted to develop solutions during the workshop. Contrary to the original plan to develop, present and discuss solutions for South Africa as a whole, it became apparent early during the workshop that this objective was neither possible nor sensible due to the country's complexity and the existing structures. That is why it was necessary to firstly define the range of the system that was to be considered.

The unit of the municipality was chosen as the system for which ideas and concepts were developed and discussed during the workshop.

Within this system three different forms of settlements have to be taken into consideration. These are the town itself, the townships, and the informal settlements. But economic and industrial areas have to be included as well. The flow of materials, energy and nutrients within the system as well as across the system boundaries were identified (see Figure 16).

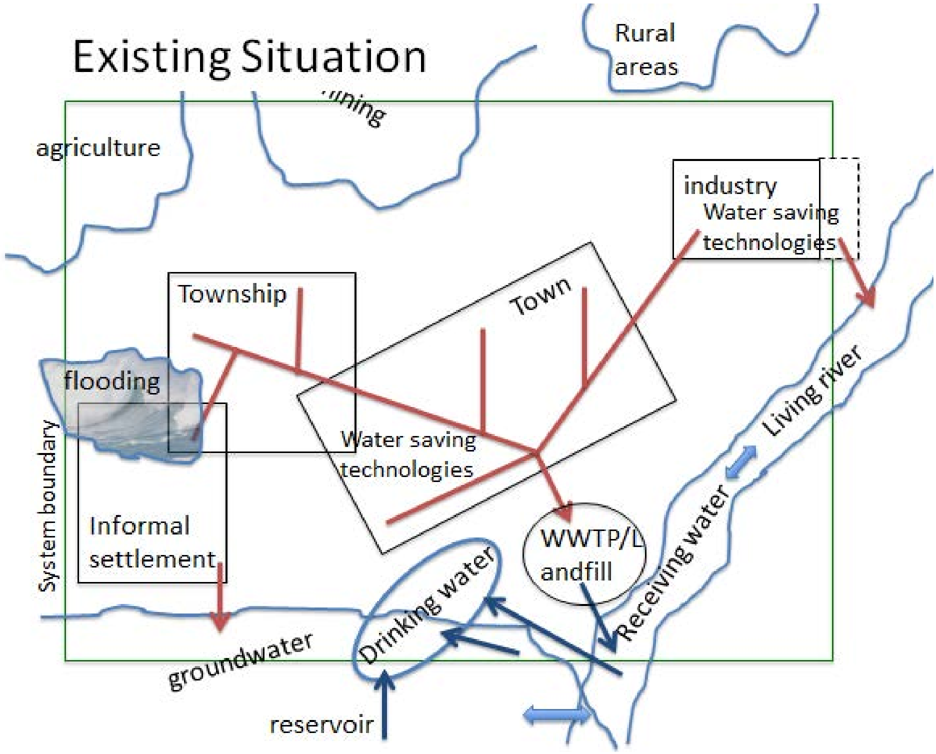

Figure 16: Flow of materials, energy and nutrients within the system and across the system boundaries

The status quo shows the considered system of the municipality with its influences from the neighbouring agricultural and rural areas and the mines. Rainwater is not collected, not diverted and not led to any kind of usage. It simply drains away.

Wastewater from the informal settlements, too, is not collected, diverted or treated in any way. This water drains away as well. Thus, rainwater and untreated wastewater from the informal settlements have a direct effect on the ground water from which, together with the river water, drinking water is obtained.

The wastewater from the townships, industrial plants and the cities is led to sewage plants, purified and discharged into an outfall. Furthermore, industrial plants have the opportunity to clean up their wastewater independently and discharge it into an outfall on their own initiative.

Savings in drinking water are realised mainly in the cities and the industrial areas by using water-saving technologies.

Wastes from the three forms of settlements are collected by using various systems and deposited on landfills.

To sum up, it can be determined that the existing system does not exploit the potentials that organic materials provide. Equally unconsidered are the opportunities that present themselves by using rainwater or treated grey water to attenuate the consequences of the water shortage in South Africa.

Intending to improve the current system, major and minor target groups of transdisciplinary research and the desired cooperation between the academic and the local government level were specified (see Figure 17).

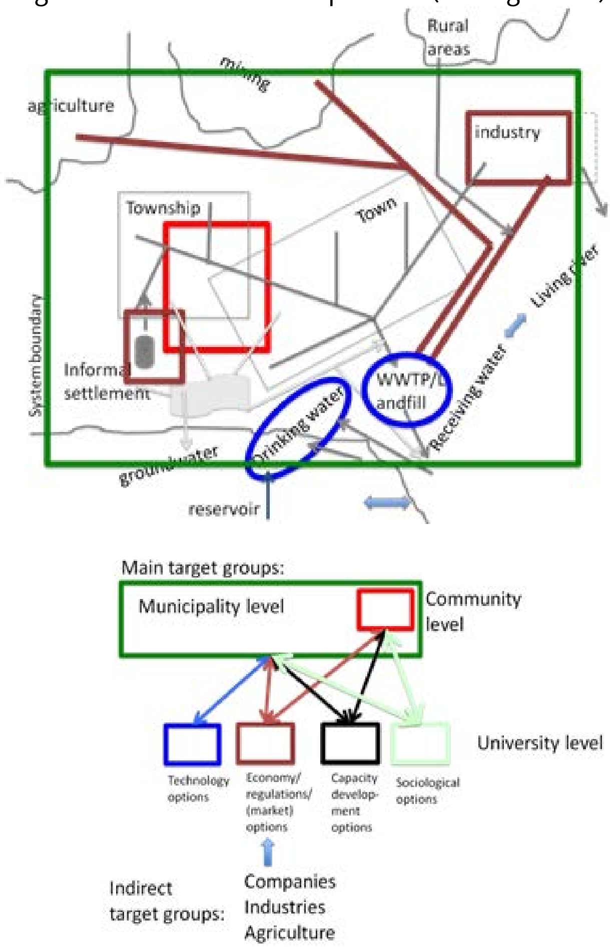

Figure 17: Target groups within the system and for the transdisciplinary research and cooperation

This research and cooperation would make it possible to improve the current system. Against this background, the following proposal of an improved technical system would be feasible (see Figure 18).

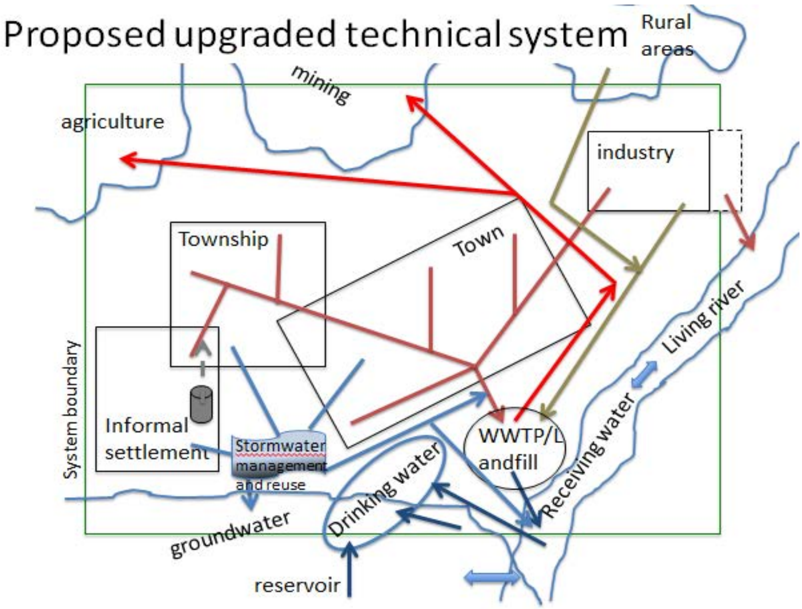

Figure 18: Proposal of an improved technical system

According to this system, a rainwater management system is to be introduced to all forms of settlements. This would mean that the rainwater can be diverted, collected, treated, and, subsequently, used as drinking water or to recharge groundwater.

The wastewater from the informal settlements is to be treated and re-used on-site by implementing new sanitation systems. This would require that the accrued flows are separated into grey water and black water. The grey water can be treated on-site with little technical expenditure or with nature-oriented methods making it re-usable in the households for irrigation or laundry. This practice would have a high potential of saving drinking water. Black water can serve the recovery of energy through anaerobic digestion.

The wastewater from the other areas of settlement would still be diverted, transported to sewage plants for treatment, and finally discharged into an outfall. But the improved system arranges for the residual materials from the sewage treatment to be treated and re-used as well. This can be realised by anaerobic stabilization of the sewage sludge, if necessary by adding different organic wastes as co-substrates. Using the produced gas in a block heat and power plant would, in turn, lead to a considerable energy yield. The residual material from the anaerobic digestion can, in turn, be used in the adjacent agricultural areas after being composted. Using the compost for rehabilitating the numerous mine areas is also feasible.

The waste from the settlements would be collected as before, but not deposited on landfills without pre-treatment. At least the separation into organic and non-organic waste is to be implemented to enable to use the potentials of organic waste. The result of this would be that the organic waste can contribute to the energy recovery through anaerobic digestion. In order to maximize this energy recovery, the organic waste materials from industry and adjacent rural areas are also to be collected and used. A further result would be that re-using the organic waste also reduces the overall amount of waste. If the remaining waste is still to be deposited that would also mean that less landfill area and activity are required. Furthermore, treatment and, if applicable, recycling of the non-organic waste materials according to the different materials are feasible, too.

Demonstrating the approaches, a vision for the city of Potchefstroom, Municipality of Tlokwe, was developed („iPotch2020“). The following Figure 19 shows an illustration of "iPotch2020".

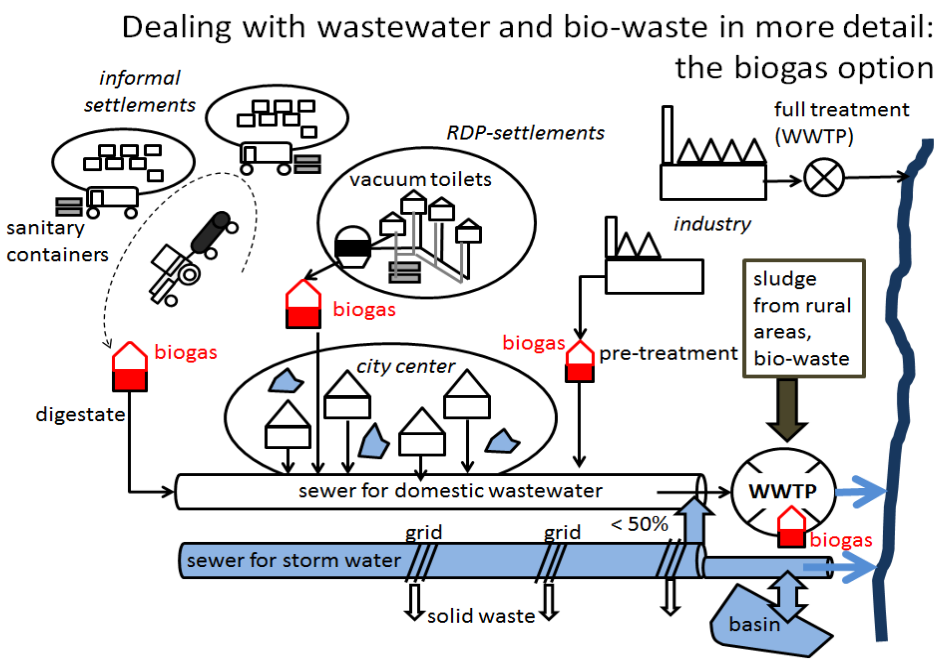

Figure 19: Die Sano-Vision „iPotch2020“

The vision's characteristics and its performance requirements are listed in Table 4.

Table 4: Performance requirements of Sano-Vision

Reference area	Topics
All locations	• Improvement of recycling, energy supply, water re-use, use of resources, good condition of waters • Maintaining good drinking water quality and drinking water safety • Better use of financial resources, e.g. tariffs for all users of water (including agriculture and industry), exceptions only for the poor, provision of subsidies, creation of incentives for more environmentally friendly actions • Enforcement of existing regulations
Informal Settlement	• Full waste disposal • Full access to sanitary facilities • Full access to drinking water
Township	• Improvement of rainwater diversion, waste collection, energy supply • Access to drinking water
City centre	• Separate collection of waste • Saving water, use and re-use of rainwater
Industrial area	• Wastewater pre-treatment • Recycling of re-usable materials, resource-efficient production (zero emission) • Re-use of process water, use and re-use of rainwater
Mine	• Use of biogas • Rehabilitation (products from sewage plant), biological pre-treatment of wastes, Recycling Centre

5.3 Summary and inferences of further research questions

Presenting the results of the workshop and discussing them at the panel discussion during the closing event of the workshop showed that the proposed approaches might be viable options for improving the South African sanitation and organic waste utilization. What was judged as especially positive were the aspects of decreasing the waste amount and of recovering energy from organic residual materials through anaerobic digestion, and the possibility to attenuate the effects of water shortage by using rainwater and grey water.

But it became obvious that a multitude of research questions have to be answered first before the implementation of the approaches is possible. Further research questions that arose from discussing the results of the workshop are listed in the following Table 5.

Table 5: Overview of further research questions

Research area	Research questions
Sociology	• What are the existing social, economic and methodological obstacles that have to be overcome in order to be able to implement the proposed technologies? • In which way can the municipality be involved into the implementation? (Good practical experiences can be found in the literature, but bad ones are rare. Nonetheless, useful insights can be gained from unsuccessful projects.) • Are there any resistances concerning the combination of waste and wastewater? • What should a bucket system look like to lose its bad image?
Economy	• How is the water pricing and fee system to be designed in order to realise iPotch2020?
Capacity building, decision making	• Do efficiency analysis and cost efficiency of the measures require any tools or improved knowledge? • Would it be helpful to develop a decision support system for the local administration? • How can the university be involved in the implementation of an effective water saving strategy? Is there a need for further research in this field in South Africa? • Which are the main problems in the area of capacity building?
Technolo gy	• Can anaerobic digestion be used for generating energy in the informal settlements and/or the industrial areas? • Can the vacuum toilet system be a suitable solution for collecting highly concentrated black water in settlements of the Reconstruction and Development Programme? • Is the (re-)use of rainwater an option in South Africa? Or is it preferred to use rainwater to recharge groundwater? • What are cost-efficient technologies for using rainwater? • What are the ecological consequences of diverting rainwater from the informal settlements and what preventive measures can be taken?

6 Conclusion and outlook

The main objectives of the project were to create a forum for young South African and German PhD students and researchers and to strengthen the good relations between Bauhaus-Universität Weimar and North-West University Potchefstroom. Another aim was to encourage South African master and PhD students to come to Germany for research periods. The workshop itself and its results were to be used to discover joint practical research topics. In this, it was expected that

- key aspects of joint activities were discovered,
- research topics were identified,
- the goal of a joint PhD programme was further developed,
- the possibilities of research at NWU were promoted,
- informal talks with PhD candidates arose, and
- a time schedule of the further actions was set.

Thus, the workshop was meant to form the basis of a long-term cooperation between Germany and South Africa.

The workshop laid the foundation for further cooperation between German and South African young scientists. During the workshop it was possible to discuss not only the topics of the workshop but also current research projects and plans of the individual chairs. Here, a lot of overlap between the individual fields could be identified, interesting discussions were had and insights were gained that were constructive for both sides. Even beyond the workshop, the young scientists keep in professional contact. Some joint research topics have already been identified as well.

As the workshop effectively strengthened the good relations between both universities, further cooperation projects are planned at the moment.

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