

SCIENCE SCOPE | VOLUME 3 | NUMBER 4 | MARCH 2009

# ScienceScope

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SOUTH AFRICA'S COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

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S&T FOR  
GLOBAL  
IMPACT

CSIR

*our future through science*

**The continent is increasingly recognised as a contributor to global knowledge and expertise – especially as far as scientific endeavour is concerned.**



# INTRODUCTION

In our fast-paced, interconnected world, mutually-beneficial partnerships across boundaries are no longer extraordinary. While Africa may, in many instances, feature on the international agenda as the recipient of assistance from the developed world, the continent is also increasingly recognised as a contributor to global knowledge and expertise – especially as far as scientific endeavour is concerned.

To this effect, the CSIR's contract research and development strategy leverages collaborations in support of cutting-edge science, engineering and technology (SET). The strategy rests on two key pillars, namely the public and private sectors. Each of these can be segmented into local, continental (African) and international markets.

We work with a variety of stakeholders and clients – from governments to peers in scientific organisations, to industry and tertiary institutions. With a strong emphasis on relevant and technological developmental work, the CSIR also has strong roots in various communities, and collaborates with a wide range of donors and funding agencies.

In Africa, our work may entail supporting the New Partnership for Africa's Development, but it may also encompass providing fire investigation expertise to private sector companies or determining the lithospheric structure of the earth for uses in the diamond exploration industry.

Further afield, projects with European Union Framework Programme participants range from bridging the digital divide through information and communications technology; to an initiative aimed at increasing safety, mobility and transport efficiency; and using laser expertise to strengthen the global competitiveness of the European gas turbine engine industry.

'S&T for global impact', the theme of this ScienceScope, features a selection of multidisciplinary projects with collaborators outside South Africa's borders – from as near-by as Namibia to as far away as Russia and the Caribbean.



# S&T FOR GLOBAL IMPACT



A solid base on which to build

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Berenice Lue-Marais,  
CSIR Group Manager:  
Contract R&D

# A SOLID BASE ON WHICH TO BUILD

BY BERENICE LUE-MARAIS

THE CSIR CONDUCTED an organisation-wide Stakeholder/Customer Survey in 2008 to achieve an understanding of stakeholder perceptions, and many of the views expressed by stakeholders were positive. In particular, the CSIR is considered to have capacity that is unmatched elsewhere in Africa. A valuable comment from stakeholders regarding a philosophy of continuous improvement is that future investments must be made to build on the organisation's foundations. The CSIR is respected for its size and 'single source' capacity. Its perceived competitive edge is the ability to deliver on multidisciplinary projects and because of this, its ability to find integrative solutions at a macro level, delivering tangible benefits to society.

A positive suggestion from the survey, which is being implemented, is enhanced focus on the understanding of the mandate as well as the required competences. The CSIR currently has a reputation of good service delivery. This also sets high future expectations, and the organisation is committed to continuing to deliver consistently. In an ongoing endeavour, the organisation is seeking to nurture deep relationships with its existing stakeholder base, as well as to create strategic new partnerships.



# AFRICA

OUR WORK IN AFRICA AIMS TO CONTRIBUTE TO THE DEVELOPMENT OF THE CONTINENT. WE ARE INVOLVED IN THE SCIENCE AND TECHNOLOGY (S&T) CONSOLIDATED PLAN OF ACTION OF THE NEW PARTNERSHIP FOR AFRICA'S DEVELOPMENT (NEPAD), WHERE THE MAIN AREAS OF PUBLIC SECTOR ACTIVITY ARE SANBIO AND THE AFRICAN LASER CENTRE.

The CSIR was officially appointed as the SANBio biotechnology hub in September 2006. Water and energy were recently added to the portfolio of CSIR-NEPAD activities and the organisation was asked to develop an energy business plan. Discussions are underway with regard to climate change, water, desertification, peace and security and materials science.

The private sector is regarded as the engine of growth in Africa. It is recognised that technological innovation and technology transfer activities are required to achieve this growth. The CSIR supports local private companies and multinationals in Africa, and take advantage of opportunities provided by country bilateral and multilateral agreements. We provide services to the African private sector across the value chain – our work in this sector revolves mainly around technology transfer – and thereby contribute to industrial development as outlined by the Council of African Ministers on Industry (CAMI).

The CSIR is also a founder member of the Regional Research Alliance, the focus of which is on multi-faceted, cross-functional activities, currently focusing on water and food security; energy and building; and construction and infrastructure.

THE  
PRIVATE  
SECTOR  
IS REGARDED  
AS THE  
ENGINE OF  
GROWTH  
IN AFRICA.



# AFRICAN LASER CENTRE

## RESPONDING TO GLOBAL CHALLENGES



### LASERS HELP DEVELOP TRADITIONAL MEDICINE TO TREAT CANCER

CANCER IS ONE of the leading causes of death worldwide. Although many types of cancer can now be successfully treated, the treatments are not specific to cancer cells and therefore cause many unpleasant side-effects. As such, the search for new and improved anticancer agents is ongoing.

Plants were the first medicines available to mankind. Medicinal plants represent a precious resource to the majority of rural populations in developing countries. This is

particularly true in Africa where a large percentage of the population depends on medicinal plants for healthcare. Due to its large geographical spread, the African continent is one with the richest biodiversity in the world. However, little effort has been devoted to the development of chemotherapeutic agents from these plants.

Dr Maryna van de Venter and Dr Trevor Koekemoer from the Department of Biochemistry and Microbiology at the Nelson Mandela Metropolitan University in Port Elizabeth, South Africa, and Dr Abimbola Sowemimo from the Department of Pharmacognosy at the University of Lagos, Nigeria, have joined forces to address this gap by investigating medicinal plants used in Nigerian traditional medicine as potential anticancer agents. Pharmacognosy is the study of medicines derived from natural sources.

Van de Venter, who has been involved in medicinal plant research for the past eight

THE NEW PARTNERSHIP for Africa's Development (NEPAD) is a vision and strategic framework for Africa's renewal. Its key stated aim is "to address the current challenges facing the African continent. Issues such as escalating poverty levels, underdevelopment and the continued marginalisation of Africa have necessitated an intervention such as this to develop a new vision and guarantee Africa's renewal."

One of NEPAD's priorities is human development with a focus on health, education, science and technology and skills development. It is in this spirit that the African Laser Centre (ALC) was established in 2002. The centre aims to enable African nations to collaborate with each other and play a major role internationally in utilising light to advance science and technology; ultimately contributing to the strengthening of their economies; global competitiveness; education; and welfare of their people. The ALC's South African participation is managed by the CSIR National Laser Centre.

Successful projects have been implemented over the past few years and, through the ALC, researchers are indeed making their mark on the African continent.

Who would have thought that lasers could be used to monitor pollution or for research into alternative cancer treatments? African researchers are in fact involved in fundamental studies such as these and their work is sure to push Africa even further into the global arena.

years, says, "Detailed evaluation of the constituents and screening of bioactive substances for chemotherapeutic purposes of African plants are urgently warranted. We have decided to test a total of sixteen plants, all of which are used traditionally for the treatment of cancer, but have never been tested against anti-cancer cell lines. Three of these, *Sapium ellipticum*, *Combretum paniculatum* and *Cyathula prostata* were selected for further research and a few more will be pursued in future."

Most research based on ethnobotanical leads (information of the traditional uses of plants for a specific disease) has followed the classical approach of identification of a single plant species with one or more biological active components. However, many traditional remedies combine one or more plants for enhanced activity and/or to reduce toxic side effects. "Optimising mixed remedies has remained largely ignored and consequently the true potential of traditional medicine may well be underestimated," says Van de Venter. "Our study aims to highlight the prospective of combination therapy by targeting two independent therapeutic objectives, namely apoptosis and replicative senescence."

Most anticancer treatments such as chemotherapy and radiation therapy induce apoptosis or programmed cell death. This is



a tightly controlled process that leads to the death of the cell and its removal without associated inflammation. "Normal cells can only divide a limited number of times and as soon as that limit is exceeded, programmed cell death is induced. This is known as replicative senescence. Cancer cells have lost this ability and are able to continue replicating indefinitely. By combining two compounds with different modes of action, it is possible to improve the efficacy without increasing the dosages required and thus potentially reducing the side-effects," says Sowemimo.

### ENTER LASER TECHNOLOGY

Explaining how a laser fits into the picture, Sowemimo says, "The methods used to evaluate the anticancer action are based on the excitation of marker molecules with lasers, enabling the detection of those markers in individual cancer cells at a very high level of sensitivity. It is important that cancer cells are killed in a specific, controlled way in order to limit side-effects. Therefore, if a plant extract or chemical compound is found to kill cultured cancer cells, the mode of cell death is investigated by tagging specific molecules inside these cells with fluorescent markers. The labelled cells are passed in single file through a laser beam that excites the fluorescent markers. This fluorescence is detected and the information

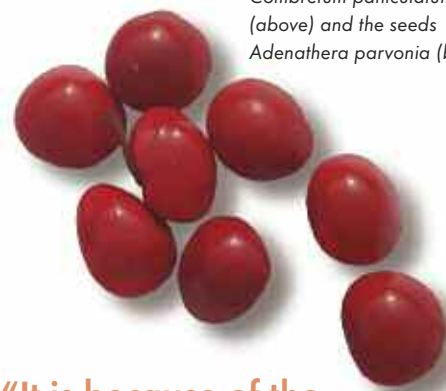
collected to determine the mode of cell death." This technique has advantages over other techniques given that vast amounts of information can be collected in a very short time. It is also more sensitive, providing an accurate quantitative measure of the processes occurring in each cell.

Van de Venter and Sowemimo collaborated via email for some time before actually meeting and tried to get funding for their project without success. They eventually succeeded when their African Laser Centre (ALC) application was granted and met for the first time in 2008 at the ALC Student Symposium held in the Eastern Cape. "It is because of the ALC funding that we have been able to make significant progress with our research," Van de Venter says. "This project constitutes the first step in the long process of drug development that could take many years to lead to a pharmaceutical product. However, without this step, our project would never have taken off. I am hopeful that this research will help validate the efficacy and safety of African traditional medicine." - Chiara Lincoln

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*Combretum paniculatum*  
(above) and the seeds  
*Adenathera parvonia* (below)



**"It is because of the ALC funding that we have been able to make significant progress with our research," Van de Venter says.**





# LASER REMOTE SENSING OF THE ATMOSPHERE ETHIOPIA AND SOUTH AFRICA TEAM UP

THE FIRST LIGHT DETECTION AND RANGING (LIDAR) MEASUREMENTS OF CLOUD HEIGHTS IN THE TROPOSPHERE WERE TAKEN IN 1963. SINCE THESE PIONEERING ATTEMPTS, LASER REMOTE SENSING OF THE ATMOSPHERE HAS COME A LONG WAY. THE DISCOVERY OF DIFFERENT LASER SOURCES, IMPROVEMENTS IN DETECTOR TECHNOLOGY, DATA COLLECTION AND ANALYSIS TECHNIQUES, HAVE RENDERED THIS TECHNIQUE A HIGHLY EFFICIENT TOOL FOR MONITORING THE ATMOSPHERE. MEASUREMENTS CAN BE MADE WITHIN A SHORT TIME SCALE – A FEW SECONDS TO COUPLE OF MINUTES – AND THE RESULTS OBTAINED CAN ACCURATELY REFLECT THE STATE OF THE ATMOSPHERE DURING THE TIME OF MEASUREMENT.

A CSIR PRINCIPAL RESEARCHER, Dr Sivakumar Venkataraman, and the head of the Department of Physics at the Addis Ababa University in Ethiopia, Dr Gizaw Mengistu, have teamed up in an African Laser Centre project to investigate the structure and dynamics of the atmosphere using lidar. "As part of our work we are attempting to study and understand global climate change and global warming, currently high on the international agenda," says Venkataraman. "The important parts of the atmosphere that contribute to global climate change and global warming are water vapour and ozone. Regular monitoring of these is important to gain a better understanding of these phenomena."

The collaboration has been ongoing since 2007 and has progressed significantly since the project's inception: a mobile lidar system has been developed by the CSIR and initial results conclude that the system is capable of providing aerosol/cloud backscatter measurements for the height region from ground to 40 km with a 10 m vertical height resolution. The complete lidar system is custom-fitted into a van and hydraulic stabiliser feet have been added to the vehicle suspension to ensure stability during measurements. "In technical terms," Venkataraman says, "an Nd:YAG laser, which is a commonly used laser source for lidar transmission, is presently employed at second harmonic (also called frequency doubling) of 1064 nm. The receiver system employs a Newtonian telescope configuration with a 16 inch primary mirror. A multimode optical fibre is used to couple the received backscatter optical signal from the telescope to the


photo multiplier tube (PMT). The data acquisition is performed by a transient recorder that communicates with a host computer for storage and offline processing of data."

In 2009, Venkataraman and Mengistu will attempt field campaign measurements in and around South Africa to provide qualitative information on pollution levels. The duo also plans to conduct novel measurements by employing high/low-repetition lasers.

As part of their efforts to also develop human capital via this initiative, lidar demonstrations will take place at African – including South African – higher educational institutions. The project has also seen the participation and training of PhD and Master's students; and collaboration with African and French scientists.

Mengistu says, "Our investigations on water-vapour concentration will contribute to the local ecological effects such as regional drought. The ozone studies will complement water vapour measurements and provide a more complete picture on the state of the atmosphere and its effects on global climate change. Therefore, our secondary aim is to upgrade the lidar at a later stage for studying the troposphere ozone – concentrations of up to 18 km." Any increase in the troposphere ozone measurements is partly attributed to the rise in temperature and thus contributes to global warming. "Therefore, by investigating these trace molecules over South Africa and the African continent, our work will contribute to studies on global climate change and global warming."

– Chiara Lincoln



**"We are attempting to study and understand global climate change and global warming, currently high on the international agenda."**

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Chris Botha, the brain behind the design of the landing light



## CSIR TECHNOLOGY LIGHTS UP THE RUNWAY

PORTABLE, USER-FRIENDLY AND NOW ALSO INFRARED-ENABLED LIGHTS ARE ASSISTING DEFENCE FORCE PERSONNEL IN AFRICA AS WELL AS OTHER COMPANIES WORKING IN INFRASTRUCTURE-POOR AREAS TO CONDUCT THEIR BUSINESS MORE EFFICIENTLY - AND SAFELY.

THE MILITARY has been touted as a fertile area for groundbreaking technological developments such as the cellular phone. These wireless mobile devices were first developed for and used by the military as a means of communication before becoming a 'must-have' gadget in the public domain during the 20th century.

Fast forward to the 21st century, where the CSIR is shaping military technology history with the design of portable landing lights for the South African National Defence Force (SANDF).

The design and development of the lights were completed in 2006 and the first sets were delivered in 2007. However, not only did the products impress the defence force, they also attracted interest from civil society. Anvil Mining, a leading copper producer in the Democratic Republic of Congo in central Africa, acquired a set to use as emergency landing lights.

According to Trevor Kirsten, head of the CSIR's technology for special operations area, mines will use the lights when there is an emergency or when a worker needs air-lifting, but also where there is no proper infrastructure for an aircraft to land. Another mine, First Quantum Minerals in Zambia, has shown interest in buying these 'magic' lights. "For the mining industry, these are portable, user-friendly and cheap to operate," says Kirsten, adding that the lights are operated via remote control. "This feature makes them unique; once switched off, the operator needs to just press the remote control button and they light up instantly." The concept won Kirsten's group a coveted International Soldier Technology Award in 2006.

However, just as time, proverbially, waits for no man, technology evolves daily. This forced the CSIR to modify and develop a more sophisticated model of these lights to suit the operational needs of the defence force. The new model, according to Kirsten,

can be switched on by an aircraft pilot while airborne from as far as 10 km to the landing zone. The new version is also fully infrared enabled. "The defence force can operate the lights without anyone else being able to see them, unless they have night vision equipment," he says.

More orders are also being delivered to other units within the SANDF, such as the 101 Air Supply Unit and 44 Parabat Regiment. "All groups within the defence force that could benefit from these lights, are now using them," he says.

A South African company has expressed interest in the technology and is engaged in contract negotiations with the CSIR.

- Mzi Gcukumana

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# GROWING TREES FOR SUSTAINED LIVELIHOODS

BY FLIC BLAKEWAY

FORESTS ARE BEING DECIMATED AT A RATE OF APPROXIMATELY 11 MILLION HECTARES PER YEAR (UNEP 1991). LARGE-SCALE DEFORESTATION IS ONE OF THE MOST CRITICAL SOCIAL AND ENVIRONMENTAL CRISES FACING ALL EAST AFRICAN COUNTRIES (THE EAST AFRICAN, SEPT 29TH - OCT 5TH, 2003). AS AN EXAMPLE, KENYA'S FOREST COVER DECLINED FROM 30% OF LAND AREA IN THE 1960s TO LESS THAN 2% AT PRESENT. CONTRIBUTING FACTORS ARE PRIMARILY HARVESTING TO MEET HUGE DEMANDS FOR FUEL WOOD AND CHARCOAL, CARVING, AND CLEARING OF LAND FOR HUMAN SETTLEMENT AND AGRICULTURE.

Benson Kanyi,  
project manager of  
the Kenya Tree  
Biotechnology Project,  
in front of a stand of  
improved Eucalyptus  
trees grown for  
fuel wood



IN KENYA, 95% OF ENERGY comes from fuel wood and charcoal, and the demand of 20 million ton in 1980 escalated to 50 million ton by 2000, with a projected deficit of three million cubic metres by 2010.

To protect and increase the remaining forests and still achieve rural development, alternative fast-growing trees and other alternative sources of energy must be put in place to meet these needs (State of World Forests, 2003). There is, therefore, a pressing need for increased support for forestry research, the development of planted forests and land-use policies that can help to reduce pressure on ancient and fragile forests.

Tree planting in Kenya has not matched tree consumption (harvesting) for many years, and in order for Kenya to achieve sustainable supply of tree products and services in Kenya, over 200 million trees should be planted annually. Currently, less than 35 million get planted, and a large proportion of the national demand for timber (mostly for charcoal) is unmet. Tree planting in Kenya has been hampered due to a lack of good quality seed and slow, inefficient traditional propagation methods.

## CSIR INVOLVEMENT

Three tree biotechnology projects (TBPs) have been initiated in East Africa from 1995 to 2008, as well as individual projects in Kenya, Uganda and Tanzania – collectively known as the Tree Biotechnology Programme. The majority of the development of these projects was funded by the Gatsby Charitable Foundation, United Kingdom, and until recently, were facilitated by the International Society for the Acquisition of AgriBiotech Applications (ISAAA) and technologically supported by Mondi forests. Each of the three countries' TBPs has links

Growing trees for sustained livelihoods are, from left: Stephen Kimani, Flic Blakeway, Rose Makena, Karen Eatwell, Lydia Wamalwa, Linus Mwangi, Steve Verryrn and Benson Kanyi

## FACT BOX

- Africa accounts for 16.8% of the global forest cover (FAO, 2003)
- Africa's forest resources are declining
- Africa has the highest net change in forest area
- Deforestation rates are highly variable in Africa – between 0.1 and 0.7% per annum (Scholes & Biggs, 2004; and Wilkie & Laporte, 2001)
- Heavy deforestation occurring in the east African region is not balanced by tree planting
- The primary use of wood in East Africa is for fuel
- Fast-growing hardwoods can contribute to fuel wood production and to wealth creation for resource-poor farming communities.

with the Forestry Research Directorates of Kenya, Uganda and Tanzania as well as with academic institutions and appropriate network partners, including the CSIR.

The projects focus on planting and sustainably managing fast-growing *Eucalyptus* within small-scale rural farming communities in order to provide an alternative source of wood for domestic use, as well as for income generation.

Designed to reduce the pressure on existing indigenous forests, and thus preserve them, the projects increase tree cover in the farmed areas, alleviate poverty within rural farming communities and enhance rural development. The projects are structured to embrace a whole-value-chain approach incorporating awareness creation, enhanced seedling availability as well as the development of sustainable marketing systems.

Introduction of clonal *Eucalyptus* propagation technology has occurred in all three countries. In Kenya, there is a self-sufficient nursery at the Karura Forestry Station, which is sanctioned by the Ministry of Natural

Resources of Kenya. The trees that are produced have been tested and proven environmentally and ecologically sustainable in many regions of Kenya and the positive impact has already been demonstrated within small and large scale farming communities of Kenya.

As a trustee of the Kilimo Trust, a funding organisation focused on broad-based wealth creation in East Africa through agriculture and agri-business, the CSIR provides strategic input to the tree planting projects and plays a technical backstopping role, injecting new innovation into the projects. In addition, the CSIR's tree improvement team has provided data analysis and data management services to the projects, and currently, the east African tree breeding data are being incorporated into the TreeBase data management package developed within the CSIR's forestry research domain.

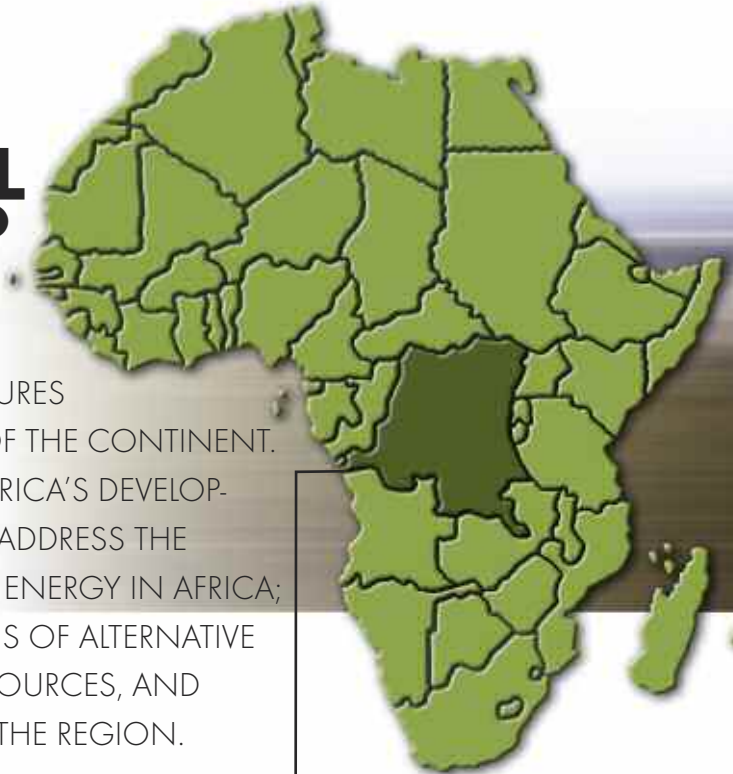
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# HYDRO POTENTIAL OF CONGO RIVER EXPLORED

BY DR ALAN BRENT, MONGAMELI MEHLWANA, MAXWELL MAPAKO



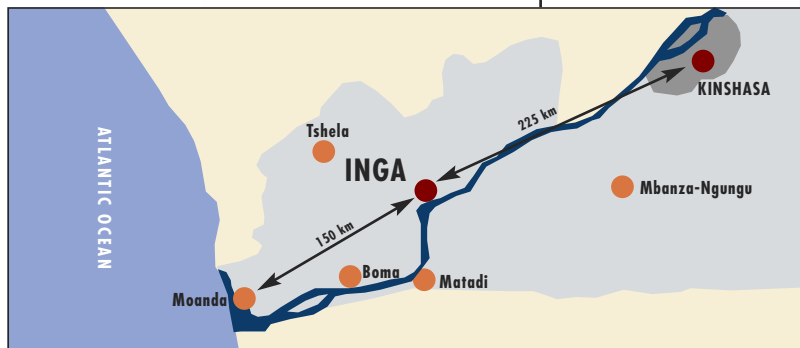
RENEWABLE AND SUSTAINABLE ENERGY FEATURES PROMINENTLY ON THE POLITICAL AGENDA OF THE CONTINENT. FOR EXAMPLE, THE NEW PARTNERSHIP FOR AFRICA'S DEVELOPMENT (NEPAD) HAS IDENTIFIED ACTIONS TO ADDRESS THE CRITICAL BARRIERS TO UNIVERSAL ACCESS TO ENERGY IN AFRICA; PRIORITIES HAVE BEEN HIGHLIGHTED IN TERMS OF ALTERNATIVE AND ENVIRONMENTALLY-FRIENDLY ENERGY SOURCES, AND ASSOCIATED ENERGY-RELATED POLICIES, FOR THE REGION.

THE CSIR has been tasked to clarify the key sustainability issues of the largest planned hydropower scheme in Africa, i.e. the Grand Inga project. The study aims to prioritise the key issues and rate the project accordingly, based on expert views across the continent. Thereby, the overall sustainability potential of the project may be determined, and recommendations made to improve its sustainability.

In essence, the Grand Inga project will exploit the vast hydro potential of the Congo River, approximately 150 km from the river mouth. The reported generation capacity of some 39 000 MW means that this is the most ambitious energy integration project in Africa and a number of additional positive aspects have been put forward:

- The series of rapids and specific topography leads to minimal environmental (and social) impact
- The river flow is seasonally constant, i.e. 'drought proof', because the tributaries of the river drain vast areas north and south of the equator
- The electricity production costs are low, although the required distribution infrastructure will require substantial investment.

Irrespective of these positive perceptions, the current phase 2 of the project, from 2008 to 2010, focused on feasibility studies; securing political, economic, social and environmental acceptance of the project; and promoting the necessary agreements among involved governments. For the different stakeholders



- **Renewability is a response to concerns about the security of energy supplies from unforeseen interruptions and the eventual depletion of some primary energy sources such as fossil fuels**
- **Sustainability is, largely, a response to environmental degradation that could leave a legacy to future generations of a reduced quality of life.**

in this phase of the project, a comprehensive understanding of the sustainability aspects associated with Grand Inga is essential. It is towards creating such a comprehensive understanding that the CSIR study makes its contribution.

## DELVING INTO HYDROPOWER

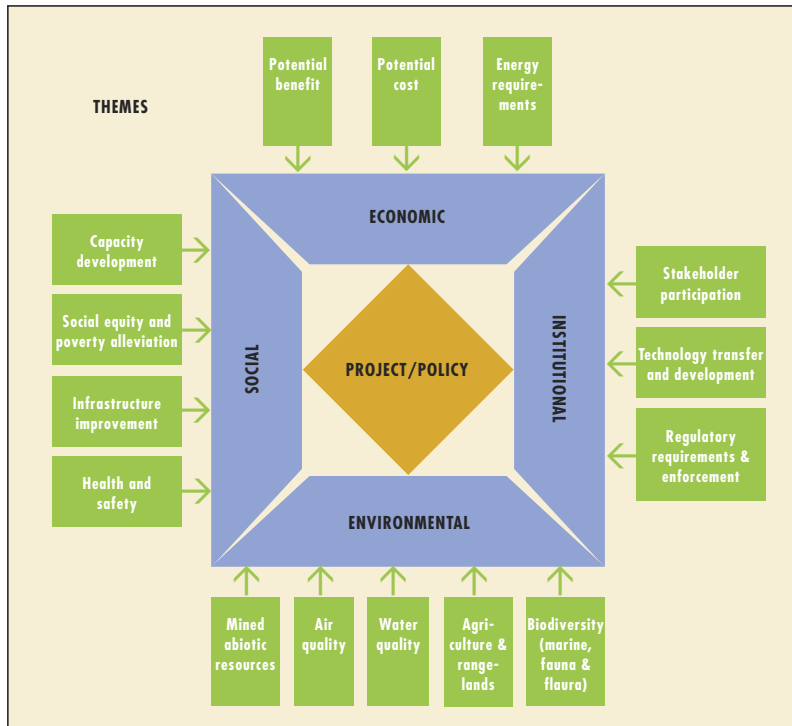
The criterion for renewability is the requirement of a technology to be relatively non-consumptive in the generation of energy. Based on this, hydropower must clearly be considered a renewable energy source. Africa can potentially meet much of its re-

newable energy priorities with, reportedly, more than 1.1 million gigawatts of exploitable hydropower capacity. What separates hydropower from other sources of renewable energy, is that it may leave substantial positive and negative legacies to future generations; these legacies must be considered in the African context.

Many of the structures of a hydropower plant, such as canals, tunnels, dams, reservoirs, or access roads, last for many generations and are, therefore, deemed enormous positive attributes. Some forms of hydropower consume large quantities of land -

“Africa can potentially meet much of its renewable energy priorities with, reportedly, more than 1.1 million gigawatts of exploitable hydropower capacity.”

Grand Inga projections and the current Inga 1 dam



### Framework of macro influencing factors for large energy projects

the reservoirs that store water for the various purposes of flood control, irrigation and electricity generation. Whether that conversion of land from a terrestrial ecosystem to an aquatic ecosystem is a positive or negative legacy depends on the particular hydro project, what the land was used for before the project, and what the artificial lake is used for afterwards.

The sustainable character of hydropower is determined by whether sustainability is seen

as an absolute concept, where a process is either sustainable or not, or whether it allows for a more flexible definition, where a process can have some positive and negative sustainability characteristics, which must be balanced. Hence, the question is not whether the environment (and society) is impacted, as much as what are the degrees of positive and negative impacts. While hydropower projects have been proven to cause substantial impacts on various aspects, it is also known to have created substantial benefits.

Hydropower projects are often multi-purpose in nature, meeting multiple needs of society in areas such as flood control, assurance of a firm water supply, recreational benefits, in addition to energy production. If the costs of acquiring those benefits include some changes in the natural environment and society, then the decision to move forward, or not, is a societal one based on value systems that consist of a range of factors. The range of potential macro influencing factors (see figure) that characterise the sustainability of large energy projects need to be considered, and (possibly) weighed up, when assessing the sustainability of hydropower schemes on the African continent.

In general, however, the key issues that must be addressed are the high technical, economic, commercial, environmental and social, including political, risks. These may be in the form of upfront investment requirements from public-private partnerships; government confirmation of political stability; technical, and institutional and regulatory support over the life cycle of the project; suitability of a proposed site from the perspectives of all stakeholders; economic development associated with a project, i.e. the means to finance the ongoing project; and the project management and technology transfer capabilities.

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# KALAHARI SANDS TESTED IN LAB FOR USE IN ROADS



THE VAST LANDSCAPE OF NAMIBIA is dominated by wind-blown Kalahari sands. Typically, this type of material is loose and does not have sufficient binding capacity to resist wheel traction forces, leading to problems such as corrugation and excessive dust generation on unsurfaced roads. In addition, the material is not sufficiently confined to support load, unless some form of stabilisation is used.

The stabilisation of sands can generally be achieved by soil blending (mechanical) or use of a binder (chemical). Potential chemical binders include:

- Hygroscopic salts
- Natural polymers
- Synthetic polymers
- Bitumen
- Sulfonated oils
- Enzymes.

The possibility of using synthetic polymer emulsions for stabilising Kalahari sands on roads was first discussed in early 2004 between the Namibia Roads Authority (NRA) and the CSIR. Subsequently, the NRA requested the CSIR to undertake an investigation to assess the performance of available synthetic polymer products for treating the Kalahari sands.

In a nutshell, the scope of the work involved obtaining representative samples from different areas of Namibia, and carrying out preliminary tests on these samples. The samples were collected from good and poor performing unsealed roads. The poor performing roads were those that exhibited surface deterioration such as faster corrugation development than would generally be considered under similar conditions.

THE CSIR ASSESSED THE PERFORMANCE OF AVAILABLE SYNTHETIC POLYMER PRODUCTS TO STABILISE KALAHARI SANDS ON ROADS. IT RECOMMENDED THAT THE NAMIBIA ROADS AUTHORITY COMMISSION FIELD TRIALS TO ASCERTAIN THE VALUE OF THESE PRODUCTS.

Included in the testing were samples from roads around Dordabis, Gobabis, Lüderitz, Oshakati, the Otjosondou mine, Solitaire, Sossusvlei, Rundu and Windhoek. On the basis of the results of the preliminary tests, a series of laboratory tests was conducted on selected sands both untreated and treated with three different synthetic polymer types in varying application rates. This was followed by analysis of the test results including economic analysis to indicate the potential and limitation of the application of synthetic polymers.

Internationally, the use of synthetic polymers in road stabilisation applications has been reported in the United States and the Middle East, while experimentation has taken place in Australia and South America. However, no comprehensive guidelines have been published on the use of synthetic polymers in road improvement. Standard geotechnical engineering tests were conducted to determine certain characteristics and properties of the sands that would give an indication of whether synthetic polymer emulsion treatment would be effective for a specific kind of sand. In addition, non-standard tests developed by Dr Dave Jones at the CSIR, specifically for assessing the effectiveness of non-traditional additives, were done. Traditional stabilisers on the other hand include cement and lime. The scanning electron microscope (SEM) technique was also used in the analysis.

When the eye microscope was used, the textural features of the samples seemed to be similar, with colour being the obvious difference. However, SEM analysis revealed further differences between the samples with respect to grain texture and structure as well

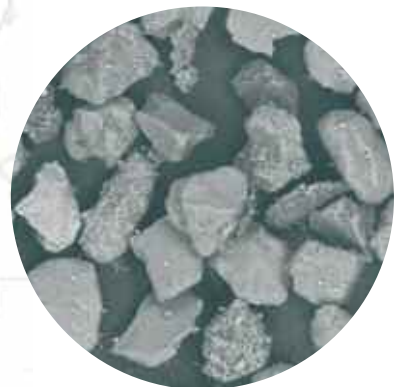
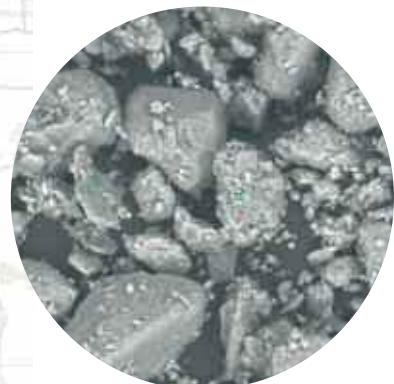
as mineralogical composition. Using the SEM it was possible to ascertain that the micro-scale characteristics of the sand samples played a major role in their performance as well as their response to treatment with the synthetic polymers.

The conclusions following the investigation included:

- Kalahari sands with at least 10% of the grains passing through a 0,075 mm sieve are most likely to perform well after treatment with synthetic polymers.
- Synthetic polymers are sensitive to moisture in terms of erosion resistance. The drier conditions experienced over most of Namibia are likely to be conducive to good performance of synthetic polymers.
- Cost-benefit analyses should be undertaken to assess the benefits of using synthetic polymers rather than maintaining roads as unsealed, or traditional upgrading to sealed standard.
- Initial cost analyses showed that paving roads are the most appropriate method for preserving a road for longer than five years, while using synthetic polymers can be justified over a 10-year period on roads with certain material properties and where about 200 vehicles per day travel on these roads.

The final recommendation was that the NRA should commission field trials on Kalahari sands roads treated with the synthetic polymers to ascertain the value of these products as road stabilisers.

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Scanning electron microscope (SEM) image of Kalahari sands that responded to treatment with synthetic polymer emulsion (top) and sand that did not respond positively to treatment (bottom). Note the contrast between the grain texture and structure of the two samples





# DEALING WITH DESERTIFICATION IN SOUTHERN AFRICA

A CSIR-LED PROJECT AIMED AT IDENTIFYING WAYS TO UNDERSTAND AND MONITOR DESERTIFICATION IN SOUTHERN AFRICA IS GAINING MOMENTUM.

THE CSIR, IN COLLABORATION with Integrated Environmental Consultants Namibia and other role players in South Africa and Namibia, is undertaking an initiative aimed at assessing, mapping, and understanding natural resource degradation and desertification in southern Africa. Funded by the Department of Science and Technology (DST), through the National Research Foundation, the initiative also addresses related social features such as negative impact on livelihood and mitigation of poverty, especially in communal areas.

"Desertification is seen as one of the major environmental crises of our time," explains Graham von Maltitz, a senior researcher at the CSIR. "It is very difficult to quantify the phenomenon; in addition to the impact on the natural environment, the livelihoods of millions of people – typically poor communities – are affected by desertification. The link between the human and environmental dimensions is highly complex – desertification is not a problem of deserts, but rather a problem of resource degradation, which is normally a consequence of unsustainable

use patterns. Equally, humans are affected by the degradation and are both directly losing access to resources, such as food or fuel, and environmental services, such as vegetation preventing flooding or dust storms."

The complexity of the desertification problem is reflected by the broad range of disciplines involved in studying the phenomenon. These include climate and ecological science, remote sensing, social and economic science.

According to Von Maltitz, it is very difficult to predict or map desertification. "Our assessment of the global map products is that they do not work in southern Africa. One of the problems is that we are in an environment with very high inter-seasonal fluctuations in rainfall and vegetation cover, which complicates things when working with satellite images. The CSIR's Meraka Institute has an established track record in the use of satellite imagery to map desertification; the challenge is to link this to what is happening on the ground."

The DST initiative kicked off with a regional workshop, held in South Africa in September 2008 and attended by more than 60 academic and political delegates from the SADC region. The aim of the workshop was to share regional experiences and learning, and develop a network of southern African scientists able to respond to research issues relating to natural resource degradation and desertification.

The next phase of the project consists of two fieldwork excursions, the first of which took place in Ovamboland in Namibia, early in February 2009. The CSIR team linked up with scientists from the Polytechnic of Namibia and the University of Namibia to develop and test methodologies for tiered assessments of desertification.

"We used different levels of assessment, ranging from satellite images to on-the-ground verification of components such as tree cover and tree density. Work was mainly focused on the collection of data for the calibration of satellite images, and to develop a set of monitoring methods that

**“We are moving towards a joint understanding of the drivers of desertification, the type and extent of current degradation and possible mechanisms for preventing such processes.”**

will be made available as a manual or a CD,” Von Maltitz explains. The team also spent time training a group of researchers in the use of the relevant methodologies.

The third phase of the project will consist of a fieldwork excursion planned to take place in the Kuruman area in the Northern Cape, in May 2009. Organised by the North-West University, this workshop will form the second tier of the assessment of the methodologies identified and developed in the first two phases of the project.

In addition to the guideline manuals and other material being developed as one of the project outcomes, the CSIR team and its partners will be publishing its research in peer-reviewed journals. Von Maltitz points out that the work currently being done focuses mainly on the policy level. “Some of the participants in the project are working at local level, helping farmers to manage their resources and put in place mitigating measures, or establishing community monitoring and evaluation systems. However, the main focus of our work is to provide information to

assist policy and decision makers in understanding and managing desertification.”

Von Maltitz is confident that the project is contributing significantly towards building regional capacity in desertification monitoring. “We are moving towards a joint understanding of the drivers of desertification, the type and extent of current degradation and possible mechanisms for preventing such processes,” he says.

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Efforts to assess and map natural resource degradation and desertification in Namibia were the driver behind a field trip in the Kavango region of Namibia. Participants are from the CSIR and the North-West University in South Africa and the University of Namibia, Polytechnic of Namibia and Integrated Environmental Consultants in Namibia. Pictured from top are Elsita Kiekebusch and John Mfune with Reagan Chunga, Brian Mhango, Yolandi Els and Festus Nashima in the middle photo. CSIR Fellow Dr Bob Scholes addresses the team in the bottom photo



# GHANAIAN ROAD AND BRIDGE SPECIFICATIONS IMPROVED

THE MINISTRY OF TRANSPORTATION, GHANA, OBTAINED WORLD BANK FUNDING FOR THE REVIEW AND UPDATE OF THE COUNTRY'S STANDARD SPECIFICATION FOR ROAD AND BRIDGE WORKS. A TEAM OF 10, CONSISTING OF CSIR STAFF AND CONSULTING FIRM STEWART SCOTT INTERNATIONAL, UNDERTOOK THIS TASK WITH THE FINAL UPDATED DOCUMENT COMPLETED IN MID-2007.



PROJECT LEADER DR PHIL PAIGE-GREEN of the CSIR explains that detailed studies of the outdated Ghanaian Standard Specification for Road and Bridge Works were followed by three events held in Ghana during the course of the project.

The first was a week long, devoted to discussions with stakeholders and role-players from Ghana and feedback workshops. The project team was also involved in visits to ongoing projects during that time, making observations and seeing whether developments were appropriate for prevailing environmental conditions. "One of the challenges was the plethora of references to specifications from around the world, which required harmonising and ensuring that only current ones were included. It was also required by the client that the specification be appropriate for all categories of roads present in Ghana, i.e. rural, urban and feeder roads," says Paige-Green.

A draft of the revised document was the topic of discussion at the second event, with participation by some 60 people from

Ghana. They were mostly from government ministries, contractors, consultants and suppliers. The interactions involved a number of general discussions with various specialist/interest group breakaways. The results of the discussions and comments obtained were considered and incorporated, where appropriate, into the final document.

Once the project was finalised, an official launch of the updated document took place in Accra, Ghana, attended by about 100 people. Among them were many primary users of the document, including agencies of the Ministry of Transportation, the Ghana Institution of Engineers, consultants and contractors. Some additional feedback from this launch was incorporated into the final document delivered to the client.

From the first edition, which was some 200 pages long, followed the updated version of 2007 consisting of about 500 pages. "In the revised version, ambiguities and conflicting clauses have been removed and recent developments included," says Paige-Green.

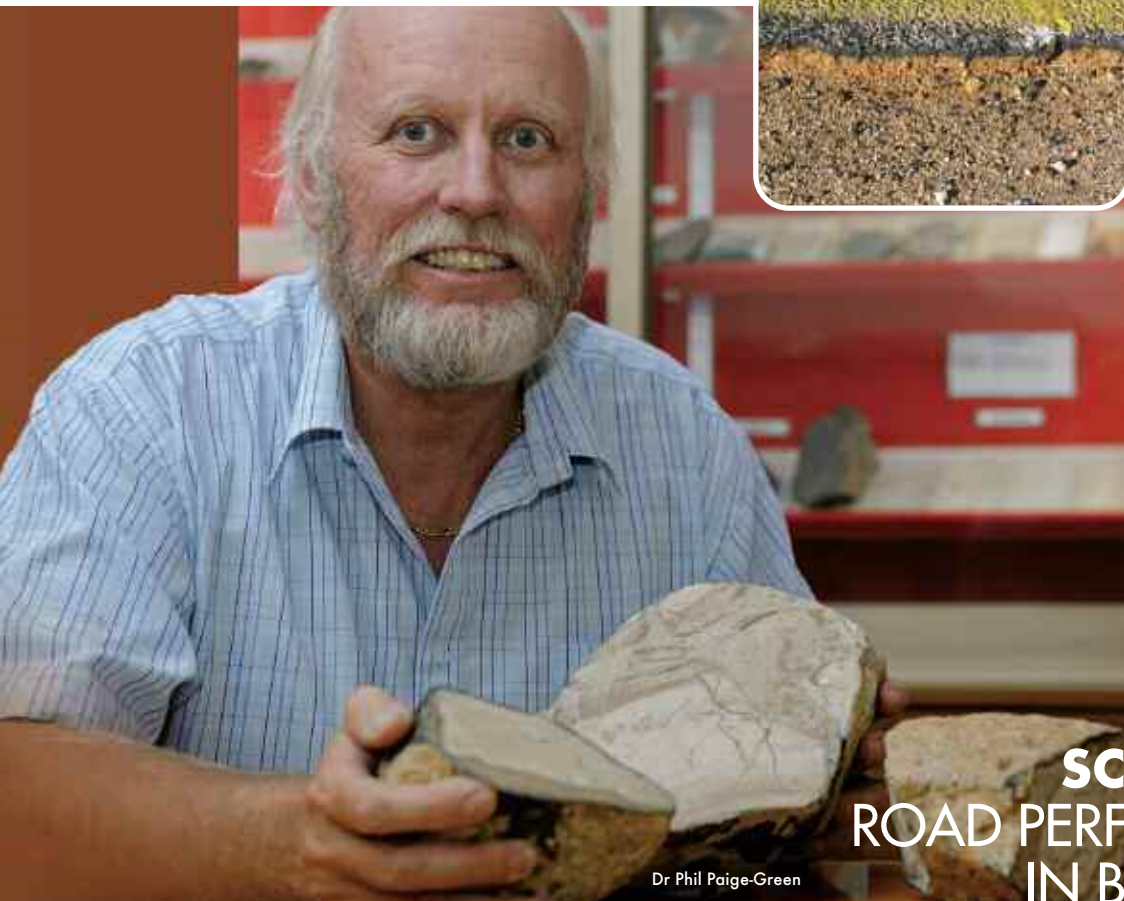
From left: A recently-constructed bridge over an estuarine river. Such bridges will comply with the new specifications

Road construction in Ghana according to the old specification standard

In some instances, rock for use in road construction is still hand-knapped. This, of course, generates employment

Major additions are the specifications for safety and the environment, street lighting and traffic lights. Specifications were also included to cover recent developments in the fields of construction material characterisation, concrete technology and current technologies for stabilisation using cement, lime and bitumen.

"The document is not meant to be used as a design manual but rather as specification standards that contractors will need to comply with on any road or bridge construction project carried out in Ghana," comments Paige-Green.   
- Hilda van Rooyen



Dr Phil Paige-Green



Left: A typical part of one of the marked sections of roads – see the hard self-stabilised lateritic base layer beneath the bitumen surfacing, which has given very good performance  
Below: A marginal quality silcrete used as surfacing aggregate in Botswana



## CSIR SCRUTINISES ROAD PERFORMANCE IN BOTSWANA

BOTSWANA IS LABELLED BY MANY AS AN AFRICAN SUCCESS STORY DUE TO ITS POLITICAL STABILITY AND ITS MANAGEMENT OF MINERAL REVENUES AND FISCAL RESOURCES. THIS ALLOWED THE DEVELOPMENT OF THE PAVED ROAD NETWORK TO INCREASE FROM 10 KM IN 1966 TO TODAY'S MORE THAN 6 500 KM. THESE ROADS ARE GENERALLY OF A HIGH STANDARD AND WELL-MAINTAINED.

CSIR ROAD MATERIALS SPECIALIST, Dr Phil Paige-Green, is currently analysing information and data, collected over the past 18 years, on the performance of a number of paved roads in Botswana.

A two-year project, the initiative involves the Norwegian Public Roads Administration (NPRA) and the government of Botswana. The NPRA set out 25 sections of road all over Botswana in a range of climates, varying levels of traffic and built with a variety of construction material in the early 1990s.

The majority of the marked sections are on the national road between Gaborone and Kasane, which is near the confluence of Zambia and Namibia. Four sections in the more arid western region were also selected.

The NPRA and the Botswana Road Department monitored these 25 sections regularly until 2008, looking at traffic flow, road performance, material properties and other important performance characteristics.

Paige-Green has undertaken a number of site inspections of sections of these roads with the NPRA and Botswana road officials over the years.

"The main project is to revise the Botswana Road Design Manual with involvement of various South African researchers and practitioners – including from the CSIR – and the Botswana Ministry of Works and Transport, under the guidance of the Norwegian collaborator and InfraAfrica Consultants in Gaborone," says Paige-Green.

Large quantities of pavement testing, traffic, environmental and monitoring data have been provided and these are being systematically assessed to determine a catalogue of the designs related to traffic and their performance. The information resulting from the analysis will be fed back into the revised manual.

"The main characteristic identified thus far is that the standard design of roads in

Botswana seems to be too conservative. At the time of construction of the majority of these roads, the Botswana government still used many of the old international standards of road design and construction. They can, in fact, get away with lower quality materials and thinner pavements under their specific dry environmental conditions and relatively lightly-trafficked loads," explains Paige-Green.

Many of the roads that were designed to carry a specific traffic volume over a period of 20 years have now carried considerably higher traffic and lasted much longer than the 20 years – the majority of these are still perfectly serviceable.

"After analysing the data obtained from the NPRA monitoring project, we'll have useful innovative information to assist with the revision of the Botswana road design manual," says Paige-Green.

– Hilda van Rooyen

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THE TRAINING AND CAPACITY BUILDING OF GEOSCIENTISTS IN AFRICA IS GAINING GREAT MOMENTUM THROUGH THE NETWORKS THAT ARE BEING BUILT BETWEEN AFRICAN, EUROPEAN AND AMERICAN TERTIARY INSTITUTIONS AND GOVERNMENT AGENCIES.

## AFRICAN COLLABORATIONS

AFRICAARRAY, a 20-year Pan-African research and capacity building programme in geophysics, was launched in July 2004 and still provides a platform on which networks are built.

The CSIR is a participant in AfricaArray through Professor Ray Durrheim's position as the CSIR/University of the Witwatersrand (Wits) South African Research Chair in Exploration, Earthquake and Mining Seismology. Durrheim is a co-director of research and training for AfricaArray and says its two main goals are to develop capacity in geosciences and promote good science.

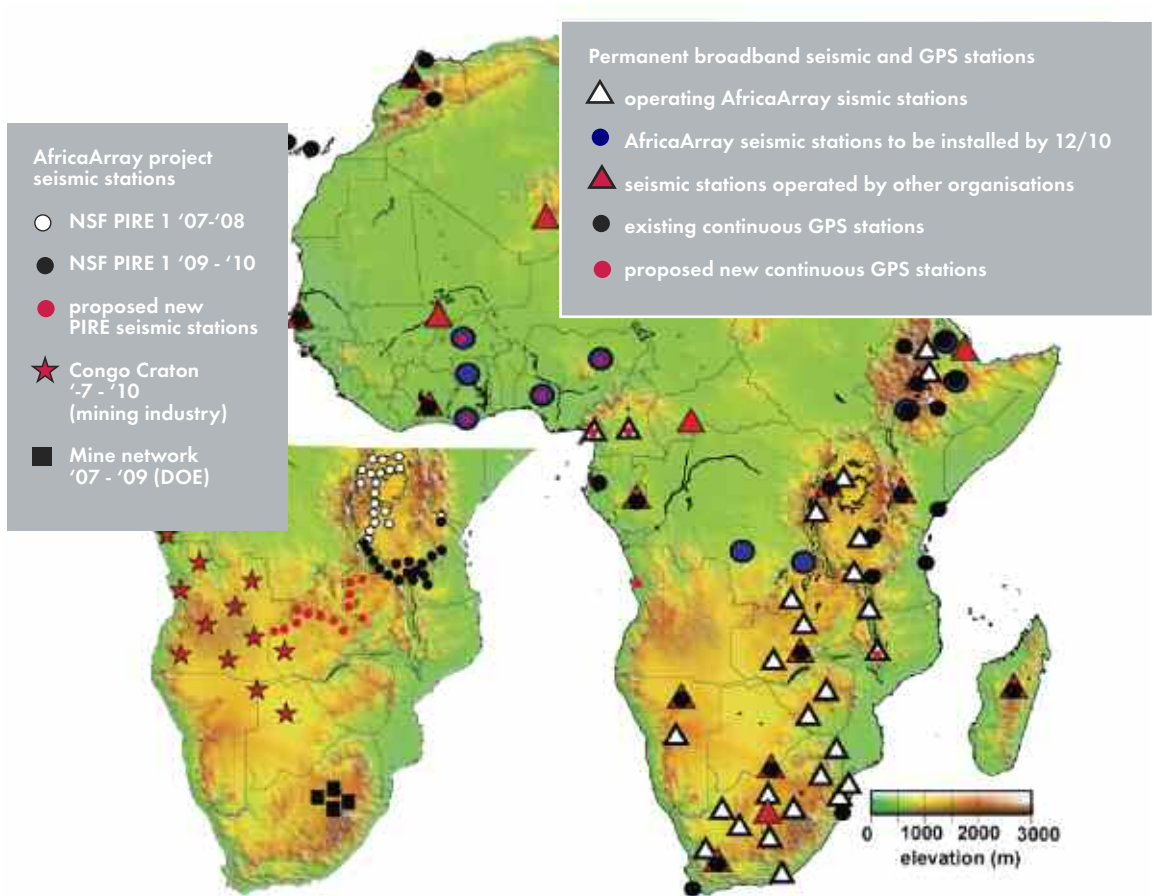
"We use geophysics to understand global dynamics and the way the earth has been constructed," says Durrheim.

"AfricaArray science is aimed at determining the deep structure of the African continent, and the origin of the largest seismic anomaly

in the Earth's mantle, found directly below southern Africa and referred to as the African superplume," says Durrheim. Permanent seismic stations have been established across southern Africa in South Africa, Malawi, Namibia, Tanzania and Zambia, among others, to provide data sets for research projects. AfricaArray plans to expand its network into other parts of the continent.

The research also has practical outcomes. It aims to characterise the source mechanisms of earthquakes in Africa and assess the risks they pose. Images of the deep structure of the continent are also useful when exploring for oil and gas, minerals, and geothermal energy.

AfricaArray initially focused on geophysics to maintain and develop geological training programmes in Africa and the USA. This was in response to industry, government and



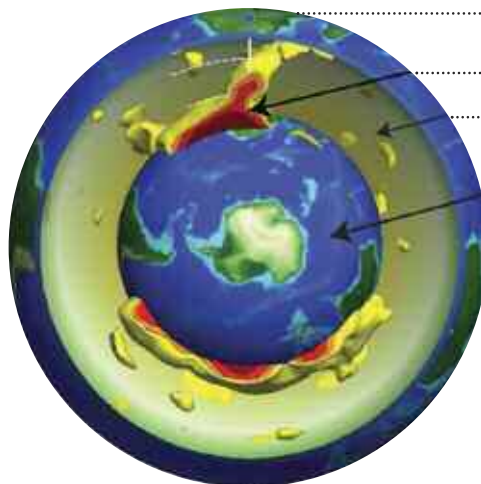
# IMPROVE STATUS OF GEOSCIENCES

university needs. AfricaArray is now expanding its activities into other areas of geoscience, earth science, mining and geological engineering.

AfricaArray is also establishing an Africa-to-Africa research support system. To achieve this, the AfricaArray programme has provided training for dozens of geoscience students and postdoctoral scientists – more than 100 students have participated in this programme.

“We set aside one month in a year for a field school. Students from other African universities, US students as well as employees from industry attend this field school. Part of the information they receive is background to the geophysics methods used,” says Durrheim.

“We want them to improve their field skills so that they can collect accurate results,” he adds.



Africa  
African Superplume  
Earth's mantle

Earth's core with the globe covering it to show the location of the superplume at the boundary between the mantle and the core.

Figure from Simmons et al., (GRL, 33, 2007) showing a 'seismic' CT scan through Earth's mantle using S waves. The red and orange areas show regions where the seismic waves travel slower than expected.

The students are required to write individual reports and hand them in before the end of the programme. AfricaArray also has an annual workshop, open to everyone.

– Kamogelo Seekoei

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# AFRICAN AGRICULTURE NEEDS TO ADAPT TO CLIMATE CHANGE

MOST OF THE RURAL POOR in sub-Saharan Africa rely for their livelihood and food security on climate-sensitive rain-fed subsistence or small-scale farming, pastoral herding and direct harvesting of natural services of ecosystems such as forests and wetlands.

The productivity of this livelihood base is highly vulnerable to climate-related stresses, such as changes in temperature, precipitation (both amount and variability), and increased frequency of droughts and floods. The vulnerability of the majority of the poor in Africa to climate-related stresses is worsened by widespread poverty, HIV/Aids, lack of access to resources (e.g. land and water) and management capabilities, as well as lack of wealth, technology, education, effective institutional arrangements and social safety nets.

Climate is changing and mitigation efforts to reduce the sources of or to enhance the sinks of greenhouse gasses will take time and may also be very expensive. Furthermore, effective mitigation requires collaboration and commitment from many countries. Adaptation is therefore critical and of concern in developing countries, particularly in Africa where vulnerability is high because ability to adapt is low. Adaptation helps reduce the impacts of climate change in the short to medium term, and is motivated from local priorities or

regional risks, without requiring multi-country commitments.

The benefits of adaptation are realised in the short term and are felt at the local community level. Adaptation measures are therefore critical in the short to medium term, while in the long run mitigation efforts are required to reduce risks and create sinks for further greenhouse gas emissions. Human and natural risks associated with climate change are determined by both adaptation and mitigation actions. Therefore, effective climate policy must integrate diverse adaptation and mitigation actions to reduce the adverse effects of climate change on human and natural systems.

CSIR research in this area assesses the impact of climate change on agriculture across Africa and identifies ways of helping farmers adapt to reduce the negative effects of climate-related stresses.

## STRENGTHENING ADAPTATION TO CLIMATE CHANGE IN AGRICULTURE

Adaptation to climate change refers to adjustments in management strategies to reduce risks or realise opportunities from actual or expected changes in climatic conditions.

Agricultural adaptations to climate change involve modifications in farm-level practices due to changing climatic and non-climatic conditions. Adaptation occurs at farm level – which focuses on micro-analysis of farmer decision making – and macro-level, which is concerned with agricultural production at national scale and its relationships with domestic and international policy. Farm-level decision making happens over a very short time-period and is usually influenced by seasonal climatic variations, local agricultural cycles and other socio-economic factors.

Strengthening farm-level adaptations for enabling farmers to cope better with climate change and related stresses need to consider:

- Modifications in crop management practices
- Innovative approaches to water management and use in agriculture
- Accessibility to climate and agricultural information
- Strengthening local capacity
- Addressing constraints to adaptation.

Favourable modifications in crop management and farming production systems include increased crop diversification and activities that take advantage of water and temperature conditions. When a variety of crops are



CLIMATE CHANGE IS EXPECTED TO RESULT IN HIGHER TEMPERATURES AND DECLINING RAINFALL PATTERNS, AS WELL AS INCREASING FREQUENCY OF EXTREME CLIMATE EVENTS, SUCH AS DROUGHTS AND FLOODS, IN AFRICA. LOCAL ECOSYSTEMS PROVIDE THE MAIN SOURCE OF LIVELIHOOD FOR MANY OF THE WORLD'S POOR.

BY DR CHARLES NHEMACHENA

grown it reduces the risk of a complete crop failure, as climate affects crops differently. Farmers could also ensure that sensitive growth stages don't coincide with harsh conditions such as mid-seasonal droughts. They could change planting and harvesting dates of different crops according to climate conditions, selecting appropriate crops for the right conditions and thereby ensuring food availability throughout the year.

Rainfall patterns and distribution necessitate innovative water management techniques for both agricultural use and economic development. According to literature, water supply management can involve developing new sources of water and groundwater, the promotion of water harvesting and the reuse of agricultural drainage.

Water demand management involves incentives (e.g. through policies) and mechanisms (e.g. through institutions) as well as new technologies that promote the efficient use of water (such as high-precision irrigation) and soil and water conservation.

Information on climate change forecasting, adaptation options and other agricultural production activities affects the adaptation measures for most farmers and communities. Agricultural and other economic policies

need to be freely available and useful climate adaptation options need to be accessible to help reduce the risks of failure that might be associated with new technologies and adaptation measures.

Building local institutional capacity is key to facilitate and promote adaptation to climate change. It is also important for research to develop new crop varieties and patterns to respond to climate risks. Active social networks within communities help to build the capacity to work together and capitalise on local knowledge systems. Cooperation also enables communities to try new innovations as the risk of new practices and technologies is spread.

Resource limitations, household characteristics and poor infrastructure have a negative impact on the ability of most rural communities to adopt new measures. Better access to markets, agricultural extension and credit services, technology and farm assets (such as labour, land and capital) are critical enabling factors to enhance the capacity of African farmers to adapt to climate change.

Policies aimed at easing identified key limits to farmers' capacity to adapt to climate change need to emphasise the critical role of:

- Extension, technology and farm assets
- Provision of improved climate, production and market information
- The means to implement adaptation through affordable credit and insurance against climate risks (safety nets).

National policies also need to support research and development that prepare the appropriate technologies to help farmers adapt to climate-related stresses.

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**CSIR research assesses the impact of climate change on agriculture across Africa and identifies ways of helping farmers adapt to reduce the negative effects of climate-related stresses.**







THE DIGITAL DOORWAY – A JOINT INITIATIVE BETWEEN THE SOUTH AFRICAN DEPARTMENT OF SCIENCE AND TECHNOLOGY (DST) AND THE MERAKA INSTITUTE OF THE CSIR – IS PROGRESSING FAST IN REALISING ITS VISION OF MAKING A FUNDAMENTAL DIFFERENCE TO COMPUTER LITERACY AND ASSOCIATED SKILLS, BOTH IN SOUTH AFRICA AND BEYOND OUR BORDERS.

# DIGITAL DOORWAY

## EXPANDS ITS OPERATIONS INTO AFRICA



Children flock to the newly installed Digital Doorway in the Ha Tsolo community, close to Maseru, Lesotho



The Digital Doorway in Addis Ababa draws young enthusiasts keen to engage with this system

THE DIGITAL DOORWAY (DD) is a free-standing computer terminal that allows 24-hour access (where feasible) for users, depending on location and community requirements. Standard content is loaded, which can be customised if made available prior to installation for a particular community. Digital Doorways are found throughout South Africa and increasingly in other parts of Africa.

### THE MOUNTAIN KINGDOM REAPS DD BENEFITS

The DD in Lesotho was officially launched at the end of August 2008 with Lesotho's Ministry of Education, the Commonwealth Secretariat and the Meraka Institute of the CSIR in attendance. This marked a significant milestone in the DD initiative in that country and hopefully opened the door for more funders to invest money in its expansion.

When the Meraka Institute was engaged by the Commonwealth Connects Programme in December 2007 to extend its Digital Doorway Computer Literacy programme to Lesotho, the institute readily embraced the opportunity. The DD initiative was already doing well in South Africa, with funding from the DST, so the institute was open to the idea of extending its services to Lesotho for a period of 12 months. The aim was to develop and implement programmes in under-served areas that enable the

bridging of the digital divide in terms of voice and data services. The project further sought to create sustainable ICT programmes orientated towards the design, development and deployment of new telecommunications, educational and health services and to support ICT-related entrepreneurial activities.

With Commonwealth funding of GBP 15 000, the Meraka Institute immediately stepped into action. The institute's research and development outcomes manager, Nicki Koorbanally, says to ensure relevance and sustainability, they had to find a suitable local partner. "Identifying a local champion who is trusted in a community, who understands the potential of technology and who is able to facilitate the uptake of the Digital Doorway was imperative for the success of the project," she says. "We were fortunate to find such a partner in Potlako Nisekhe-Nzima – nicknamed PK – who is a research and community development consultant based in Maseru. Up to now, PK has played a key role in compiling a community needs assessment report, identifying a suitable site for the installation of the DD, mobilising local stakeholders and monitoring usage.

"The community also has someone with whom to communicate directly. She will hopefully continue to play a role in ensuring sustainability of the DD even after we cease to be directly involved there."



The Meraka Institute's Grant Cambridge with Seth Herr of UNICEF at its headquarters in New York

As a result of Ntsekhe-Nzima's initial report, the Ha Tsolo community, situated 10 minutes' drive from the city of Maseru, was identified as a good location for the DD. Explaining why this community was ideally suited for the DD, Koorbanally says, "The Ha Tsolo community has a sizable learner population as well as a number of factory workers, mostly women, from the industrial area close to the community. It is also near a new settlement of displaced people from the area where the Katse Dam was built."

To date, the feedback on the Lesotho DD has been exceptionally positive. According to Koorbanally, "The uptake has been really good and one of the best remarks I have heard so far is that parents no longer worry about the whereabouts of their children after school or on public holidays because they know they are at the DD."

### FURTHER AFIELD: UNICEF DD-IN-A-SUITCASE

Meraka Institute design engineer, Grant Cambridge, visited New York as part of a ground-breaking collaborative initiative with the United Nations Children's Fund (UNICEF). The initiative is based on the locally-developed DD concept.

When UNICEF visited the Meraka Institute, the delegation was so impressed with the DD that it immediately purchased one to stand at

the main entrance to its headquarters in New York. This was the start of a relationship that is now growing steadily, as UNICEF and the Meraka Institute jointly investigate various additional applications.

Having the DD on site was the spur for UNICEF to refine its concept of a portable ICT hub to use in situations where no ICT infrastructure exists. Cambridge says he is working closely with UNICEF engineer, Seth Herr, to build an updated prototype. As he explains, "The concept was to develop a 'DD-in-a-suitcase', which could be checked in with an airliner carrying UNICEF staff to various disaster areas. UNICEF designated the project BEE - as in Honey Bee. The BEE will act as a content server and a communication hub within disaster areas. As UNICEF's relief work progresses and the process of re-building of communities starts, it will then deploy the full DD - the Queen BEE." UNICEF has now built a concept demonstrator using the DD as a reference.

Cambridge's visit to New York has brought him into contact with many other interested parties, who are keen to use the DD. "I have met with people from Millennium Villages, International Children's Digital Library and several other interested parties. The development process has resulted in the BEE evolving into what we call a 'Village Server'. This will provide content as well as a gateway for other services to other devices via GSM, WiFi or other communications backbones. This will allow UNICEF staff to use their Blackberries or i-pods to communicate with the Village Server."

Cambridge believes that beneficiary groups will expand as the concept develops. The initial beneficiaries are UNICEF field workers and with time, local communities will benefit more and more.

The UNICEF-Meraka team is currently developing a collapsible mast that will support all the required antennas, and be easy to transport and assemble in rough terrain. The mast will fit into a 2 m long case. Future plans include simplifying the user interface for basic services as well as simplifying the housing or developing new housing for the Village Server. The prototype BEE will continue to be in use while those plans are being developed.

### DD POPS UP IN ETHIOPIA

This growing relationship between UNICEF and the Meraka Institute has borne other fruit. Ethiopia has joined the list of other African countries that are set to benefit from this collaboration.

A demonstration of a three-seater DD to African Union (AU) representatives gathered in Addis Ababa, was held on 31 October 2008. The DD was purchased by UNICEF and delivered by the Meraka Institute to Addis Ababa in a remarkably short period of time, thanks to the efforts of Louis Bapela of Ingwapele and the Meraka Institute's Ronel Smith, who is the DD project manager. The purpose of the demonstration was to highlight the UNICEF Rapid SMS facility (similar to the Meraka Institute's MobilED technology) and the DD's usefulness as a tool for emergency response and connectivity.

This DD was then donated to the Pioneer Adama Youth Group and launched on 1 November 2008. Adama is an educational initiative for young people interested in technology. It focuses on localising software into Amharic, a local language.

### THE DD INTO THE FUTURE

It is envisaged that the DD will remain the system of choice for many countries, seeking to expand the reach and potential of information and communications to a range of audiences in a sustainable manner.

- Biffy van Rooyen

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**“Ultimately, the environment and society are our key stakeholders.”**



# ENVIRONMENTAL SPECIALISTS PROMOTE GLOBAL SUSTAINABILITY

THE CSIR'S ENVIRONMENTAL MANAGEMENT SERVICES GROUP IN STELLENBOSCH HAS AN IMPRESSIVE RECORD OF WORKING WITH LOCAL AND INTERNATIONAL CLIENTS (INCLUDING PRIVATE COMPANIES, GOVERNMENTS, PARASTATALS AND INTERNATIONAL FUNDING INSTITUTIONS, SUCH AS THE WORLD BANK). THE GROUP SEEKS TO WORK WITH STAKEHOLDERS IN ORDER TO CREATE AND SHAPE VENTURES AND PROJECTS SO THAT THEY PROMOTE DESIRABLE SOCIO-ECONOMIC DEVELOPMENT AND ENVIRONMENTAL SUSTAINABILITY.

ENVIRONMENTAL MANAGEMENT specialists at the CSIR conduct complex environmental studies in challenging environments on behalf of their clients. To achieve this, says Paul Lochner, who heads the group, the team has experience in the energy, mining, industrial and transport sectors (e.g. petroleum and renewable energy projects, exploration for mining, smelting and ore beneficiation, and port and associated industrial development).

Language presents few obstacles to these scientists who operate in countries as linguistically diverse as Russia, Uruguay and Mozambique. Lochner explains, “With sustainable development at the local scale in

mind, our group works extensively with companies that are active in the oil and gas sector, including major players such as Chevron, ConocoPhillips, BP and Shell. Companies seeking to develop mineral resources in Africa, such as BHP Billiton and Rio Tinto Alcan, are also valued clients.”

## **FINDING THE RIGHT FORMULA FOR THE CLIENT**

Specialist services are applied to suit individual situations. “When working with a private company starting on a project cycle, we are involved in pre-feasibility studies. At this stage, projects are typically only roughly conceptualised. Through environmental

screening studies, we seek to identify potential ‘red flags’ and in this way inform what then becomes the more firm conceptual design of the project, with the aim of avoiding or mitigating environmental issues.” This service is also extended to companies embarking on acquisitions, where environmental risk and due diligence assessments can highlight potential downstream problems.

Where projects advance past environmental screening and enter the feasibility phase, the CSIR typically becomes involved in environment impact assessments (EIA). Lochner says, “Our involvement continues as our clients move into feasibility assessment of project proposals that are increasingly robust in



The environmental management services group of the CSIR: From left, seated, are Christable Geland, Henri Fortuin, Paul Lochner, Brent Johnson, Stephanie Dippenaar and Minnelise Levendal. Standing from left are Pat Morant, Emma Gordge, Petal Cornelius and Mike Burns. Insert: Annick Walsdorff

"For example, sharing water quality information in remote African villages with the local communities empowers them to manage their water supply for improved human health."

In another example, surveys among artisanal gold mining communities in the border region between Cameroon and Central African Republic revealed many environmentally-friendly opportunities to increase production, and to grow and retain income derived from mining.

Further afield, in the far northern part of Komi Republic in Russia, a welcoming attitude by remote mining communities proved essential to the success of the environmental due diligence and EIA projects undertaken by the CSIR team during the planning phases of a bauxite mine and alumina refinery.

## CAPTURING AND SHARING LEARNING

Lochner concludes, "This type of work requires an adventurous, motivated person, with the ability to integrate a range of scientific disciplines. We are also actively involved in conducting training courses throughout Africa on environmental assessment and management. Lessons learnt from project experience are communicated through these training courses as well as via written publications, book chapters and conference presentations."

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terms of their sustainability implications – this is influenced by the environmental screening that has been undertaken. Throughout Africa, EIA is mandatory for companies seeking development or funding approval, and we play a critical role in this regard."

Moving into implementation, the group assists with environmental management, monitoring and reporting during the construction, start-up, operating and decommissioning phases. Assistance is provided in preparing environmental management plans for these different project phases.

Lochner points out that, "Our role is to assist clients in ensuring the sustainability of their projects in terms of environmental and socio-economic criteria – from cradle-to-grave." He affirms that "our philosophy towards supporting sustainable development is the same, whether we are working with institutions such as the World Wide Fund for Nature, the Global Environment Facility, World Bank,

governments or the private sector. Ultimately, the environment and society are our key stakeholders."

## OUT IN THE FIELD

Good data, analysis and credible science form the foundation of projects. This requires field investigations, surveys and measurement exercises, often in interesting environments. The team, with local counterparts, has found itself working in places as remote and understudied as the Congo River mouth, the Lake Chad floodplain, the mangrove forests at the foot of Mount Cameroon and the western Sahara.

Environmental philosophy specialist Dr Mike Burns has led many of the group's studies in West Africa. He emphasises that "these scientists make it their business to establish a good rapport with local communities, who benefit from the information gained through field surveys.



Emma Gordge and Dr Pete Ashton in Gabon on a mining rehabilitation project

# TECHNOLOGY FINDING ANSWERS: **HOW DID THAT FIRE START?**

IN AFRICA,  
FIRE INVESTI-  
GATORS ARE  
FEW AND FAR  
BETWEEN.  
THEIR RARE  
SKILL MEANS  
THEY ARE IN  
DEMAND ALL  
OVER THE  
CONTINENT  
TO INVESTI-  
GATE FIRES  
AND GIVE  
CLOSURE ON  
THE LIKELY  
CAUSE OF  
FIRES.

CSIR fire investigator  
Anina Burger rummages  
through the remains  
of a fire





SOUTH AFRICA HAS FEWER THAN 20 fire investigators whose work takes them all over the continent. This is no different for the CSIR's Anina Burger, who, with her group, uses scientific methods to investigate the origin and cause of fires for, among others, the short-term insurance industry.

"While individuals also make use of our services, we mainly do work for insurance companies," she says. They provide a sustainable, high quality forensic fire investigation service that adapts to market interest and adheres to international standards. Strategic affiliations and global networking are an integral part of the group's operations, resulting in access to leading international research and innovation in fire investigations.

The forensic fire investigation services undertaken are typically related to losses caused by fires to structures, vehicles and grasslands.

"We do not focus on the losses when we conduct these investigations. Our main aim is to tell the client what the cause of the fire was," she explains.

Burger, who has a BSc degree in chemistry and applied mathematics, was recently in Ghana, where she investigated a fire that occurred in a big corporation.

Prior to that, she investigated a fire at Swazi Plaza, Mbabane in Swaziland, after a convenience store burnt down.

## WELL TRAVELLED

Her investigations have taken her to Botswana, Namibia, Seychelles, Madagascar and Mauritius. Most people equate this island off the African coast in the Southwest Indian Ocean with sun, sea and sand – not sugar cane, smoke and soot. Yet, this is ex-

actly what Burger found when she arrived at the Mon Loisir sugar mill in Rivière du Rempart. The smoke may have died down, but the damage left by an underground fire brought the mill's electricity production plant to a standstill.

Apart from processing sugar cane, Mon Loisir has used the waste product (bagasse) to produce electricity for the past 50 years. This it uses to power its own operations, as well as supply the government with electricity on a tender basis. Therefore, when the mill is unable to fulfil the tender requirements – as in the case of this fire – penalties are levied.

"The fire originated in an underground cable way that extended from the basement of the power station where an amount of 6,6 kV electricity were carried through 1 MWatt cables. Fire fighters struggled to extinguish the fire as the basement could not be accessed due to the overwhelming smoke. The cableways in the separating floor allowed fire spread from the transformer section in the basement to ground level and fire fighting was accordingly directed towards the switch gear rooms that were located above the transformer section," she explains.

After extensive interviews with the production manager and electrical engineers, Burger braved the cable way – an uncomfortably hot and dirty affair, she says.

Hundreds of photos later, she could report to the loss adjuster that the fire was accidental and that no foul play was suspected.

## TRAINING

"To date we have not actively pursued forensic fire training outside of our borders, but we envisage doing that in future. Our training has been limited to members of the South African Police Service to improve

crime investigation, and some groups of the Botswana police service," she says.

But with so many fires to investigate and only a handful of investigators, "We need more fire investigators because fires are a daily occurrence and forensic fire investigators are a species nearing extinction. In many African countries, the investigation into fires ends with loss adjusters quantifying the losses after a fire," she says.

Burger takes obvious pride in the ethics and independence required by the job, saying that the results of her findings cannot be swayed by an outcome that is desired by any party involved. "An investigation can point to arson, or it can point to an accidental cause. In both cases, it will be an unwelcome result for someone involved," she explains.

But Burger's main concerns are the scarcity of fire investigators and the need to train people on fire prevention.

"We need to work on scenarios that allow for ordinary people to be taught about the dangers of some of the equipment they use in their homes. Most people misuse electricity without even knowing it, all because they do not have the basic information." For instance, people sometimes connect more than three appliances to one wall plug, "and that can be hazardous," she says.

She also warns against putting heaters underneath desks in offices. "This is very dangerous and can cause a fire if the heater is left burning through the night."  
– Kamogelo Seekoei

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Karel Mathee with some of the COTS (components off the shelf) equipment used by LinkNet



Fred Mweetwa in the Macha Internet Cafe

# WIRELESS MESH CONNECTIVITY OPENS NEW DOORS

The signing of a memorandum of understanding (MoU) between LinkNet (Zambia) and the CSIR in August 2007 was a significant step towards the creation of low-cost, wireless connectivity and training for rural communities.

Mesh networking is a particularly suitable technology to initiate and support growth of connectivity in rural and underserved areas and for emergency response situations. The latter was demonstrated when a temporary licence was granted in the USA for the speedy construction and operation of a mesh network, after Hurricane Katrina left existing telecommunications infrastructure devastated.

## MAKING A DIFFERENCE TO ZAMBIAN COMMUNITIES

The Meraka Institute's Karel Mathee, who is responsible for maintaining the relationship with LinkNet, is excited at the ongoing rollout

and its positive outcomes in Zambia. "The hands-on training course with LinkNet and the availability of our mesh networking do-it-yourself guide (see box) helped to propel progress with our partners on this project," he explains. Ongoing discussions with the Zambian government may see the project elevated to a national initiative.

Macha and its environs, and Mukinge have an estimated population of 128 000 and 25 000 respectively. Mathee notes, "It was clear from the growth in the number of mesh nodes deployed in the communities, that a big demand exists and that the LinkNet support organisation was able to supply in that demand." LinkNet's Gertjan van Stam confirms this, "I would estimate that we have covered about 50 buildings per community with about 150 computers online per site at any given moment."

The results and recommendations of a net-

work audit one year after initial deployment were presented to the LinkNet team in Macha. A visiting student from Germany, Lutz Engels, was able to incorporate the findings into his BSc Honours work, leading to a revised internet protocol numbering scheme for the community network.

Mathee points out that mesh networking was part of a holistic approach to stimulate economic growth in this rural area. The Macha mission hospital serves the surrounding area. A medical research facility was established to study malaria, tuberculosis and HIV/Aids in the community.

An HIV/Aids care wing was added to the local hospital. An airfield was constructed to facilitate the transport of people and goods into and out of the community as the road infrastructure is not well developed. Increased demand led to the construction of accommodation units for guests.



Mathee and Mweetwa outside the LinkNet administration building

The Meraka Institute released 'Building a Rural Wireless Mesh Network: A do-it-yourself guide to planning and building a Freifunk based mesh network' on the internet under a Creative Commons licence. The authors used the Creative Commons licence, in support of the open content philosophy, to allow users to repackage the material. Freifunk is a well-known technology; both this technology and the requisite skills are relevant to Africa. The solution requires only off-the-shelf components, making wireless mesh connectivity relatively cheap and fast to implement.

## THE RURAL COMMUNITIES OF MACHA IN THE SOUTHERN PROVINCE AND MUKINGE IN WESTERN ZAMBIA ARE REAPING THE BENEFITS OF WIRELESS MESH CONNECTIVITY, THANKS TO THE ONGOING COOPERATION BETWEEN LINKNET, A NON-GOVERNMENTAL ORGANISATION, AND THE MERAKA INSTITUTE OF THE CSIR.

### FACILITATING ACCESS TO BANDWIDTH

A mesh network must be linked to the internet for users to become full citizens of the information society. In rural Africa this is achieved through satellite links (VSAT). Currently, the cost of bandwidth remains a concern. Van Stam explains, "From 1 January 2009, our C-band [satellite] connection has gone up in price from USD 1 141 to USD 1 291 per month – and we hardly see speeds over 256k. At the same time, the price of our Ku-band VSAT increased from USD 400 to USD 485 with no guaranteed throughput." These costs are exorbitant for a rural community for whom the internet offers the promise of advancement and education.

He adds, "We want to start remote education and talent development and boost the LinkNet IT Academy. All in all, we need much more bandwidth in Macha."

A paper, 'Bringing internet connectivity to rural Zambia using a collaborative approach' was jointly authored by the Dutch TNO, LinkNet and the CSIR's Meraka Institute, and presented at the ICTD2007 Conference in India. It deals with the need for internet in rural Zambia, the delivery using a combination of satellite and mesh networking technology and the benefits to the community of Macha in the Southern Province of Zambia.

In a subsequent development, TNO (The Netherlands), VTT (Finland), Fraunhofer (Germany) and the CSIR's Meraka Institute – all members of the Global Research Alliance – are cooperating with LinkNet on a new initiative called AfricaWorks to bring affordable internet connectivity initially via satellite to rural Africa. The group compiled an overview of the initiative and specified a preliminary research agenda to address the needs identified in rural Africa. The GRA

members will submit proposals to all relevant EU FP7 calls in order to seek funding for the research work in cooperation with the African partners.

Meanwhile, various African countries are taking the bold step of installing terrestrial fibre optic networks. "Fibre optic networks offer better bandwidth," explains Mathee. "By instituting a public works programme, communities are participating in these activities, which will ultimately link the community networks to the new undersea cables planned for the east coast of Africa. This promises to bring true broadband internet into Africa. Wireless mesh networking still could play a valuable role in connecting distributed communities cost effectively to the nearest fibre connection."

– Biffy van Rooyen

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# HEALTH HELPLINE BRINGS HOPE TO CAREGIVERS IN BOTSWANA

**CAREGIVERS RESPONSIBLE FOR VULNERABLE HIV-POSITIVE INFANTS AND CHILDREN IN BOTSWANA HAVE BEEN GIVEN ACCESS TO HEALTH INFORMATION, THANKS TO WORK BY THE MERAKA INSTITUTE AT THE CSIR ON SPOKEN DIALOGUE SYSTEMS.**

The OpenPhone team: Mpho Kgampe, Bryan McAlister and Aditi Sharma, who work with Jama Nokwe and Christiaan Kuun (not present)



THE DESIGN OF A SPOKEN DIALOGUE system (SDS) for the provision of health information to caregivers of HIV-positive children was the responsibility of the Meraka Institute's OpenPhone team. The team achieved a project milestone when its automated health helpline was piloted at the Botswana-Baylor Children's Clinical Center of Excellence in April 2008. The team combined its technical and creative skills to achieve its goal, namely to show that automated telephone systems can be used to create positive social impact. Preparation for the pilot involved careful design and implementation of the system, voice recording, movie making and lots of planning.

The original team of human language technology (HLT) researchers Aditi Sharma, Christiaan Kuun, Bryan McAlister and Victor Zimu, together with visiting researchers Dr Madelaine Plauché and Richard Carlson, invited caregivers of HIV-positive infants and children to interact with their technology at the clinic for five days. Their aim was to test two automated telephone systems: a touch-tone system and a speech recognition simulator. Both systems provided caregivers with relevant health information on topics ranging from nutrition, hygiene and cleanliness to antiretroviral medication and facts about HIV, in their home language, Setswana.

### A TELEPHONE-BASED, SPEECH-DRIVEN INFORMATION SYSTEM

The health helpline makes use of an open source telephony platform. A major part of the platform is made up of the Asterisk software PBX system, which runs on standard Linux operating systems. Asterisk provides access for standard PC-based systems to deliver services over telephony networks. An additional layer was added above Asterisk, which enables IVR (interactive voice response) application development

and deployment. Content for the health helpline application (audio recordings, dialogue flow) had to be captured in a form that could be used by the application layer of the telephony platform to deliver the service.

A dual set-up was arranged for the sample group at the hospital. Each individual was required to sign a consent form, after which the group viewed a video made by the HLT group, which explained when to use the system and clearly illustrated the impact it could have in day-to-day life. After a live demonstration and some scenario sketching, users were primed and encouraged to use both systems. Plauché explains, "Our aim was to establish which input method is preferred and whether the content on the helpline is accessible and usable to our target user group."

Interesting findings surfaced from evaluation questions. Despite the common assumption that speech recognition is an ideal technology for less literate people, the OpenPhone team found that the low literacy caregivers in the study – mostly females between 25 and 45 years of age – preferred the touch-tone system. They cited as reasons for their preference its speed and the added benefits of privacy and accuracy.

Users were caregivers responsible for children between four months and eight years of age, and all found the available information both accessible and usable. Comments such as "It saves money" and "I am pleased I can reach it from home and educate myself and my family members" attest to the efficacy of the helpline in empowering people through access to information. A stated requirement was that it should be toll free, and the team is looking into ways to make this possible.

Christiaan Kuun, who was tasked with finding a voice artist to record the prompts, shares

some of the secrets of the helpline's success: "We were fortunate to be able to use the vocal talent of Connie Ferguson to record the information in Setswana. Our user group reacted very positively to the reassurance and empathy, which were implicit in her tone and delivery." Connie is better known as an actress who plays in a well-known South African soapie, 'Generations'.

### POSITIVE FUTURE PROSPECTS

The HLT team is delighted with the outcome of the pilot, results show that 40% of first-time users were successful in using the telephone health helpline to access the information they need. Sharma is pleased that "HLT technology is out there being used to make a difference in lives".

In addition, the OpenPhone team's close partnership with the clinic enabled them to craft accessible, relevant content for the health helpline. Staff at Baylor confirmed that the helpline enhances existing services offered to the community. "The nurses really liked the system and were keen on adding further content to it," Sharma observes. "We're sure they are going to pass on the good news to the caregiver community."

What lies in the future? The team will continue to monitor use of the helpline to enhance usability and will update information remotely as needed. It is hoped that a parallel system can be developed in South Africa in places where Setswana is spoken. Other possibilities are to extend this to other languages or share the content with others working in the Aids care and prevention technology domain. – Biffy van Rooyen

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Botswana-Baylor Children's Clinical Center of Excellence, where caregivers tested two spoken dialogue systems



# SAMTEX

INVESTIGATING EARTH'S STRUCTURE



BY DR STOFFEL FOURIE

INVESTIGATION OF THE VERY DEEP CRUSTAL AND LITHOSPHERIC STRUCTURE OF CONTINENTS IS NOT EASY. MAN-MADE ENERGY SOURCES THAT ALLOW SCIENTISTS TO INVESTIGATE THE STRUCTURE OF THE EARTH DOWN TO 300 KM INTO THE MANTLE ARE HARD TO FIND. SCIENTISTS, THEREFORE, DEPEND ON NATURAL ENERGY SOURCES TO ACHIEVE THIS. CURRENTLY ONLY TWO GEOPHYSICAL TECHNIQUES ALLOW FOR THESE KINDS OF INVESTIGATIONS: THE EARTH QUAKE SEISMOLOGY TECHNIQUE AND THE MAGNETOTELLURIC (MT) TECHNIQUE.

CSIR SCIENTISTS are participating in the Southern African MagnetoTelluric Experiment (SAMTEX). It is a project with local, SADC and international partners from governments, academia and industry. The project aims to determine the lithospheric structure of the earth, especially for uses in the diamond exploration industry.

Other partners include the Dublin Institute for Advanced Studies; Woodshole Oceanographic Institute in Massachusetts; the Geological Survey of Canada; the Geological

The magnetotelluric method uses the sun and sunspots as a source. Sunspots are usually associated with an increase in solar activity. In times like this, the sun ejects large numbers of particles into space (solar winds).

These solar winds interact with the earth's magnetic field. The magnetic field of the earth then generates electrical currents in the different layers of the earth, and we measure these variations in the earth's electrical and magnetic fields.

structure of the craton by using MT, to such an extent that it will soon be impossible to do this survey satisfactorily. Once this point is reached, the opportunity will be lost forever.

This survey should be done as soon as possible and as a matter of urgency. Man-made interferences – pipe lines, electric trains, electric fencing and the like – pose a great threat to the success of the magnetotelluric technique as these activities influence measurements.



Survey of Botswana; the Geological Survey of Namibia; Rio Tinto, an Australian mining company; and locally, the Council for Geoscience, De Beers and the University of the Witwatersrand (Wits).

The SAMTEX project is the first step to unravel the unknown lithospheric structure of southern Africa, and especially the Kaapvaal Craton. Estimated at 3 600-4 000 million years, the Kaapvaal Craton is the oldest surviving continent in the world. It underlies close to 75% of South Africa. The Kaapvaal Craton was also, for a very long time, the only area where economic Kimberlites, the rock best known for containing diamonds, were found in large numbers. So, it has to be special and this study was in part to start unravel that mystery.

During the past six years, close to 900 magnetotelluric temporary stations were set up across southern Africa, for an average of five days per station. The data processing has not been completed, but preliminary results show that the Kaapvaal Craton has a very thick root – accounting for its stability.

This was the first step in the process to unravel the secrets of the Kaapvaal Craton. In order to fully understand the physical form and structure of the craton, it is necessary to survey the complete area at a grid of 20 km by 20 km.

Continuous infrastructural development in South Africa will affect the country and its surroundings. This will jeopardise the possibility to determine the physical form and

The magnetotelluric method is not only suited for very deep lithospheric studies, it can also be used to explore for moderate to deep mineral deposits. In addition, it is suited to look for possible hydrothermal targets and to aid in the location of structures close to the coast that could be utilised as carbon sequestration portholes.

The CSIR contributed to this research as part of the SAMTEX group, and although the field work is completed, the CSIR will still be involved with the data processing and interpretation.

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# SEYCHELLES MARINA SUCCESSFULLY MODELLED

BY CRAIG JOHNSON

SEYCHELLES, A RECENTLY INTRODUCED MEMBER OF THE SOUTHERN AFRICAN DEVELOPMENT COMMUNITY (SADC), HAS A LARGE PROPORTION OF ITS GDP HEAVILY DEPENDANT ON TOURISM. HOTELS ARE PLENTIFUL ON THE MANY ISLANDS THAT MAKE UP THE NATION, AND SMALL CRAFT MARINAS OFTEN COMPLEMENT THE HOTEL COMPLEXES. ONE SUCH COMPLEX, THE ZILWA DEVELOPMENT, HAS BEEN PROPOSED FOR STE ANNES ISLAND, 4 KM EAST OF MAHE, THE MAIN ISLAND OF THE SEYCHELLES.



Construction of the physical model



Physical model prior to testing



Craig Johnson

THE CSIR WAS CONTRACTED by WSP Africa Coastal Engineers to verify the design of the proposed marina through scaled physical modelling. The development has been proposed by IFA Hotels and Resorts. The tests were conducted at the CSIR in Stellenbosch in September 2008, and included damage, overtopping and wave penetration measurements. Along with the verification of the design, physical models are a useful tool to visualise a potential development. Developers frequently use these models as a marketing tool.

### LAYOUT OF THE PROPOSED ZILWA MARINA

As part of the physical model tests, the coral-composed bathymetry was reproduced to high accuracy from a carefully blended mixture of cement and sand. High detailed areas were modelled with masonite templates shaped to perfectly reproduce the important effects of the wave dynamics on the main breakwater. The core material making up the

main breakwater was scaled to reproduce the flow through the core, based on the theory of flow through porous media.

This is necessary to reproduce the damage levels on the breakwater and overtopping discharges over the crest of the breakwater.

“The CSIR Hydraulics Laboratory in Stellenbosch has significantly improved its physical modelling capabilities through the purchase and development of high accuracy wave generation and measurement equipment, implementation of new scaling methods, network and IT improvements, and expansion of office space for employees and international clients,” says Kishan Tulsi, laboratory manager.

Recently purchased, high-accuracy capacitance probes were utilised to measure the calibrated incident wave conditions. Ke-floats, a novel, CSIR-developed method of measurement of very small waves was used to measure the wave agitation within the

marina basin. This method achieves an accuracy of less than 0,3 mm.

Digital image technology tracked the movements of the rock armour on the toe and the face of the breakwater. Overtopping measurements were made using watertight containers, correctly sized for the available space on the crest of the breakwater. Based on the physical model tests, damage levels were within acceptable limits and some portions of the toe of the structure were recommended by the client to the project developers for regular monitoring.

The project was successfully carried out to confirm the final design of the Zilwa Marina. During a site visit in December 2008, the marina developers, architects, consultants and representatives from the Seychelles visited the CSIR and were impressed with the organisation’s physical modelling expertise.

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# AFRICA CONNECTS THROUGH WIRELESS INITIATIVE

THE BENEFITS OF CONNECTIVITY FOR THE AFRICAN CONTINENT ARE BECOMING A REALITY THROUGH THE EFFORTS OF WIRELESS AFRICA, A UNIQUE PAN-AFRICAN INITIATIVE LED BY THE MERAKA INSTITUTE OF THE CSIR.

WIRELESS AFRICA is a collaborative research and development (R&D) project to study, validate and enhance business models that achieve economic sustainability of wireless infrastructure in rural and remote areas. It receives funding from the Canadian International Development Research Centre (IDRC) for a period of two years, which commenced in June 2008.

## FLEXIBLE CONNECTIVITY SOLUTIONS

Wireless technologies offer solutions to connect remote communities on the world's least wired continent. The Meraka Institute's Chris Morris (project coordinator) states, "Why should rural, poor and remote areas in Africa be denied access to the information society through lack of infrastructure or because of excessive telecommunications costs?"



Chris Morris at the second workshop held in Pretoria during 2008 with Professor Samwel Maghimbi from Tanzania

"Through Wireless Africa, we aim to have an increased understanding of the reasons for this failure. This, in turn, will inform the development of business models that may contribute to addressing the challenge of sustainable solutions."

Four consortium partners work closely with the Meraka Institute: IT+46 delivers hands-on training and technical advice in the areas of voice over internet protocol and traffic management. Wire.less.dk is involved in the technical development of the wireless internet technologies. Kwantu-Media leads the demand-side studies and business modelling, and the Edge Institute is involved in policy research.

## ACHIEVING THE OUTCOMES

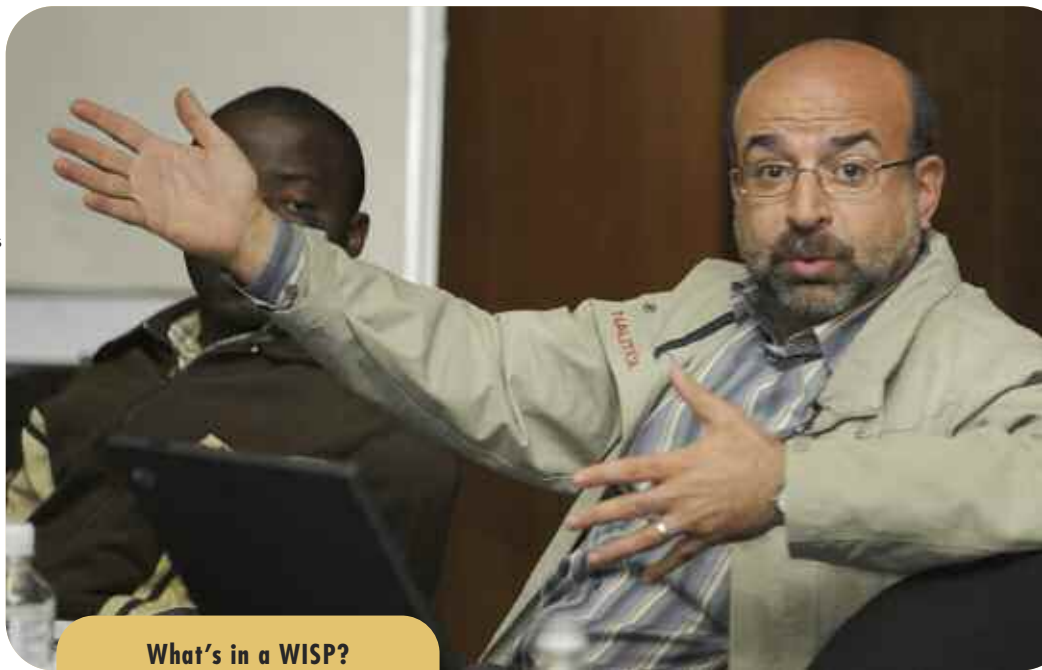
The Wireless Africa team works together to achieve project outcomes through the organisation of workshops held in Africa.

"The first three-day workshop was all about listening and sharing of proposals by participants from 15 countries in Africa," explains Morris. "The greatest challenge we face is sustainability." The event also allowed Morris to present the broader project plan, which deals with technology and business training, sustainability, policy and environmental issues.

Three organisations active in the field of wireless connectivity – Fantsuam Foundation in Nigeria, OneVillage Foundation in Ghana and Community Wireless Resource Centre in Uganda – were selected to set up reference sites for this project. These frontrunners were joined later by Tanzania, Kenya, Morocco, Zambia, Rwanda, Mozambique and Angola.

In August 2008, a training workshop organised in Ghana by OneVillage Foundation gave participants the opportunity to acquire skills in social research. Morris explains, "This methodology, dubbed outcomes mapping, requires the researcher to plan activities, and monitor and map developments associated with changes in behaviour."

The third workshop focused on technical and business skills. Dubbed 'VOIP & WISP in a box', the hands-on programme was aimed at building capacity in technical and business/social entrepreneur skills, and was attended by some 40 delegates from 17 African coun-



### What's in a WISP?

Most internet service providers are not wireless. WISP (wireless internet service provider) comprises hardware and software as bundled components. In Africa where infrastructure is only just starting to expand, WISP can provide creative ways to grow infrastructure.

tries. Its purpose was to equip delegates with the necessary technical skills to deploy voice over internet protocol (VOIP) and WISP (wireless internet service provider) in a box, and the requisite training to apply the business models.

Morris comments, "This is the first time that we have brought technology and business partners together to think about sustainability. I think most delegates were challenged in preparing business plans and everyone supported the idea of providing low-cost voice and internet services in their communities.

"This is a great step forward in building community wireless networks and we look forward to the continued growth of the Wireless Africa Alliance."

This unique network unites like-minded supporters of community-owned networks. With a constitution to underpin its activities, partners in this alliance will share resources and expertise, and collaborate in finding solutions to Africa's communications challenges. An office has been set up in Ghana with an executive officer.

A Kenyan workshop planned for June 2009 will allow participants to give feedback on

Dr Adel El Zaïm, senior programme specialist of the IDRC at the Wireless Africa workshop in June 2008

the implementation of all three skills sets. Morris stresses, "To achieve lasting benefits, we will test and develop business models that support community-owned networks. Infrastructure supporting these networks is owned and/or operated locally."

## EARLY SUCCESSES

The Kenyan ICT Board has accepted the Wireless Africa project as one of its 10 key projects for the year. In Nigeria, an IDRC-funded project, ZittNet, will see wireless replicated in a neighbouring community supported by the telecoms commission. In Angola, ANGONET has been responsible for the rollout of ICT centres for government throughout the country. In Zambia, wireless technology will promote its e-health programme.

Morris concludes, "The R&D of this project will result in easily scalable and replicable use of these technologies with a high level of acceptance from end users. This, we believe, will provide sufficient motivation to influence policy makers and demonstrate the failure of the monopoly service providers in experimenting or allowing cheaper access technologies. Wireless Africa envisions the expanded use of ICTs in remote African locations." – Biffy van Rooyen

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# FURTHER AFIELD

INTERNATIONAL RESEARCH AND DEVELOPMENT (R&D) ENABLES THE CSIR TO CONTRIBUTE TO THE GLOBAL POOL OF KNOWLEDGE, ACCESS OPPORTUNITIES FOR STRENGTHENING THE SCIENCE, ENGINEERING AND TECHNOLOGY BASE AND CONTRIBUTE TO FINANCIAL SUSTAINABILITY. IT ALSO ACTS AS AN IMPORTANT BENCHMARK OF RELEVANCE AND QUALITY.

“INTERNATIONAL R&D ACTS AS AN IMPORTANT BENCHMARK OF RELEVANCE AND QUALITY.”

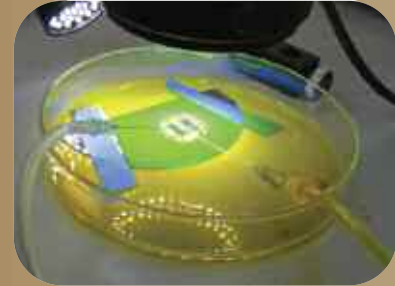
The European Union (EU), the USA, China, France and the UK are the top foreign countries from which the CSIR has secured contract R&D. Effort will go into building on this track record and expanding our reach.

The CSIR is a founder member of the Global Research Alliance, a network of some 50 000 scientists and engineers with expertise in a wide range of disciplines.

The organisation is analysing its international contract R&D partners and is targeting specific multinational corporations with which to develop strategic partnerships. The aim of these partnerships is to move towards more strategic multi-year collaborative R&D.



The completed moulding process for levels two and three of the cell capturing device. Each of the 'blocks' inside this sphere contains four 1mm sized cups, of which the membrane is approximately 150µm. Each block was cut out and is used separately in the cell capturing device



An experimental set-up of a working cell capturing device. A fluorescent dye was used in one needle with the other needle being the pneumatic actuation needle

# MICRO-MANUFACTURING AT WORK TO DEVELOP A CELL CAPTURING DEVICE

**WHILE THERE ARE KNOWN METHODS FOR CAPTURING SINGLE BIOLOGICAL CELLS, RESEARCHERS AT THE DEPARTMENT OF MICROSYSTEMS ENGINEERING (IMTEK) AT THE UNIVERSITY OF FREIBURG, GERMANY, REQUIRED A TAILOR-MADE METHOD THAT WOULD SUIT THE NEEDS OF A PARTICULAR PROJECT.**

THE CSIR AND IMTEK are in the process to establish a collaboration that would see the two institutions working together on micro manufacturing projects. When the CSIR's Kevin Land, a senior researcher, visited Professor Jan Korvink's laboratory at IMTEK he was given the opportunity to assist with a large project by doing research on a specific, key component: manufacturing a cell capturing device that would suit IMTEK's specific needs.

Biological cells are very small and measured in microns (µm). A red blood cell, for instance, measures around 10µm to 12µm. To put this into perspective, a human hair is approximately 100µm thick.

"The basic specification was simple: build a device capable of capturing a single particle of 50µm (to be scaled down later) and hold it in a cup, where further tests can be performed on the cell," explains Land. While this sounds simple enough, keep in mind that the size of the cups that would hold the cells are between 100µm and 800µm wide, with the entire cup (including its outer shell) only 1 mm in diameter.

Designing the device started off with a concept, after which Land used mechanical design software to build the concept into a virtual model.

"We settled on a design that would require a four-level structure," says Land. "Level one, the bottom layer, consists of a set of four round cups fabricated from a silicon substrate and photo resist. Level two is a gap between the top and bottom cups. Level three consists of the top cups, which are required to initially capture the cells and then be actuated so that the cells flow into the bottom cups. The final layer is the actuation layer that consists of an air chamber, which is used to move the top cups up and down as required."

A process called soft lithography was needed to manufacture levels two and three of the device. In this process one manufactures a mask that contains all the tiny ridges and holes needed in order to make the required mould. A low cost mask is printed on a thin transparent film using a photo plotter.

Land explains how it is done: "One uses a process called spin coating to put a 100µm layer of photo resist on a silicon wafer. Then you illuminate the photo resist with an ultraviolet light through the mask. Where the light hits the surface it hardens the photo resist, keeping the unexposed areas soft. The next step is to bake the wafer and place it into a developing liquid that strips off the soft sections of the photo resist while the harder sections remain. In this way you have a mould made of silicon and hardened photo resist. It is only then that you pour polydimethylsiloxane (PDMS) over the mould, cure it in an oven and peel the PDMS off the mould. In this way a functional component is made."

Once all the parts have been put together, the cell capturing device is tested. Actuation of the device works with pneumatics (air pressure). Cells literally get sucked into the different cups by the opening and closing of these through this pneumatic actuation.

"Our device worked, and what was remarkable is that we achieved it within a matter of two weeks," says Land. "There are some hiccups to sort out but we laid a basis for future work to continue and have gained valuable experience that would assist greatly with any future collaboration with IMTEK. The biggest challenge is to integrate other components, such as sensors, into the device."  
- Petro Lowies

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# THE HUNT FOR STRONGER, BIODEGRADABLE COMPOSITE MATERIALS



IN CHINA, A GROUP OF SCIENTISTS IS WORKING ON FINDING NEW BIODEGRADABLE POLYMERIC MATERIALS. THEY HAVE ALREADY FOUND BIOPOLYMERS THAT GREATLY ASSIST RESEARCHERS AT THE CSIR IN THEIR TASK TO FIND BIO-COMPOSITES WITH IMPROVED PROPERTIES SUCH AS BETTER MECHANICAL AND THERMAL BEHAVIOUR. THE COLLABORATION IS ALSO TEACHING THE CHINESE A BIT MORE ABOUT NATURAL FIBRE-BASED COMPOSITES AND THEIR APPLICATION IN VARIOUS FIELDS.

Dr Babu Rao Guduri, who works in collaboration with colleagues at the Sun Yat-sen University (SYSU) in Guangzhou, China, to find new, biodegradable composite materials

THE CHINESE, especially those at Sun Yat-sen University (SYSU) in Guangzhou, with whom the CSIR's Dr Babu Rao Guduri works, are experts at finding new biomaterials. Most of their work focuses on making new polymeric materials for fuel cells. They do not, however, know as much about natural fibres or how to use it together with polymers in order to find new, better composite materials. Fortunately, for both the Chinese and the CSIR, the three-year, National Research Fund-funded collaboration is working out well, so that both sides benefit from it.

Guduri is a biocomposites scientist with the task to find new, biodegradable composite materials. He explains why: "As the world becomes more environmentally aware, the drive towards eco-friendly products and materials becomes stronger. We have to rethink the materials we use for packaging, building and manufacturing so that, when these materials reach the end of their natural lives, they would simply be absorbed back into the earth without harming the environment."

Composites are materials that are formed by mixing two or more materials, one of which generally is a polymer (popularly referred to as 'plastics'). This is done to make stronger, better materials that can be used in all kinds of applications. Unfortunately, most compo-

sites are not biodegradable and therefore very environmentally unfriendly. This is especially the case with glass fibre composites, one of the strongest composite materials around.

Biocomposites on the other hand – sometimes referred to as 'green' composites – are biodegradable. Their drawback is, however, their lack of strength. It is Guduri's task to research the optimum mix of natural fibres and biopolymers (polymers that actually are biodegradable) to find a biocomposite that has properties similar to that of glass fibre composites.

During a recent visit to Sun Yat-sen University, Guduri premixed samples of natural fibres and biopolymers on which he wanted to work and characterised the biocomposites in the laboratories at Sun Yat-sen University. These laboratories have advanced equipment for scanning electron microscopy, dynamic mechanical analysis and for measuring mechanical properties. "I also brought back samples of some of their new biocomposites, which I now use for more biocomposite experiments," he says.

The characterisation bit is important as part of Guduri's work involves fibre and polymer modification. "One needs to understand exactly what characteristics both the fibre and polymer being used display before

being mixed, and how that has changed after the mix," explains Guduri. "Natural fibres, for instance, are hydrophilic. This means that they absorb moisture easily, which creates problems when you need them to bond with a polymer matrix. We therefore attempt to modify the fibres in order to make them less hydrophilic."

The same goes for the polymers. Here Guduri mentions as an example polylactic acid, which is very brittle. "Here, too, we have to modify the polymer. By adding a more elastic polymer as a blending material we can make the polylactic acid less brittle."

One very tangible example of how Guduri's research will be applied involves Boeing, the international aeronautical company. Boeing's overhead lockers, the ones passengers use to stow their hand luggage during a flight, is currently made of a glass fibre material.

Guduri is working on finding a biocomposite material that mixes natural fibres and a special fire-resistant polymer, with the specific aim of replacing the glass fibre material of the overhead lockers. – Petro Lowies

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Dr Babu Rao Guduri (front, fifth from left) with a group of students at the Institute of Energy & Environment Materials, Sun Yat-sen University (SYSU) in Guangzhou, China

# STIMULI-RESPONSIVE POLYMERS HELP WITH CELL CULTURING

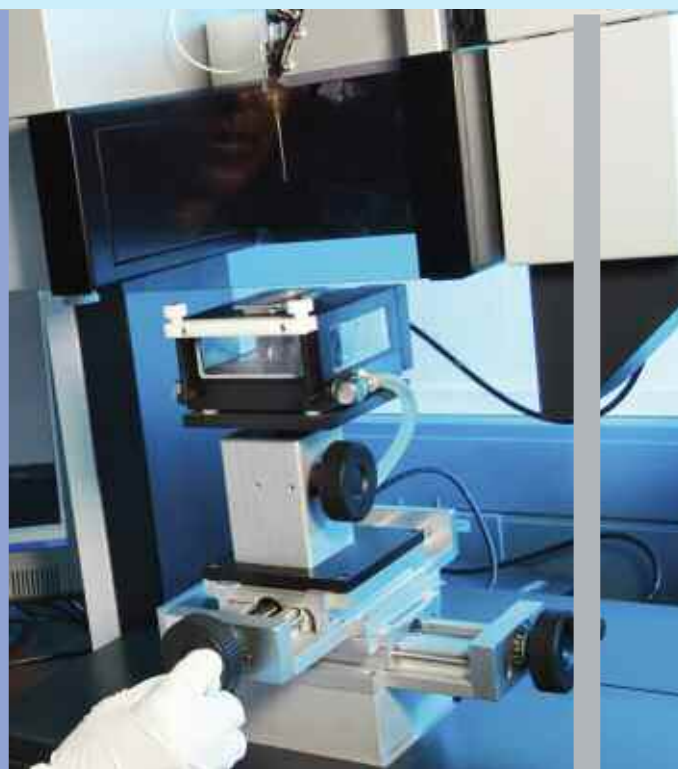
IS IT POSSIBLE TO CULTURE HUMAN CELLS WITHIN A LABORATORY ON A MASS SCALE, WITH AS LITTLE HUMAN INTERVENTION OR EFFORT AS POSSIBLE AND WITH THE EXACT CONDITIONS FOR THESE CELLS TO FLOURISH? THIS IS THE FUTURE TOWARDS WHICH RESEARCHERS AT THE CSIR AND THE BUDAPEST UNIVERSITY OF TECHNOLOGY AND ECONOMICS (BUTE) IN HUNGARY ARE WORKING.

Avashnee Chetty working in her laboratory on stimuli-responsive polymers

TRADITIONALLY, WHEN SCIENTISTS want to culture human cells for eventual implantation into the body or for testing of new drugs, they do so in a petri dish. It is a time-consuming process that is tedious as well as prone to contamination and human error, not to mention that one usually needs at least  $10^{6-10}$  cells, which can take weeks to achieve. The conditions in which these cells have to grow are not ideal either. A petri dish is a flat surface, as opposed to the human body where cells grow in three dimensions (3D).

"This means that the cells in a petri dish do not grow in the ideal clusters they would have, had they been grown inside the body itself. When this happens they don't 'communicate' with each other well enough, which is necessary to know what kind of cells they are, and without which they will lose some of their activity - if you are growing bone cells, their communication will tell them that they should act and grow as bone cells. The same goes for myocardial (heart) cells, skin cells or any other kind of human cell," says CSIR polymer scientist Avashnee Chetty.

Chetty has been working closely with scientists from the BUTE on a programme to develop a novel, 3D scaffold for cell culturing. The ultimate aim is to develop a high-throughput cell culturing device that would eliminate the human factor in cell culturing as much as possible, and allow cells to grow in an envi-



ronment that far better resembles conditions within the human body.

"The first step was to find a way to release cells from the surface on which they have grown without damaging them. Cells that grow in a petri dish produce proteins that anchor them to the surface. Old technology dictated that, to free the cells, these proteins had to be degraded, which harmed the cells and made them separate. This led to poor quality cells and poor communication between them."

To eliminate this drawback scientists started to use stimuli-responsive polymers, also referred to as 'smart materials', in a coating on the petri dish to which the cells could bind. These are materials that respond to stimuli within their environment and then change their surface properties accordingly. The stimuli could be changes in temperature, pH, magnetic or electrical fields, and the effect is reversible. Chetty's research concentrated on a temperature sensitive polymer to which the cells could bind on a surface and, when the temperature is changed, would release the cells without harming them. In this way one can harvest and release cells by merely changing the temperature of the media, and without damaging the cell's surface proteins. The BUTE scientists' expertise in hydrogels, polymerisation and characterisation came in particularly handy at this point.

The temperature sensitive polymer Chetty uses, either swells or precipitates in water when the temperature is either lower or higher than 33-34 °C; temperatures that are ideal for biological applications.

"The next step was to find a way that cells can grow in 3D rather than on a flat surface," she explains. "With the help of our CSIR fibres and textiles scientists we created a cotton-wool-like fibre mat that is porous yet with enough surfaces for the cells to bind to. The fibres are coated with the temperature sensitive polymer before the cells are allowed to grow on them. What happens now is that the cells attach onto the coated fibres, and grow into the open pores created by the fibre-web, in clusters in the way one would want them to grow," explains Chetty. "Once the cells are fully grown, the medium and/or polymer is cooled to the right temperature and the cells are released from the fibre surface without damage."

The CSIR's bioscientists assist with the actual cell culturing. The group's research now focuses on optimising the process and, with a patent registration already filed internationally for the CSIR's high-throughput cell culturing device, Chetty is confident that the collaboration between the Hungarian and South African scientists has proven to be a success. – Petro Lowies

## Why would one need to culture human cells?

One application for culturing cells in a laboratory is for tissue-implantations. In many operations materials foreign to the body are used to replace damaged parts. Titanium, for instance, which is sometimes used in bone-reconstruction surgery. This, however, is not ideal. Neither is using the cells from a donor, where it is difficult to find a perfect match.

The perfect answer is to use a person's own cells, which could be grown outside of the body. This is already possible in skin and cornea implantations. New breakthroughs are now being made with respect to growing new heart muscle tissue, or tissues for other complex organs such as the liver or kidney.

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The CSIR's Avashnee Chetty is confident that an optimum method will soon be found for high through-put culturing of cells with minimal cell damage in a laboratory.



CSIR cyber forensic experts Jaco Robertson (standing), Marthie Lessing and Simon Nare

# COMPUTER SECURITY GETS ITS OWN RESPONSE TEAM

SOUTH AFRICA HAS BECOME PART OF THE GLOBAL VILLAGE, AND FOR MANY OF THE COUNTRY'S PEOPLE, THE INTERNET HAS BECOME A VITAL TOOL FOR CONDUCTING BUSINESS OR ACQUIRING NEW KNOWLEDGE. IT IS USED, AMONG OTHERS, TO FILE TAXES, UNDERTAKE BANKING TRANSACTIONS, BUY GOODS, ORDER PRODUCTS AND SERVICES AND TRACK LOGISTICAL STATUS OF TANGIBLES.

While the internet helps to make life easier and people have access to services at the push of a button instead of standing in long queues, it could be to the users' detriment if security issues are not heeded.

Estonians still remember vividly what happened in 2007 when the first digital intruders slipped into this Baltic country's cyberspace and brought it to its knees. Computers became foot soldiers in a cyber war as the bulk of the cyber assaults used a technique known as a distributed denial-of-service (DDOS) attack by bombarding the country's networks with data.

Against this backdrop, the establishment of a Computer Security Incident Response Team (CSIRT) in South Africa is gaining momentum. This capability, which could help to avoid incidents such as the one that hit Estonia, is sorely needed in South Africa.

Recently, CSIR safety and security experts met with their Finnish counterparts to share their experience and give advice. Finland has a computer security incident team in place. It is run under the auspices of the Finnish Communications Regulatory Authority.

CSIR cyber security researcher Jaco Robertson says there is a need for a CSIRT, "We are moving deeper into the information society as broadband penetration increases. Our key commodity has become information

and more of our lives revolve around information infrastructure," he says, adding that this has its downside. "We have to make sure that this infrastructure becomes more reliable and secure to use."

He alleges that malicious intent is an undeniable reality; and information and communications infrastructure is abused to commit criminal deeds. "Without a CSIRT, no one will be able to stop these criminals in their tracks," says Robertson. "What makes it more worrisome is that hackers from other countries can reach us just as easily as someone here in South Africa."

"Without wanting to sound alarmist, South Africa is a lot more vulnerable than the country should be, because it has no national level CSIRT. We use the same systems as the rest of the world and it is not impossible for hackers to create havoc," he says.

A CSIRT is a service organisation that is responsible for receiving, reviewing and coordinating responses to computer security incident reports and activity. It may perform both reactive and proactive functions to help protect and secure the critical information technology assets of an organisation or even the country.

The first large-scale incident was an internet worm that brought the whole internet to its knees in 1988 and according to Robertson,

this is when the first CSIRT was established at the Carnegie Mellon University in the US. Currently, Finland's networks are regarded as some of the safest worldwide.

"In South Africa, the weakest link is the user," says Robertson, adding, "Users are vulnerable because they overlook certain security measures such as updating their operating systems." Viruses, Malware, Adware and Trojans, easily affect the users.

"The other issue users should consider is Botnets. "This can turn a computer into a 'zombie' to become part of the Botnet," warned Robertson. "The user's computer can then be used for nefarious purposes by the controllers of the Botnet." He says the size of a Botnet ranges from a couple of PCs to a million of these machines. The biggest is known as the Storm Botnet. "Botnets are probably the largest threat to the internet's safety and security," he says. "This is the biggest problem that we need to solve."

Robertson says that Botnets are complicit in a wide range of malicious activities, ranging from spam, phishing and DDOS attacks. "This is the reason we are working with Finland to establish a CSIRT in South Africa," he concludes.

- Mzi Gcukumana

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# COLLABORATION TACKLES GRAND HEALTH CHALLENGE NO 9

"IN 1900, THE GERMAN MATHEMATICIAN DAVID HILBERT PRESENTED THE INTERNATIONAL CONGRESS OF MATHEMATICIANS WITH 23 UNSOLVED PROBLEMS. THESE WERE PROBLEMS HE BELIEVED COULD GUIDE MATHEMATICS RESEARCH OVER THE NEXT 100 YEARS ... RESEARCH INTO THESE PROBLEMS GUIDED 20TH-CENTURY MATHEMATICS AND LED TO SIGNIFICANT BREAKTHROUGHS IN TECHNOLOGY AND MEDICINE." THIS BEGAN FOUNDER OF MICROSOFT AND PHILANTHROPIST BILL GATES'S ARTICLE IN THE WALL STREET JOURNAL ON THE GRAND CHALLENGES FOR GLOBAL HEALTH (GCGH) INITIATIVE.



MATHEMATICIAN DAVID HILBERT'S insight into what would shape research in coming years, gave the impetus for the charitable Bill and Melinda Gates Foundation (BMF). In collaboration with three other partners, BMF established the GCGH in 2003.

GCGH awarded grants to 43 projects that addressed the 14 grand challenges identified. The funded projects address health problems that disproportionately affect the world's poorest people and which do not often attract the attention of medical research.

One such project is Africa Biofortified Sorghum (ABS). The international consortium led by Africa Harvest Biotechnology Foundation International from Kenya and including the CSIR and seven other research partners received in the region of US\$ 18.6 million over five years to develop a more nutritious sorghum for the arid and semi-arid tropical areas of Africa.

In this manner, the group of scientists from mainly Africa and the United States could assist in fulfilling the goal of grand challenge no 9: Creating a full range of optimal, bio-available nutrients in a single staple plant species.

### TECHNOLOGICALLY-SOUND RESULTS

"The CSIR's role in the ABS project is to generate the germplasm and develop a strategy to facilitate the use of the resultant technology by the end user. For example, each time we do work from a technical perspective we have to ask ourselves how will the technology impact the seed development and distribution to the poorest of farmers in sub-Saharan Africa and the rest of the developing world, most of whom do not have formal seed systems," explains Dr Rachel Chikwamba, the CSIR principal investigator on the ABS project.

"They usually retain the seed from a harvest and replant that same seed. The challenge of doing that is that the genes re-shuffle and re-mix. To address this, the team adopted technologies to cluster the nutrition genes together so that in the improved seed, these genes will not reshuffle. Vitamin A will serve as a visual marker to identify the seeds that farmers, using openly pollinated varieties, should retain," she adds.

"We are also challenged to think about how they process the grain and food and we design the technology to be compatible with all these aspects. This approach is necessary to ensure that technology developed is applicable to the target users," Chikwamba reveals.

"The one thing we do effectively with the end users is that in a research environment and through our project collaborative partner, the University of Pretoria, we process genetically modified strains to

check cooking quality and processing quality of the grain harvested from the genetically modified sorghum."

The project, now in its fourth year, will near the end of phase one in 2010. Phase two will deal with field trials to make sure that traits induced in the laboratory into improved sorghum seed will be present in agriculturally-grown sorghum.

### PROTECTING INTELLECTUAL PROPERTY

In the meantime, progress on the scientific research front has allowed the CSIR, in collaboration with another project partner, Pioneer Hi-Bred International Inc, to file applications for two inventions arising from work on this project.

This is a move that Chikwamba believes is in the best interests of the intended beneficiaries and overall project objectives.

"We need to protect the scientific innovations generated for humanitarian purposes, this is compliant with the global access strategy for humanitarian purposes," says Chikwamba.

"Intellectual property protection is extremely enabling, it allows us to protect discoveries that are translated into technologies to benefit the poor. If someone else patents in that area they could prevent you and your end users from using that technology. Farmers will not be asked to pay additional fees or a premium on the introduced nutritional traits. Again, this is compliant with the global access strategy for humanitarian purposes," she explains.

When the GCGH was established, no absolute definition of 'grand challenges' could be identified but they are regarded as a "specific scientific or technological innovation that would remove a critical barrier to solving an important health problem in the developing world with a high likelihood of global impact and feasibility."

Gates in his 2009 annual letter on the BMF web site acknowledges that "these investments are high-risk and high-reward. But the reward isn't measured by financial gain, it's measured by the number of lives saved or people lifted out of poverty." - Asha Speckman



**When the GCGH was established, no absolute definition of 'grand challenges' could be identified but they are regarded as a "specific scientific or technological innovation that would remove a critical barrier to solving an important health problem in the developing world with a high likelihood of global impact and feasibility."**

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# SPECIALLY DESIGNED HOSPITAL WARDS TO CURB TB INFECTION ON THE CARDS

SOUTH AFRICA FACES ONE OF THE WORST TUBERCULOSIS (TB) EPIDEMICS IN THE WORLD IN TERMS OF INCIDENCE - OR NUMBER OF CASES PER CAPITA - AND OVERALL TB BURDEN. RECENT STUDIES INDICATE THAT MORE THAN HALF THE TB PATIENTS ARE ALSO HIV-INFECTED, WITH THE CO-INFECTION RATE APPROACHING 75% IN SOME PROVINCES IN SOUTH AFRICA.

TUBERCULOSIS is an airborne disease, hence making it especially problematic in hospitals and clinics, which house immune compromised people. Infection control policies, standards and guidelines are all critical to effective healthcare services; they serve to protect the health of the patient and the healthcare worker.

The US President's Emergency Plan for AIDS Relief (PEPFAR) funds and provides technical expertise through US government organisations such as the Centers for Disease Control and Prevention. Several hundred governmental and non-governmental organisations in South Africa are PEPFAR partners, actively involved in the prevention, treatment and

care of people infected and affected by HIV and Aids, and one of the largest drivers of the epidemic, TB. The CSIR was selected as a PEPFAR partner in 2008 because of its expertise in infection control of airborne micro-organisms such as *M tuberculosis*, particularly in health facilities. Dr Sydney Parsons of the CSIR drives this project. He works closely with other PEPFAR partners and the South African Department of Health to strengthen TB programmes at all levels of government.

"In order to incorporate preventative design elements in hospitals and clinics it is essential to understand the dynamics of TB transmission. We investigate and propose minimum

controls and interventions that would minimise cross-infection of multi and extensively drug-resistant TB (MDR and XDR-TB). All these interventions are dependent on facility design and the CSIR has undertaken extensive research to fast track the construction of designs to meet the growing demand for specialised hospitals to treat patients with drug-resistant TB," explains Parsons.

The CSIR has not worked in isolation. Harvard University and the Medical Research Council are two other internationally-renowned organisations that have participated in the development of these facility-based approaches to preventing the spread of TB.



Dr Sidney Parsons

South Africa is a country of contrasts. There are major differences in the various healthcare facilities and the populations they serve. Factors such as economic resources, the organisation of healthcare services, service level, referral patterns, climate and geography contribute to these disparities. In response, the CSIR has researched and developed an appropriate generic design brief that can be used for all levels of facilities. This brief was developed to assist planners and designers of South African healthcare facilities and is fundamentally based on architectural engineering design guidelines.

“One has to connect the design of buildings with disease transmission without compromising operational procedures in hospitals; an in-depth understanding of how specialised design will affect maintenance of the health facilities is also necessary,” comments Parsons. He is assisted by colleagues with architectural science skills and healthcare facility

expertise. The team examines the functionality and design of hospitals and then models facilities through computer-aided-design and computational flow dynamic studies. “We do infrastructure modelling to determine the impact of airborne diseases transmission and how to control these in hospital spaces.

“Although the primary aim of our work has been to develop planning, briefing and design guidelines for the South African national Department of Health, these guidelines are so generic, they can be applied equally effectively in other resource-limited countries, particularly in Africa, to minimise the spread of TB in health facilities,” says Parsons. The guidelines include infection control standards for new facilities, how to renovate and upgrade existing facilities and operational protocols for managing and maintaining facilities. Parsons and the team also train provincial health facility staff on how to implement infection control processes to curb transmission of infectious diseases like TB.

The guidelines and integrated framework are being finalised in 2009. In addition, a set of complete standards for setting up new facilities for MDR and XDR-TB patients are being developed. These provide standards for newly-built facilities and for renovation of existing accommodation.

“The next step in this national effort is to provide seven of the South African provinces each with a 40-bed ward for treating MDR and XDR-TB,” explains Parsons. “We are excited to have reached this stage, which requires continued close cooperation at strategic, technical and development levels with the national and provincial Departments of Health and Public Works in order to deliver these specialised wards, built according to CSIR specifications, within the next two years.

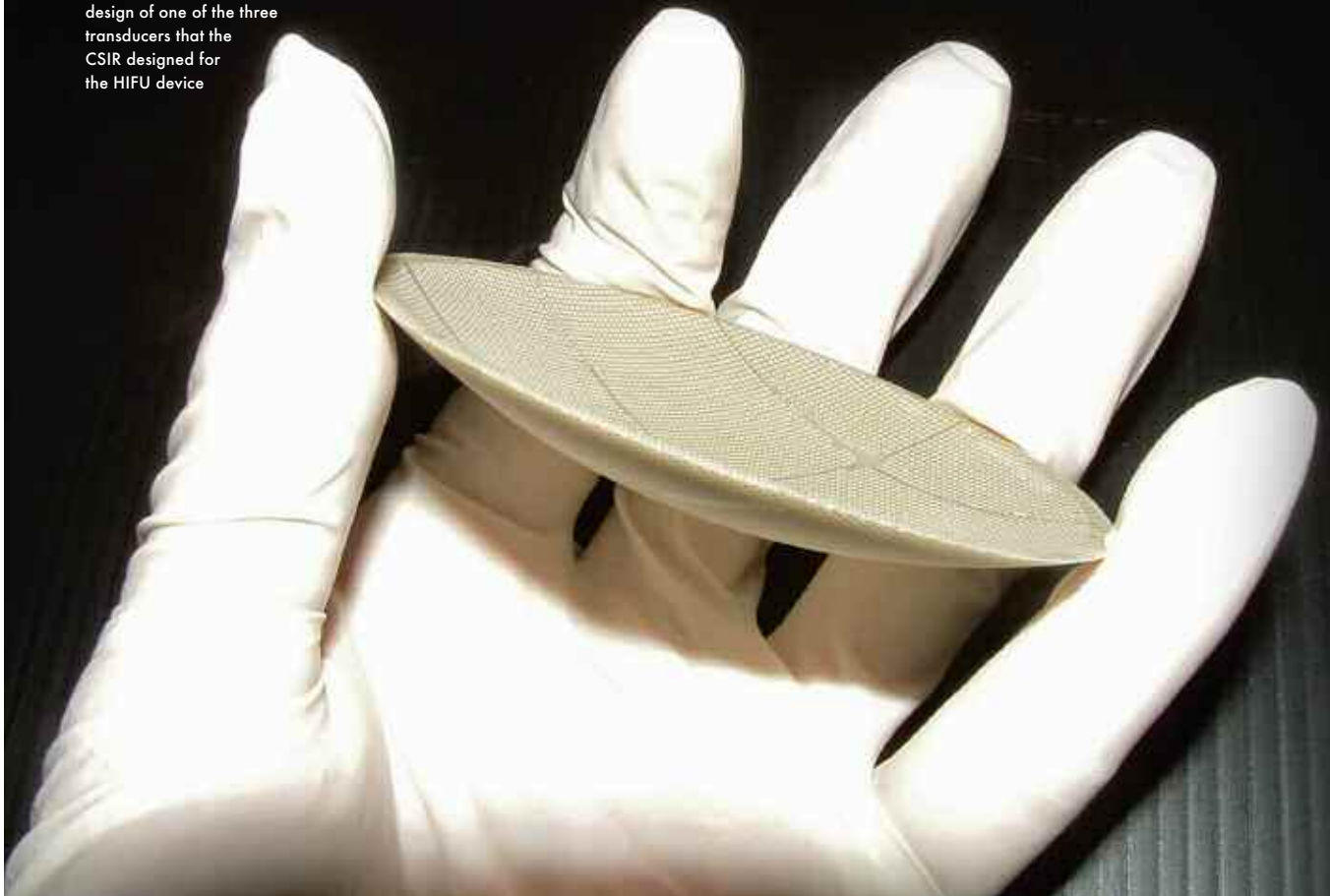
– Hilda van Rooyen

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# TREATING INTERNAL BLEEDING ON THE SPOT

THE MOST CRITICAL PERIOD OF TIME FOR THOSE SUSTAINING INJURIES IS THE MINUTES AND SOMETIMES HOURS THAT PASS BEFORE THEY ARRIVE AT A MEDICAL FACILITY. THIS IS EVEN MORE CRITICAL WHERE THERE IS INTERNAL BLEEDING PRESENT - EXACTLY THE TYPE OF INJURY A PARAMEDIC IN THE FIELD CANNOT DO MUCH ABOUT.

The piezocomposite concave disk used in the design of one of the three transducers that the CSIR designed for the HIFU device





The team from the University of Washington conducts trials using the CSIR-designed transducers for high intensity focus ultrasound

Medical facilities, even most field hospitals these days, have sophisticated methods of successfully dealing with internal bleeding. Out in the field, however, medics are mostly powerless to stop it. If a way could be found to treat the exact area where the haemorrhaging occurs, many lives could be spared en-route to more sophisticated medical care. It is this problem that had the United States (US) military thinking of a transportable device that would be able to treat internal bleeding on the spot, right there on the battlefield, before the injured soldier is transported to a medical facility. They turned to a technology that has been in use in the medical field, albeit mostly experimentally, for some years – high intensity focused ultrasound (HIFU).

RESEARCHERS at the University of Washington (UW) in Seattle, USA, tackled the problem in partnership with Siemens and Philips. In a collaboration with UW, scientists at the CSIR assisted by developing transducers (devices that convert electric pulses to ultrasound waves) that could interface with UW's electronics and be used in deep tissue bleeding experiments.

"For many years HIFU was used to destroy kidney stones. The only other approved application for it in the medical field is for the treatment of prostate cancer, while currently approval is also being sought for the treatment of pancreatic cancer and uterine fibroids," says CSIR physicist Nic Nicolaides.

He explains how HIFU works: "Ultrasound waves are directed towards a specific point within the body where it very rapidly heats up the diseased or injured tissues. Temperatures within the tissue rise to above 70 °C, causing biological tissues where the ultrasound is focused to shrink and fuse together, stopping bleeding. It is a very precise, non-invasive way of treating the patient, which means you do not have to make cuts to reach the area in need of help and no area is damaged other than the targeted tissue."

The focal length of the transducers of the HIFU model used by the UW researchers needed to be adjusted manually. A better solution would be if the focal length could be adjusted electronically, thereby limiting the possibility of harming the surrounding tissue and minimising the radiation time.

"We developed three types of transducers with which UW could experiment. These transducers were tested in the US by UW during clinical trials. One particular transducer model outperformed the other models in these experiments," says Nicolaides. "Our particular interest is not just defence, however, as South Africa has a high incidence of blunt trauma in its civilian population. This technology is being evaluated with a view to one day being used by our emergency response personnel for civilian care."

The CSIR team working on the transducers consisted of physicists and electronic engineers. The challenge facing the Americans now is to automate the bleeding detection and treatment and to make the HIFU device portable enough for a medic to carry. "We would like to thank Professor Shahram Vaezy and his team from the University of Washington for their collaboration and technical contribution and for the funding assistance from Armscor and the South African Military Health Services," concludes Nicolaides.

– Petro Lowies

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Ndeke Musee explains the process of his research to Linda Godfrey

# HEALTH, SAFETY AND ENVIRONMENTAL EFFECTS OF NANOTECHNOLOGY EXPLORED

BY NDEKE MUSEE AND LINDA GODFREY

**NANOMATERIALS HOLD ENORMOUS PROMISE FOR MORE ENERGY AND MATERIAL-EFFICIENT PRODUCTS AND PROCESSES. THESE INCLUDE POTENTIAL EXCITING NEW OPPORTUNITIES IN ENVIRONMENTAL CLEAN-UP AND WATER TREATMENT PROCESSES.**

OTHER NOVEL INDUSTRIAL applications of nanotechnology include nanoelectronics, molecular assemblies, tissue engineering, biomedicine, nanocomposites and cosmetics. Presently there are over 800 company-identified nanoproducts globally. The anticipated rapid increase in the production of nanomaterials in coming years makes it more likely that living organisms will be exposed to these materials.

The South African government has committed considerable research funding in support of



fundamental research in nanotechnology fields ranging from energy, water, health, chemical and bio-processing, mining and minerals as well as advanced materials and manufacturing (South African National Nanotechnology Strategy, 2004).

There is, however, growing consensus among scientists, government officials, legal experts and civil societies, both locally and internationally, that responsible growth of the nanotechnology industry requires a clear understanding of the public health, safety and environmental (HSE) – nano-HSE – implications of the technology, from the point of production to safe disposal of nanomaterial wastes.

The CSIR's natural resources specialists have been tasked as lead agents in the establishment of a nano-HSE research platform, which includes local and international research partners.

The alliance with international specialists provides opportunities for north-south research collaboration, information exchange and capacity development.

In view of potential human and ecological health consequences of nanomaterials, and as South Africa aims to exploit the numerous benefits of nanotechnology, it becomes critically important to ensure that the health, safety and environmental aspects of this new technology are addressed at its infancy phase.

### PARALLEL RESEARCH

It is for this reason that the South African Department of Science and Technology has established a parallel research initiative in support of understanding the effects of nanotechnology-enabled materials and products.

The first South African Workshop for Nanotechnology Risk Assessment will be held in Pretoria from 30 March to 1 April 2009. The objective of the workshop is to promote the exchange of knowledge between local and international stakeholders on the health, safety and environmental implications of nanomaterials.

Global leading scientists in nanotoxicology, who have experience in establishing national risk assessment programmes related to this

field of research, will be invited speakers at this workshop.

The workshop provides a unique opportunity for diverse stakeholders in South Africa's nanotechnology industry – scientists, government, regulatory agencies and industry – to contribute towards a common understanding of the highest priority areas of concern in nanotechnology risk assessment and the best practices to address these concerns.

Invited local and international specialist researchers who will be participating with the CSIR on this project include Professor Günter Oberdörster, Professor of Toxicology in Environmental Medicine at the University of Rochester, New York (USA); and Professor Kai Savolainen, Professor and Director of New Technologies and Risks at the Finnish Institute of Occupational Health (Finland), and Professor Mary Gulumian of Pathology at the University of Witwatersrand (South Africa).

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# ANALYSING WATER OPPORTUNITIES TO PROMOTE DEVELOPMENT

WATER AVAILABILITY AND SUSTAINABILITY HAS BECOME A HOT TOPIC AMONG MANY WATER SCARCE COUNTRIES. GROWING ECONOMIES AND POPULATIONS SUPERIMPOSED BY CLIMATE CHANGE, REQUIRE DECISION MAKERS TO HAVE NEW TOOLS TO SUPPORT SOCIETAL DEVELOPMENT AND MAINTAIN KEY SERVICES.

AN OBVIOUS SOLUTION to the concern of water availability and sustainability is to conserve whatever water there is and use it sparingly. However, a challenge with this approach is that in certain regional contexts water sources are shared by numerous countries.

This creates problems when it comes to the sharing of water due to a sense of entitlement.

The CSIR and its African and international partners have developed a contextual frame-

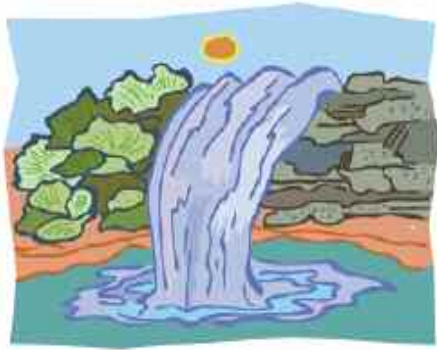
work that can be used by stakeholders concerned for the development and management of shared freshwater resources. This framework is called the Trans-boundary Waters Opportunity (TWO) analysis.

"Trans-boundary waters relate to water or benefits that passes national borders but also economic, policy, trade, social, cultural, environmental and knowledge boundaries," says the CSIR's Dr Marius Claassen.

He says the CSIR partnered with the Stockholm International Water Institute (SIWI) and

Phillips Robinson and Associates to develop approaches to support benefit sharing in this trans-boundary context. A memorandum of understanding between SIWI and the CSIR strengthened this relationship and funding support through the Swedish-South African bilateral agreement on science cooperation gave momentum to the initiative.

"The story of ancient civilisations and human development is also a story of water. Through the ages, the distribution of humans has been defined by the proximity to water," says Claassen.



**Characterise the resource**



**Identify socio-economic activities**

Claassen explains that the Roman Empire changed this in the 7th century BC, when it built aqueducts to move water to preferred settlement areas. This trend has continued, with massive infrastructure investments now moving water within and between countries.

"It is this movement of water and the benefits associated with its use that is a critical driver to social and economic development."

The objective of the TWO analysis is to promote the sustainable and equitable use of trans-boundary water resources, and to clarify trade-offs relating to development. "The framework outlines a concept for analysing potential benefits in a trans-boundary river basin to optimise economic growth, political stability and regional integration," says Claassen.

The conceptual framework is intended to be used by basin state governments, regional economic communities and financing entities.

Claassen explains that the TWO approach characterises the availability of water and then assesses the potential socio-economic activities that can be supported by the resource. There are three potential sources of water to support development.

'New water' can be introduced to a basin through desalination technologies, interbasin transfers or other means of adding water to the inland water cycle. Water can also be made available through more efficient use of water. Thirdly, some basins have surplus water that can be put to productive use. The assessment of socio-economic development options includes hydropower, primary production, urban and industrial use, tourism and aesthetic use.

"The different potential combinations of water sources and water uses are presented as development scenarios. The costs and benefits of these scenarios can be considered to select the options that will contribute most to regional social and economic development," explains Claassen.

The TWO approach was recently used in the Nile basin, where participants remarked on its utility to identify and distribute benefits, something that the Nile Basin Initiative has been aspiring to for more than a decade. The South African Development Community Water Sector (through GTZ) recently appointed the CSIR to implement this approach in the region, with a particular focus on the Orange-Senqu basin.

"The TWO concept builds on lessons learned by the researcher from engagement in, for example, the Nile and Jordan basin processes. In the Nile case the TWO framework may provide a structured approach for the riparian countries to continue exploring TWO in the basin as a whole and in sub-basins," says Jakob Granit, project director of Stockholm International Water Institute.

"The Baltic Initiative in Europe is also considering the approach, which will be a first for developed countries," Claassen concludes.

- Kamogelo Seekoei

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Dr Marius Claassen



## Assess and distribute benefits



# COUNCIL AIMS TO TAKE GRAPES TO GLASS IN OPTIMAL WAY

WITH THE WINE INDUSTRY BEING VERY COMPETITIVE INTERNATIONALLY, WINERIES NEED TO ALLOCATE THEIR RESOURCES IN A WELL PLANNED MANNER.

LOGISTICS ISSUES AT WINERIES were one of the factors leading to the establishment of the international Wine Supply Chain Council (WSCC).

The members of this research network look at improving international supply chains for wine, while sharing the results of their research. One of the major aims is to use opportunities of making the wine supply chain as lean as possible.

Established in 2006, the WSCC's member organisations are the CSIR in South Africa, CSIRO Australia, the Catholic University of

Chile and the Georgia Institute of Technology in the USA. The latest member to join towards the end of 2008 was the National University of Cuyo in Mendoza, the most important wine-producing region in Argentina. South Africa is represented on the WSCC by CSIR supply chain analyst, Dr Esbeth van Dyk.

Research conducted by members of the WSCC focuses on a number of issues, namely:

- The elimination of waste: This includes double-handling, such as moving wine among tanks and repacking bottles.

- Management of variability: Process time variability means downstream customers must protect them with safety stock, which is an additional expense, or endure stock-outs.
- Synchronisation and alignment: All participants in the supply chain must coordinate to match production with consumption. This is especially challenging in the case of wine because production depends on unforeseeable factors such as weather.
- Continuous improvement: Processes must be in place to constantly review and evaluate supply chain performance as a whole, and not just the independent enterprises along the chain. The supply chain must also look ahead to new challenges, such as carbon-based costs.

Each WSCC member organisation undertakes one or more research projects, on which they report back during the annual workshop of the WSCC. The last workshop was held in January 2009 at the CSIRO in Australia. Broad themes dealt with were variability in wine supply chains; wine supply chain planning and scheduling; and sustainability and wine supply chain futures. "This year, interesting research that we could learn from included grape maturation forecasting using statistics and meteorological data, and innovation opportunities in bulk wine transport," says Van Dyk.

## DECISION-SUPPORT

At the workshop, Van Dyk presented the research of an MSc student from Stellen-



The CSIR's Dr Esbeth van Dyk (right), with MSc student Adri van der Merwe and main supervisor Professor Jan van Vuuren of Stellenbosch University

The CSIR's Dr Esbeth van Dyk

bosch University whom she is co-supervising, Adri van der Merwe, on a decision-support system for a South African winery. Professor Jan van Vuuren of Stellenbosch University is her main supervisor.

For the CSIR research, the focus was on scheduling problems experienced at a typical South African producer cellar. A producer cellar is a winery where the grapes are received from a number of producers who are members of the cellar, as opposed to an estate winery where all grapes are grown by the winery itself. Wamakersvallei Winery in Wellington was selected as a case study. Some 80 different suppliers, each with a number of vineyards, deliver grapes to this cellar after harvesting.

If grapes from too many vineyards are received in one day, a bottleneck can occur at the cellar. "The main objective of the research project was to design a decision-support system that could assist the group of winemakers and viticulturists to draw up a schedule for grape intake over a specified number of days. The decision-support system takes into account the same data and factors usually considered by the winemaking group," comments Van Dyk.

The scheduling problem consists of two components, namely harvest scheduling and cellar scheduling. The aim of the harvesting schedule is to group vineyard blocks to be harvested as close as possible to their optimal ripeness without causing intake bottle-

necks at the cellar. Tabu searches (see block) have been implemented to draw up a good harvesting schedule and determine a feasible cellar schedule. An optimality score is calculated for each candidate harvest solution considered. The score combines the number of blocks harvested within their optimal sugar level period with an additional feasibility score, which is calculated by the cellar scheduling problem. The feasibility score represents the likelihood that the amount of grapes scheduled for harvesting on that specific day will not result in any bottlenecks in the cellar.

Wamakersvallei Winery will receive the CSIR research results as a decision support system to save time and effort during the busy harvesting season.

## COLLABORATIVE RESEARCH

In a collaborative effort, the WSCC partners have a joint research project on tracking the variability of temperature within cartons of wine along international supply chains. At production points in participating countries – including South Africa – temperature-recording devices are inserted in cartons of wine. At the point of destination the devices, which record time and temperature at two-hourly intervals, are retrieved.

"Four wineries in South Africa are involved in this project. We monitor wine sent to the USA and Sweden, with the latest destination of a consignment being Scotland," says Van Dyk.

**TABU SEARCH is a mathematical optimisation method, belonging to the class of local search techniques. It enhances the performance of a local search method by using memory structures: once a potential solution has been determined, it is marked as 'taboo' ('tabu' being a different spelling of the same word) so that the algorithm does not visit that possibility repeatedly. (www.wikipedia.org)**

Researchers correlate time with location by interpolating data collected along the supply chain. The aim is to try to understand the causes of temperature variations, while variations in transit time are also documented. The history of measurements is shared with all collaborators. "Each participating winery sees its own raw data but only the aggregated, anonymous data of others," explains Van Dyk.

This is not the first time that the effects of temperature on the quality of wine have been measured. What makes this project unique, however, is its scale, scope and duration. In addition to work on wine supply chains, future plans of the WSCC include other projects to help improve global supply chains in the areas of fruit and other high-value, temperature-sensitive perishables.  
- Hilda van Rooyen

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FARMERS HAVE RELIED ON SELECTIVE BREEDING FOR CENTURIES AS THEY SOUGHT TO IMPROVE CROPS, STOCK AND ENHANCE PRODUCTIVITY AS WELL AS RESISTANCE TO EXTREME CLIMATES. THEN, MODERN SCIENCE INTRODUCED GENETIC MODIFICATION, A TECHNIQUE OF MANIPULATING AND MODIFYING INDIVIDUAL GENES THAT CONTROL SPECIFIC CHARACTERISTICS FOR A PARTICULAR PURPOSE. MORE RECENTLY, THE CSIR'S DR LUKE MEHLO AND A RESEARCH PARTNER AT PIONEER HI-BRED INC IN THE UNITED STATES OF AMERICA, HAVE ADDED A NEW DEVELOPMENT TO THE SCIENTIFIC ANNALS ON GENETIC MODIFICATION.

# NEWER, BETTER, FASTER PLANT BREEDING THROUGH A COMBINED EFFORT

GENETIC MODIFICATION in plant biotechnology research is conventionally conducted using a variety of approaches, which include agrobacterium or applying a gene gun to shoot desired traits into plant cells. The latter is considered a more random process and does not reliably produce desired results of simpler integration patterns and single trait copies.

Mehlo and his co-researcher, Dr Zhao Zuo-Yhu, have developed two novel techniques of enhancing the efficiency of genetic transformation of plants for scientific research and plant breeding.

The novelty of Mehlo and Zuo-Yhu's inventions provides scientists with a deeper understanding of the cell cycle while another invention centres on the modification of using agrobacterium.

"Agrobacterium is a bacterium that is known to naturally transfer a segment of its DNA into plants for the purpose of synthesising nutrients for its survival," explains Mehlo, a plant biotechnology researcher.

**"Essentially, these scientists have invented a manner of recruiting somatic cells, and abundant callus, converting them into cells that can grow and give rise to multiple organs of a plant and regenerate the entire plant."**

Scientists noticed the wonder of this plant pathogen and found a way to exploit the bacterium for the purpose of transforming and transferring valuable genetic traits into plants as expression systems. "Scientists realised that they can replace the T-DNA, a segment of agrobacterium that is transferred to plant cells, with genes of interest so that when the bacterium comes into contact with the plant, it transfers genes of interest thinking its transferring its own DNA to create nutrients for its survival.

"Once these genes are integrated into the plant's genome, the plant uses its own machinery to reproduce and express in its own cells the trait genes of interest to scientists. However, to fulfil genetic modification, you have to conduct transformation and use enabling technologies," he says.

Essentially, these scientists have invented a manner of recruiting somatic cells, and abundant callus, converting them into cells that can grow and give rise to multiple organs of a plant and regenerate the entire plant – much like stem cells in an animal or human being. The second technology enables them

to use agrobacterium to transfer improved sorghum genes back into the plant by activating genetic sequences that are responsible for transferring the T-DNA.

## TRANSFORMING CELLS

Mehlo explains: "Plants contain different types of cells; somatic cells as well as germ cells that give rise to any tissue. What we did is to find a way of recruiting somatic cells, which usually do not play a greater function than forming the body of the organism, and converting them into pluripotent, totipotent and progenitor

cells. These are like germ cells and are equivalent to stem cells found in animals.

They then become flexible and can be redirected using hormones to form any cell type for the plant and eventually an organ, be it the leaves, flowers, roots or shoots. Plants possess a special quality not found in animals – the ability of a single cell to form an entire organism."

The second technology provides a new method and the materials for activating genes in agrobacterium that are responsible for the transfer of valuable traits inserted into agrobacterium.

"Cells sitting around the perimeter of agrobacteria respond to signals such as sugars and phenolic compounds to move their DNA into the plant. We have found a way of moving the genes that are found in sorghum into agrobacterium and then into the plant."

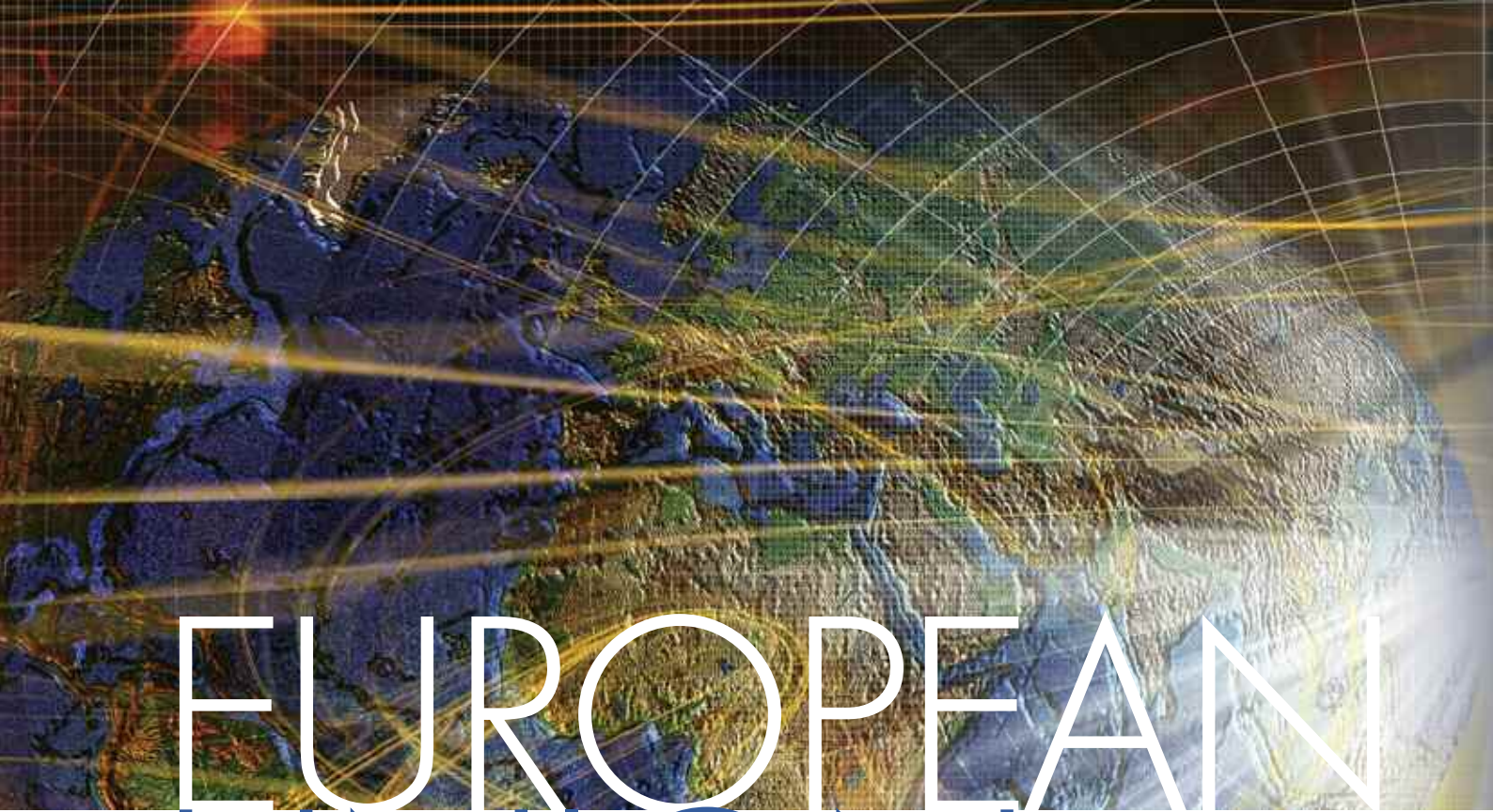
Mehlo and Zuo-Yhu met while working on the Africa Biofortified Sorghum (ABS) project, a humanitarian project funded by the Grand Challenges for Global Health initiative, a programme linked to the Bill and Melinda Gates Foundation. The project is currently in its fourth year of existence and is aimed at improving the nutritional content as well as protein digestibility of sorghum – a crop consumed as a staple by about 300 million Africans. Their inventions, for which they filed two joint patent applications in late 2008, arise from work on the ABS project.

"The combined inventions are aimed at enhancing transformation efficiency so that one achieves transformation events faster. We envisage this technology to be useful for genetic engineers and plant breeders who will on a charitable basis produce the seed for poor farmers – the sector targeted by the ABS project," says Mehlo.

All technologies generated under this programme will be protected through patenting.

– Asha Speckman

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# EUROPEAN UNION

THE EUROPEAN UNION'S (EU) FRAMEWORK PROGRAMMES (FPs) ARE THE MAJOR INSTRUMENT FOR FUNDING RESEARCH AND DEVELOPMENT IN THE EU AND BEGAN WITH FP1 IN 1984. FOLLOWING THE SIGNING OF THE SCIENCE AND TECHNOLOGY (S&T) AGREEMENT BETWEEN THE EU AND SOUTH AFRICA, THE LATTER BECAME ELIGIBLE TO COLLABORATE IN FP PROJECTS STARTING WITH FP4.

Since FP4, South Africa is one of the leading non-EU countries with over 200 participants in projects. This success has been greatly assisted by support in recent years from South Africa's Department of Science and Technology.

Involvement in the FPs plays a major role in developing the CSIR's science and technology expertise, enhancing human resource development and creating international networks.

FP7 will run until 2013 and includes nine high level themes, namely health; food, agriculture, biotechnology; information and communications technology; nanosciences, materials, new processes; energy; environment, climate change; transport, aeronautics; humanities; and space and security.

The Science and Technology-Europe Africa Project (ST-EAP) aims to strengthen S&T cooperation between African scientists and between African and European scientists. Although the geographical focus is on sub-Saharan Africa, ST-EAP seeks to create an increased awareness of the role of the EU FPs. The partnership between the African Academy of Sciences (in Kenya) and the CSIR contributes to the success of ST-EAP.

INVOLVEMENT  
IN THE FPs PLAYS  
A MAJOR ROLE  
IN DEVELOPING  
THE CSIR'S  
SCIENCE AND  
TECHNOLOGY  
EXPERTISE,  
ENHANCING  
HUMAN  
RESOURCE  
DEVELOPMENT  
AND CREATING  
INTERNATIONAL  
NETWORKS.

# COMMUNICATING BENEFITS OF E-INFRASTRUCTURE

IN LINE WITH ITS ROLE OF SUPPORTING THE DEPARTMENT OF SCIENCE AND TECHNOLOGY'S CYBERINFRASTRUCTURE INITIATIVE, THE MERAKA INSTITUTE OF THE CSIR IS PARTICIPATING IN BELIEF-II (BRINGING EUROPE'S ELECTRONIC INFRASTRUCTURES TO EXPANDING FRONTIERS - PHASE II)



Johan Eksteen



Dr Jeff Chen

SOUTH AFRICA'S MERAKA INSTITUTE, India's ERNET and Brazil's Escola Politécnica da Universidade de Sao Paulo have partnered with leading European institutions on BELIEF-II, a two-year project to support e-infrastructure (also known as cyberinfrastructure) projects. Funded by the Capacities Programme, a part of the EU's FP7, since April 2008, this project will strive to maximise synergies between research, scientific and industrial communities in specific areas relevant to e-infrastructure development and application. European partners include Metaware SpA, Brunel University, the Institute of Information Science and Technologies, and the National Kapodistrian University of Athens.

Building on the successes achieved in its first phase, BELIEF-II has as its strategic objective to coordinate the communication of the results achieved by all the e-infrastructure projects. This will be done through organising networking activities, and promoting those worldwide initiatives that could be of interest to future potential users. The project also produces an electronic e-infrastructure news magazine, 'Zero-In'.

Commenting on this participation, Johan Eksteen, manager of the Meraka Institute's technology research programme, notes, "South Africa's e-infrastructure is currently expanding on an almost daily basis. This is largely the beneficial outcome of the investment by the Department of Science and Technology in the Centre for High Perform-



## Belief

### Global Access Point To e-Infrastructures

ance Computing, the South African National Research Network, and the Very Large Database Initiative." He is joined on the project by Dr Jeff Chen of the Centre for High Performance Computing.

Eksteen is confident that this participation has boosted local activities in the e-infrastructure domain, and promoted integration with international e-infrastructure activities for the purpose of joint research and collaboration. "It is particularly important for grand challenges in a number of domains, such as medicine and health, and climate change, to name a few. e-Infrastructure, from high-end computing and broadband communication through to large-scale data issues, is no longer a luxury - it has become integral to our efforts in addressing these challenges."

Chen notes, "It is of huge value to us to participate in BELIEF-II, which has as its goal the promotion of synergy between e-infrastructure projects to promote national and regional initiatives, as well as mutual cooperation."

Additional goals set by BELIEF-II are to reinforce the relevance of e-infrastructure world-

wide, to sustain the successful development and exploitation of these globally, and to develop stronger cooperation links with emerging economies, specifically in Latin America, India and South Africa.

To achieve these goals, BELIEF II has provided a communication platform to allow e-infrastructure projects to manage content and communicate activities to users and the public, while serving as a unique access point for more information on e-infrastructures.

A number of events have been planned, such as international symposia for major decision makers, top researchers, scientific policy makers and industrial organisations, focusing on a future framework for a common agenda regarding e-infrastructure research in the world. Eksteen explains, "The first symposium took place during January 2009 in India. The second will follow during July 2009 in Brazil, and the third and final event will be in Cape Town, South Africa, during December 2009." - Biffy van Rooyen

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# WORKING TOWARDS SUSTAINABLE BIO-ENERGY DEVELOPMENT

ACCORDING TO GRAHAM VON MALTITZ, A SENIOR RESEARCHER AT THE CSIR, RISING FUEL PRICES, GROWING ENERGY DEMAND, CONCERNS OVER GLOBAL WARMING FROM GREENHOUSE GAS EMISSIONS, AND DOMESTIC ENERGY SECURITY HAVE LED TO PROMOTION OF BIO-ENERGY DEVELOPMENT IN GENERAL AND CROP BIOFUELS IN PARTICULAR. GOVERNMENTS IN INDUSTRIALISED AND DEVELOPING COUNTRIES ALIKE ARE SHOWING KEEN INTEREST IN RENEWABLE ENERGY SOURCES, PARTICULARLY BIOFUELS.

THE CSIR IS PARTICIPATING in an international project aimed at identifying options for sustainable biofuel production in developing nations. Funded by the European Union, the main objective of the initiative is sustainable bio-energy development that benefits local people in developing countries, while at the same time minimising negative impacts on local environment and rural livelihoods, and contributing to global climate change mitigation.

The three-year project, titled 'Bio-energy, sustainability and trade-offs: Can we avoid deforestation while promoting bio-energy?' is

led by the Centre for International Forestry Research in Indonesia. Other members of the consortium include the CSIR, Joanneum Research in Austria, the Universidad Nacional Autónoma de México and the Stockholm Environmental Institute.

While questions have been asked on the potential of bio-energy to compete with food crops, further analysis is needed to investigate other concerns, such as the potential impact of bio-energy development on forests and on those who depend most on the natural resources displaced by biofuels.

"The potential impact of bio-energy development on forests presents a significant challenge, due to associated social and environmental impacts beyond carbon emissions," Von Maltitz says. He points out that satisfying demand for bio-energy, given that fuel demands are so vast, will require major land-use changes.

"In some cases, new bio-energy crops may indeed be grown on degraded land. But in many other cases, bio-energy development may result in high levels of deforestation, which will have a major impact on biodiversity and other ecosystem services. In many



**“At national and global level, the capacity of policy makers in developing countries to develop policies and instruments for sustainable and equitable bio-energy development, based on scientific evidence, will be strengthened through consultative design and implementation of research, and through knowledge-sharing processes between countries.”**

parts of Africa, it is likely to displace customary land uses (grazing, fuel collection) independent of whether it leads to deforestation, placing an additional burden on women and the poor.”

Von Maltitz also points out that the current concentration on bio-energy development is largely ignoring the role of forests as a sustainable source of bio-energy for rural communities and industry. “Already, firewood and charcoal make up a major portion of energy use in sub-Saharan Africa, and play an important role in local livelihoods. We need to look at the nexus of forests and rural energy in the context of climate change mitigation and adaptation.”

In general, the production of bio-energy can provide an opportunity for many developing countries to diversify agricultural and forestry activities, reduce dependence on fossil fuels (mainly oil) and contribute to economic growth in a sustainable manner. Policy and decision makers in developing countries are in a key position to define national policies and their instruments for bio-energy development. However, the picture among developing countries is differentiated depending on environmental, economic and social context of each country. Thus, it is important to develop mechanisms for dissemination of

information and knowledge-sharing between the countries.

The EU project aims to inform bio-energy-related policies in both consumer and producer nations, to ensure that forest destruction and rural economic disempowerment are not unintended consequences of bio-energy development. The project will contribute to good governance by ensuring that the processes of decision making related to bio-energy development are participative, accountable, transparent and responsive to the present and future generations. “The views of minorities will be captured in formal research, and we will employ multi-stakeholder policy processes to ensure the voices of the most vulnerable in society are heard by decision makers,” Von Maltitz points out.

The project includes global analyses of different aspects related to sustainable forest-based bio-energy development. In addition, studies will be carried out in selected case study countries in South-East Asia, sub-Saharan Africa, and tropical Latin America.

“The selection of these countries will be carried out based on several criteria, including their potential for forest-based bio-energy development, past experience and availability of data,” Von Maltitz says.

Exchange of information and experiences will be organised through workshops and meetings at national, regional and global levels. In addition, the project provides information to relevant international policy processes, including the Intergovernmental Panel on Climate Change and the United Nations Framework Convention on Climate Change.

Von Maltitz points out that the project will strengthen capacity at several levels. “At national and global level, the capacity of policy makers in developing countries to develop policies and instruments for sustainable and equitable bio-energy development, based on scientific evidence, will be strengthened through consultative design and implementation of research, and through knowledge-sharing processes between countries. They will also be familiarised with the mechanisms for inclusive processes of decision making. This will enable them to capture and assess trade-offs associated with diverse policy options and inputs from diverse stakeholders, and develop socially-informed policies.”

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# ACHIEVING FLUTTER CONTROL IN FUTURE

Project FUTURE team members, from left, Louw van Zyl, Eric Wegman, Pieter Rossouw and Glen Snedden standing next to INKWAZI, the Presidential Jet at Denel Aviation.



FOLLOWING THE RECENT SUCCESSES IN MAJOR RESEARCH PARTNERSHIPS, INCLUDING THE EU'S SIXTH FRAMEWORK PROGRAMME'S VITAL PROJECT AND THE FLUID STRUCTURE INTERACTION PROJECT WITH AIRBUS, THE CSIR HAS BEEN INCLUDED IN **FUTURE** - AN EU FP7 PROJECT.

FUTURE brings together European and international centres of excellence. By advancing the state-of-the-art in flutter prediction capabilities and design rules, FUTURE will lead to decreased development cost, reduced weight and fuel consumption, and increased ability to efficiently manage flutter (a potentially dangerous oscillation of an aircraft or part thereof). The objective is to increase the understanding of the flutter mechanisms and improve the accuracy of numerical tools to increase the current design space by performing new experiments.

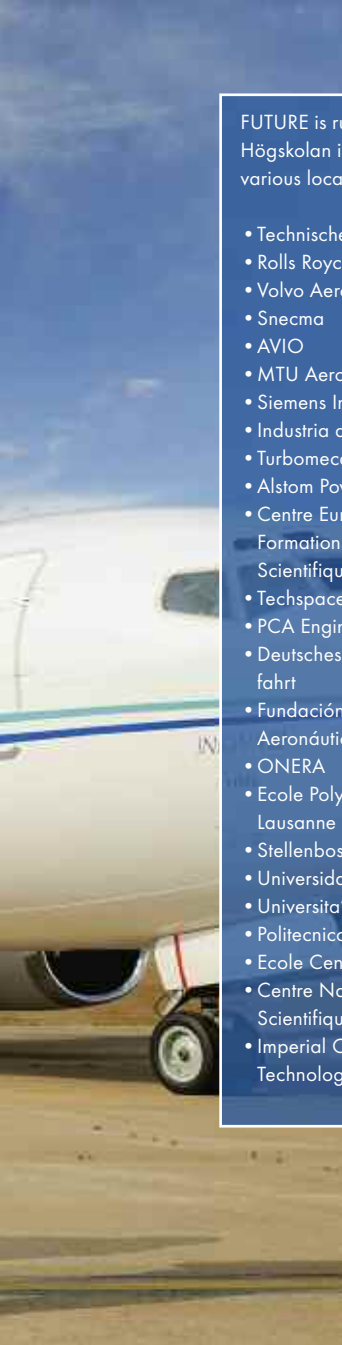
Flutter is one of the most severe failure modes encountered in design of modern turbomachinery and, as such, potentially impacts aircraft safety. It is estimated that although 90% of the potential high cycle fatigue (HCF) problems are discovered during development testing, the remaining problems account for nearly 30% of the total development cost and are responsible for over 25% of all engine distress events.

Flutter events impose large cost and programme delays since they are encountered

late in development when engines are tested in full power or in flight conditions. The US Air Force and Navy estimate that HCF-related problems are the leading cause of engine failure and cost approximately US\$400 million per year.

## A POTENTIAL SOLUTION

The CSIR and Stellenbosch University will be working with Volvo Aero and Darmstadt University to develop a novel flutter excitation system for the transonic compressor at Darmstadt University. This effort will use the



FUTURE is run by Kungliga Tekniska Högskolan in Sweden and involves various local and international partners:

- Technische Universität Darmstadt
- Rolls Royce
- Volvo Aero
- Snecma
- AVIO
- MTU Aero Engines GmbH
- Siemens Industrial Turbomachinery
- Industria de Turbopropulsores
- Turbomeca
- Alstom Power Ltd
- Centre Europeen de Recherche et de Formation Avancee en Calcul Scientifique
- Techspace Aero
- PCA Engineers Limited
- Deutsches Zentrum für Luft- und Raumfahrt
- Fundación Centro de Tecnologías Aeronáuticas
- ONERA
- Ecole Polytechnique Fédérale de Lausanne
- Stellenbosch University
- Universidad Politécnica de Madrid
- Università Degli Studi di Firenze
- Politecnico di Torino
- Ecole Centrale de Lyon
- Centre National de la Recherche Scientifique
- Imperial College of Science, Technology and Medicine

## MORE WORK ON FLUTTER-FREE AIRCRAFT

**Understanding aerodynamics at constant speed is relatively easy but with the introduction of agile air vehicles, engineers need to understand the forces affecting an object when it makes a fast turn.**

**CSIR scientist Igle Gledhill explains that the CSIR has worked with the Swedish Defence Research Agency for the past six years on manoeuvrability in flight. According to Gledhill, CSIR researchers are using Swedish code, and implementing new theories in it.**

**“Military aircraft need to change their paths much faster than they used to,” she says. “As we go into the future, we need more precise predictions of the aerodynamics. The work on agility, using the same code as the flutter, will contribute to this.”**

CSIR's expertise in developing flutter excitation equipment for aircraft, combined with turbomachinery knowledge at the CSIR and Stellenbosch University as well as the compressor test rig at Stellenbosch.

“Essentially, we need to know more about flutter margins in the increasingly long blades of the modern civil airliner engines, especially as the drive to higher propulsive efficiencies forces us to develop larger diameter engines, evident on the newer aircraft such as the Airbus A380,” says principal engineer and project leader Glen Snedden.

Snedden says that the reason Volvo Aero and the EU chose to involve the CSIR is that “we have recently developed a series of flutter exciters for light commercial aircraft and transonic military aircraft. Combined with the development of in-house FUTURE excitation

and prediction software, the CSIR has gained a reputation as a service provider to light aircraft developers, Grob and Diamond, mitigating the cost of maintaining this advanced technology.”

“Our part in Project FUTURE is to develop a system to excite the flutter mode of a fan blade into a test rig,” he says. “We are not doing anything on turbine design or compressor design; we are designing components that can disturb the flutter modes by integrating the excitation system.”

### PROPOSED METHODOLOGY

Reducing the rotor blade airfoil chords for a given flow path reduces the weight and cost of the rotor blade and has a large impact in the disk (through a reduction of the pull load) and the casing (through a reduction of the containment requirements). In addition, the number of rotor blades of the wheel is increased, boosting the blade-passing frequency and decreasing the perceived noise.

Unfortunately, the reduction on the blade's natural frequencies due to its larger flexibility induces flutter problems that require more sophisticated and accurate tools.

Exploring the research outcomes are expected to:

- Enhance the knowledge about turbomachinery aeromechanics
- Reduce the gas turbine time-to-market by 10% and development cost by 15%
- Reduce the aero engine maintenance cost by 3%
- Reduce the airline CO<sub>2</sub> emissions by 2 million ton per year through a decrease of 2% in fuel burn
- Contribute to the improvement of aircraft safety
- Improve teaching material in turbomachinery aeromechanics at the participating universities.

Snedden says that the project is very challenging because “we are dealing with excitation frequencies an order of magnitude higher than previously attempted.”

“Thanks to our experience, human capital and the scale and scope of the national aeronautical facilities, not least of which are the CSIR's eight wind tunnels, we are leading the pack in the Southern Hemisphere in terms of partnering for aerospace research and development,” he concludes. – Mzi Gcukumana

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**CROSS-  
BORDER  
INNOVATION  
IN LASER  
SCIENCE**



**HIGH-LEVEL RESEARCH IS INCREASINGLY COMPLEX, INTERDISCIPLINARY AND COSTLY, AND REQUIRES A CONSTANTLY GROWING CRITICAL MASS, AS WELL AS INTENSIVE INTERNATIONAL COOPERATION. THE BUILDING OF STRONG INTERNATIONAL RELATIONS IS ALSO SEEN AS CRUCIAL TO ACHIEVING AND MAINTAINING ENDURING AND EQUITABLE BENEFITS FROM SCIENCE AND TECHNOLOGY (S&T) FOR ALL SOUTH AFRICANS. STRONG RELATIONS WITH THE EUROPEAN UNION (EU) ARE UNDOUBTEDLY ONE OF SOUTH AFRICA'S MOST SIGNIFICANT STRATEGIES IN THE INTERNATIONAL ARENA.**

SOUTH AFRICA AND THE EU have enjoyed longstanding political, economic and development cooperation ties. The first inter-governmental agreement ever concluded between South Africa and the EU, the Agreement on Science and Technology Cooperation signed in 1996, gave South African researchers the opportunity to participate fully in the EU's framework programmes for research and development.

The CSIR was selected to lead India, China, Brazil, and Russia, (four of the world's top developing countries), in a collaborative two-year research project with a European partner. The project, termed EUDEVLAS (European Union-Developing Countries Laser Processing Initiative), aimed to promote European research collaboration and stimulate innovation in Eastern Europe, while benefiting developing country partners through dissemination of EU knowledge. The CSIR was responsible for leading the developing country aspects of the research, while the Europeans were led by Laser Zentrum Hannover, a top laser R&D centre in Germany. This project was supported (as a specific action) under the EU 6th Framework Programme.

"Europe, like the developing countries, has realised that the only way of combating unemployment (while maintaining environmental sustainability), is through the establishment of a competitive manufacturing industry," says the CSIR's Hardus Greyling. "Laser technology has proven its contribution as a leading edge tool in manufacturing," he adds.

Charl Smal of the laser centre says, "European researchers within project EUDEVLAS learnt a lot about the production, maintenance and logistic problems faced by emerging markets. They also noted new research approaches already taken by these players to face such challenges. In addition, the emergence of radically different, high-power, high-beam quality laser sources warranted further investigation. "Combining these two facets, this project succeeded in stimulating innovation in laser science, thereby radically changing the face of future manufacturing."

The project plan included the mapping of current and potential common interests in the field of laser material processing; undertaking a foresight study to indicate what technologies will grow in prominence over the next ten years; prioritising these interests; defining teams of excellence and lastly compiling project concepts and proposals for future collaboration. "This has led to the establishment of effective and lasting international teams of excellence in laser material processing R&D that can add real value to the European framework programmes," says Greyling.

He says that while the participating countries were already engaged in innovative research in laser materials processing prior to the EU project, "participation in this project was driven by the realisation of the value of R&D in economic development, as well as the need to establish competitive manufacturing industries."

**"Europe, like the developing countries, has realised that the only way of combating unemployment is through the establishment of a competitive manufacturing industry... Laser technology has proven its contribution as a leading edge tool in manufacturing."**

Smal concludes: "The European South Africa Science and Technology Advancement Programme (ESASTAP, a specific support action), implemented by the South African Department of Science and Technology and funded by the European Union, will continue to enhance the support available to both South African and European researchers to optimise mutual benefits from this partnership. Through enhanced networking and partnerships, scientists and institutions from the EU and South Africa can explore new and emerging scientific and technological areas together. They will be able to anticipate the future need for technology-based solutions and contribute to resolve major global issues. This bodes well for the future of developing countries." - Chiara Lincoln

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# ICT CONNECTIONS ACROSS THE GLOBE



BY TSHEPANG MOSIEA

**A CONSORTIUM OF EUROPEAN, AFRICAN AND CARIBBEAN PARTNERS ARE TRYING TO BRIDGE THE 'DIGITAL DIVIDE' BY PROMOTING COLLABORATIVE RESEARCH PROJECTS IN INFORMATION AND COMMUNICATIONS TECHNOLOGIES.**

One of the key challenges in Africa is the deployment of ICT infrastructure including internet connectivity, computers, mobile telephones and landlines. Massive inequalities can be found between access to ICT in the urban and rural areas, resulting in the now well-known 'digital divide'. This situation also extends to the connectivity of research groups in Africa and the Caribbean with their peers in Europe and elsewhere.

Although much has been done to bridge this gap in Africa, more improvement is needed for Africa to combat the scourge of the digi-

tal divide and take advantage of ICT benefits. Among others, the need exists to strengthen collaboration and networking between the sub-Saharan Africa and European organisations for ICT partnerships in the context of the EU's FP7, and to develop and deepen scientific and technological cooperation between the two regions.

Under a two-year EU-funded programme, a consortium of nine partner organisations – including the Meraka Institute of the CSIR – aims to improve the connections between ICT research organisations in Africa, the

Caribbean and Europe. The consortium partners are assisting such organisations in developing projects to access funding available for collaborative research under FP7.

FP7 is the EU's main instrument for funding research in Europe and runs from 2007 to 2013 with a budget of €50.5 billion. Of this, some €9.1 billion is earmarked for ICTs research.

Not surprisingly, most of this will go to European institutions. However, the EU is committed to increasing its funding for institutions in

developing countries and all of sub-Saharan Africa. However, researchers in these countries are often unaware of the available funding and the processes required in answering a call for proposals. For these reasons, the Meraka Institute and its EuroAfriCa-ICT partners will catalyse the formation of partnerships between institutions in Africa or the Caribbean with European institutions. This is being achieved through a series of inter-connected activities.

## AWARENESS WORKSHOPS AND CONCERTATION MEETINGS

The EuroAfriCa-ICT project began in January 2008 and will continue until December 2009. During the lifetime of the project, a series of small-to-medium-sized meetings is planned.

**Awareness workshops** are held in 'third countries' and are designed to provide information to local scientists on how to find potential project partners, use the facilities provided by EuroAfriCa-ICT project partners, build consortia and submit successful applications to the EU. The workshops also provide time for networking for discussion on projects between like-minded participants and experts from the consortium.

**Concertation meetings** are held in Brussels and tend to involve mostly representatives of European institutions and other EU or internationally-funded projects – as well as some representatives from African organisations. They are designed primarily to aid the exchange of information and promote networking.

To date, two workshops and two concertation meetings have been held. The workshops, held in Pretoria, South Africa, and Kampala, Uganda, attracted more than 150 local scientists and other ICT-for-development organisations. Three more awareness workshops are planned during 2009.

## PROMOTING FLAGSHIP PROJECTS

While the workshops and concertation meetings are designed to promote networking among the ICT community, a set of activities has been developed to identify and promote partnerships in ICT research and potential cooperation projects.

These include:

- The development of a EuroAfriCa-ICT mapping database
- The availability of support services
- Assistance with identifying partners
- The development of a EuroAfriCa-ICT community
- Links with other programmes.

EuroAfriCa-ICT project partners have now expanded a database of the key projects and institutions carrying out ICT research in Europe and sub-Saharan Africa to more than 450 entries, including some from the Caribbean. This is available from EuroAfriCa-ICT partners as a tailored list of possible collaborators.

The importance of such a tool with searching and mapping facilities allows a better understanding of current activities, participants, needs, partnerships and synergies.

EuroAfriCa-ICT helpdesks – based in France for Europe, Senegal for west Africa, Rwanda for central Africa, Uganda for East Africa, South Africa for southern Africa, and Jamaica for the Caribbean – provide assistance on the actual procedure of preparing and submitting applications in response to open EU FP7 calls for proposals.

EuroAfriCa-ICT partners are also identifying flagship projects, projects that involve partners from sub-Saharan Africa and/or the Caribbean as well as European partners, and are maintaining direct communication with the project leaders throughout the application procedure.

A number of other international cooperation programmes on the development of science and technology and ICT already exist. At present the project prioritises the links with

the European Technology Platforms (ETP) and Joint Technology Initiatives.

The ETPs provide a framework for industry stakeholders to define R&D priorities, timeframes, action plans on strategic development issues in order to achieve European future growth, sustainability and competitiveness. The EuroAfriCa-ICT initiative is supported by these technology platforms.

## EUROAFRICA COOPERATION FORUMS

The EuroAfriCa-ICT team is planning two major scientific meetings designed to bring together a critical mass of researchers from Europe, sub-Saharan Africa and the Caribbean. The First EuroAfrica Cooperation Forum for ICT research took place on 25-26 March 2009 in Brussels, bringing together more than 300 ICT experts, policy and decision makers, heads of stakeholder institutions and international organisations, as well as representatives from each of the EuroAfriCa-ICT partner organisations. The Second EuroAfrica Cooperation Forum for ICT research is scheduled for Addis Ababa, Ethiopia, in November 2009.

These events aim to highlight to European researchers and decision makers the range and excellence of ICT research in Africa and the Caribbean, to spur the creation of new north-south partnerships.

The ultimate aim is to bridge the digital divide by providing access to information technologies to the world's developing countries, and developing practical ICT solutions to many of the problems afflicting these regions.

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## EUROAFRICA-ICT PROJECT PARTNERS

- Third World Academy of Sciences ([www.twas.org](http://www.twas.org))
- Sigma Orionis ([www.orionis.com](http://www.orionis.com))
- The Panos Institute West Africa ([www.panos-ao.org](http://www.panos-ao.org))
- The Meraka Institute of the CSIR ([www.meraka.org.za](http://www.meraka.org.za))
- The Kigali Institute for Science and Technology ([www.kist.ac.rw](http://www.kist.ac.rw))
- Faculty of Computing and Information Technology, Makerere University, Uganda ([www.cit.ac.ug](http://www.cit.ac.ug))
- The Caribbean Academy of Sciences ([www.caswi.org.jm](http://www.caswi.org.jm))
- The Africa Unit of the Association of Commonwealth Universities ([www.acu.ac.uk](http://www.acu.ac.uk) and [www.caast-net.org](http://www.caast-net.org))
- The Agence universitaire de la Francophonie ([www.auf.org](http://www.auf.org)).

# EuroAfriCa-ICT

[www.euroafrica-ict.org](http://www.euroafrica-ict.org)





# AERO-ENGINES GET LASER TREATMENT

THE CSIR, through the CSIR National Laser Centre, became a consortium member with leading European research institutes and end users from the aerospace industry when it joined the EU Sixth Framework Programme project, FANTASIA. The strength of the centre's capability in laser metal deposition (LMD) as well as diagnostic capabilities available at the National Metrological Laboratories (NML) and the South African Nuclear Energy Corporation (NECSA) led to this partnership.

Operations manager, Hardus Greyling, says, "The key objective of FANTASIA (an acronym for 'flexible and near-net shape generative manufacturing chains and repair techniques for complex-shaped aero engine parts') is to strengthen the global competitiveness of the European gas turbine engine industry through comprehensive re-engineering of the entire value chain, from initial design all the way through manufacturing to repair and maintenance.

"The competitive advantage will be realised through greater freedom in component design and reduced manufacturing times as well as increased component lifespan. This will shorten market response times and also reduce raw material and maintenance cost. These objectives become possible by exploiting the flexibility and rapid response capabilities of generative manufacturing to produce near net shape components that do not need any subsequent machining operations."

Generative manufacturing is the three-dimensional build up of complete components from powder as the feed material.

Greyling adds, "The techniques identified for this purpose are LMD and direct laser forming. We have been tasked with the manufacturing of components via LMD. Partners in the consortium include the German-based Fraunhofer Institute for Laser Technology (ILT), Rolls-Royce and Turbomeca. ILT is active in the contract repair of worn turbine blades

and blisks for European gas turbine manufacturers. Rolls-Royce and Turbomeca are prominent suppliers of gas turbine engines for the big passenger aircraft and helicopter markets respectively.

**A blisk is a single engine component comprising a rotor disc and blades, either machined from a solid piece of material or made by welding individual blades to the rotor disc. ([www.wikipedia.org](http://www.wikipedia.org))**

FANTASIA commenced in June 2006 and will conclude in 2010. - Chiara Lincoln

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# SECURITY RESEARCH SUPPORTED BY EU

THE EUROPEAN UNION'S FRAMEWORK PROGRAMMES HAVE CHANGED THE OUTLOOK OF RESEARCH BY PROMOTING TRANSNATIONALITY, PARTNERSHIPS AND SHARING OF RESEARCH RESULTS.



In South Africa, the Department of Science and Technology (DST) is spearheading the European-South African Science and Technology Advancement Programme (ESASTAP).

According to safety and security expert and national contact point (NCP), Dr Barend Taute, "The EU receives research funds from all its member states. This [funding] has been combined in the 7th Framework Programme to promote research based on 11 themes, and my role as NCP relates to the security research theme."

"As NCP for security research in South Africa, my role is to liaise with local researchers as well as NCPs and research organisations in European countries," he says. Taute is currently working on Project SEREN (Security Research Network), a joint project between all the security NCPs with the intention to share information and

develop mechanisms whereby better support can be provided to FP7.

FP7 seeks to address security issues including security of citizens and especially critical infrastructure, intelligent surveillance and border control, security in case of a crisis, security systems integration, interconnectivity and interoperability, and aspects of security and society.

"The programme helps us to access European research results and funding," says Taute, adding, "It also helps to build a network of researchers in areas that are important to South Africa such as border control."

Taute reveals that unlike other research areas, security research in South Africa has not been successful in getting funding from the EU, until now. "Security research is still relatively new, but we have set our goal on South African participation," he says.

Previously, the CSIR has had relationships with individual organisations, but collaborating in FP7 multiplies research opportunities. He says the DST strongly supports the initiative. "It helps knowing that there are other people in other countries who are doing the same research in areas that matter to us," he says. "This continues to open doors."

Taute and his group are trying to find alignment between South African research requirements and those of the EU. "Research is there for the benefit of everybody and it is more beneficial if more people participate," says Taute, adding that "some projects will remain country confidential".

- Mzi Gcukumana

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A photograph of a small, clear stream flowing through a dense, green forest. The water is white and frothy as it cascades over numerous dark, moss-covered rocks. Sunlight filters through the thick canopy of trees and ferns, creating dappled light on the water and rocks. The overall scene is vibrant and natural.

# FINDING A BALANCE BETWEEN LIVELIHOODS AND BIODIVERSITY



Team members Nikki Funke, Marius Claassen and Maronel Steyn (insert)

## THE CSIR'S EXPERTISE IN WATER RESOURCE MANAGEMENT AND SOCIO-ECOLOGICAL SYSTEMS ALLOWS IT TO PLAY A LEADING ROLE IN A NEW EU FP7 PROJECT, TITLED 'LIVE-DIVERSE – SUSTAINABLE LIVELIHOODS AND BIODIVERSITY IN RIPARIAN AREAS IN DEVELOPING COUNTRIES'.

Riparian areas, being the interface between inland surface waters and terrestrial environments, contribute significantly to livelihoods in rural areas. In response to EU FP7, case studies will be undertaken in Vietnam, India, South Africa and Costa Rica.

Research staff from the CSIR's water resources area will work with peers from Sweden, Vietnam, India, Costa Rica, the Netherlands, the UK and Italy on this project,

which will run from 2009 to 2012. Led by Dr Marius Claassen, an expert on decision support systems and transboundary waters, the CSIR team comprises Karen Nortje (social, cultural and spiritual values, attitudes, practices and beliefs), Nikki Funke (policy implications and social value mapping) and Maronel Steyn (human health and vulnerability). The project will investigate the links between socio-economic development and biodiversity.

Steyn, an environmental health expert, explains more about the project, "LiveDiverse concentrates on the interface of livelihood and biodiversity, in this case in communities living close to water and who depend on these resources for their livelihoods. The CSIR's role will be to lead partners in developing a methodology to help increase knowledge of how public beliefs, perceptions, values and attitudes towards biodiversity and livelihoods are formed and organised in belief systems.

"A second objective is to provide an analytical framework for better understanding of the role of beliefs, values and attitudes in perceptions of biological, socio-economic and cultural-spiritual vulnerability. Human vulnerability is a key concept defined as the interface between exposure to physical threats to human well-being, and the capacity of people and communities to cope with those threats.

"Our third objective is to construct, test and validate a biodiversity and livelihoods belief scale that can be used to examine public belief systems through specific statistical methods."

She includes health as an essential aspect of the livelihoods and biodiversity interface, "Socio-economic sustainability is a key issue and lies at the heart of this project."

In addition to leading these activities, the CSIR will conduct research through an integrated study of the ecological, socio-economic and cultural/spiritual vulnerability of aquatic (water) and riparian biodiversity in the Greater Kruger area in South Africa. This will be complemented by studies of the Be Be/Na Hang Conservation Complex in northern Vietnam, the Western Ghats in India and the Terraba River basin in Costa Rica.

"We envisage that our research will cover land-use practices, culture, spiritual and physical health, and the influence of witchcraft," Steyn confirms. "Vulnerability is a key concept, particularly relating to access to natural resources, such as land, water and air."

The kick-off meeting in Costa Rica took place in February 2009. Project partners met under the leadership of Professor Geoffrey D Gooch, based at the Linköping University in Sweden, to coordinate and finalise work plans. The project should add substantially to sustainable livelihoods in South Africa and the southern African region.

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- Biffy van Rooyen



# WATER RECLAMATION PROJECT

## EXPANDS GLOBAL KNOWLEDGE

Colilert is an 18-hour sampling method. Sealed water samples are exposed to an ultraviolet light; fluorescence on samples indicates the presence of E. coli

## COLLABORATION WITH EUROPEAN RESEARCHERS ON HOW TO ENSURE THE SAFETY OF WATER FROM RECHARGED ACQUIFERS HAS BENEFITED THE TOWN OF ATLANTIS IN THE WESTERN CAPE.

IN THE CONTEXT OF growing global evidence of water stress, the search is on for alternative water sources. Two southern African countries, Namibia and South Africa, emerged as leaders in the field of reclaiming municipal wastewater, for drinking water (or potable use) and indirect potable use.

In South Africa, Dr Gideon Tredoux from the CSIR has been active for many years in artificial groundwater recharge, a technology that is receiving growing attention worldwide. Groundwater occurs in geological formations in the subsurface. An adjoining groundwater resource that yields usable quantities of water is called an aquifer. Aquifers are replenished naturally by rain, or seepage from rivers and other surface water bodies. Generally, storing water in an aquifer offers certain advantages such as little or no evaporation, and natural purification treatment such as filtration, adsorption and precipitation of contaminants.

Resident experts Tredoux and Bettina Genthe have worked for two years with international peers on a global effort coordinated by the EU FP6 to research effective technologies to ensure reclaimed water is safe for potable use.

Bettina Genthe, a microbiologist, is proud of the CSIR's involvement in this technology. "Artificial recharge has played a key role in the augmentation of groundwater supplied to Atlantis, a town located in a semi-arid region 50 km north of Cape Town," she explains. "Since the establishment of Atlantis during the 1970s as a national growth point, the town has depended on groundwater as a water resource.

"The water reclamation scheme at Atlantis is operated by the City of Cape Town. The CSIR has been involved in an advisory capacity in this pioneering application of artificial groundwater recharge as a water

management tool for bulk water supply in southern Africa."

### WORKING TOWARDS SAFE, RECYCLED DRINKING WATER

The aquifer covers an area of about 130 km<sup>2</sup>, stretching inland from the Atlantic Ocean to the town of Atlantis in the east. Its natural yield is too little to sustain the water supply to the town. Genthe's team has, therefore, played a vital role in monitoring and finding plans to address possible risks posed by chemicals and pathogens, which may still be found in reclaimed waters. The latter is essential to supplement existing groundwater supplies.

Broadly speaking, the process of artificial recharge starts with the treatment of domestic wastewater and collection of storm water.

Domestic wastewater is treated in an activated sludge process designed for the biological removal of organic matter and nutrients. Maturation ponds polish the treated effluent before being blended with storm water. This project confirmed findings from other studies that show treated wastewater effluent to be of better quality than storm water. The blend of treated effluent and storm water is routed to infiltration basins, from where it seeps through the sand into the aquifer. Only treated domestic water is recharged for indirect potable reuse.



Industrial wastewater is treated separately and discharged into the coastal recharge basins, which seep into the ocean. In the subsurface the recharged water blends with the natural groundwater and this blended water is pumped from boreholes at the Witzand Wellfield and diverted to the Witzand wastewater treatment works for softening and chlorination. Once water is treated, it is blended with surface water to supplement the volume needed by the town.

Genthe outlines the role her team played in ensuring that this recycled wastewater is safe for the inhabitants of Atlantis to drink, "Our research focused on determining the presence and concomitant threat of chemicals, pharmaceuticals or drugs, micro-organisms, such as coliforms and E. coli, and parasites such as worms."

## ANALYSING RESULTS

The sampling programme, which followed the RECLAIM water standardised protocols, was intended to determine how effectively these contaminants were removed; sampling points were at the source, infiltration basins, in the aquifer and the final product.

The testing programme was done with partners at the Technische Universitaet Berlin, Germany, and Unesco IHE in the Netherlands, to determine characterisation of natural organic matter and effluent organic matter. Sampling for pharmaceuticals and



Maronel Steyn, Bettina Genthe and Dr Jac Wilsenach

other media was done in collaboration with project partners of the Federal Institute of Hydrology in Germany.

Genthe is pleased to report that no dangerous substances were found in the final product, "We found no anti-inflammatory drugs, no antibiotics, no estrogen, no psychoactive drugs, no parasites, no viruses and low levels of bacteria, which mean that this water is safe to drink. Ongoing research is needed to ensure that our expertise remains at the cutting edge to benefit those people who rely on this resource.

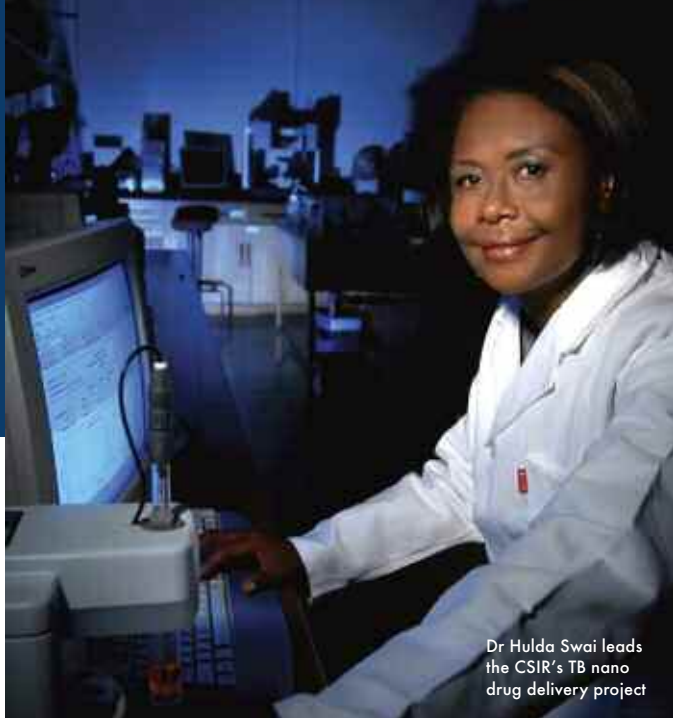
"The Atlantis groundwater scheme provides a cost-effective water supply option, when coupled with strict management of the resource. Future refinements of current

processes may even allow possible export of potable water to other residential areas."

Her team found participation in this project of great value. "Not only has our research effort benefited greatly, we were privileged to work with partners from around the world. In our case, I would like to single out the leadership provided by Dr Thomas Wintgens of the Rheinisch Westfaelische Technische Hochschule Aachen, as well as our collaboration with Cranfield University's School of Water Science," she concludes. - Biffy van Rooyen

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# DELIVERING DRUGS THROUGH NANOTECHNOLOGY



Dr Hulda Swai leads the CSIR's TB nano drug delivery project

IMAGINE A DRUG TECHNOLOGY discovery that could benefit sufferers from a range of illnesses, such as malaria, cancer, HIV, tuberculosis (TB) or pain. Imagine being able to treat a TB patient successfully within six to 12 weeks rather than six to nine months. Scientists at the CSIR imagined exactly this – and possess the know-how to make it happen – nudging the organisation and several international partners closer to this reality.

Leading the CSIR's TB nano drug delivery project is principal researcher Dr Hulda Swai, a formidable biomaterials scientist. Swai believes that it is possible to develop an anti-TB drug delivery system that will improve the lives of thousands of TB sufferers by improving their drug regime, and that the answer lies in nanotechnology.

"There is an effective therapeutic regimen for TB available, but it fails more often than not because of patient non-compliance," says Swai. "Currently, patients need to take up to four anti-TB drugs (ATDs) several times a week for up to nine months. They often miss their scheduled ATD because of time constraints, nasty side effects of the medication, not having access to their ATDs or simply because they forget. Eventually the treatment fails."

Swai and her team are developing a drug delivery system that may lead to TB patients

**The CSIR's TB project is committed towards human capacity development, especially to the previously disadvantaged groups. So far, the project has hosted three postdoctorate students, three PhD students, one Honours student and four interns registered at the neighbouring tertiary institutions. A number of African scientists are working on the project and, to date, eight international exchange programmes for the students and postdoctoral fellows have been secured.**

only having to take their ATDs once a week and only for up to 12 weeks. This means the dosage taken should have a slow-release mechanism within the body so that not all the medicine is delivered at once. Instead, the medicine is released over a number

of days and only taken up by the body and delivered to the respiratory system gradually, making the medicine very effective. The secret lies in the development of a capsule through nanotechnology that is able to achieve this goal.

"With nanotechnology, one can manipulate and harness the properties of assemblies of various biomolecules that are at the nanosize scale. In addition, nanotechnology allows scientists to alter the chemical, physical, and biological properties of these assemblies, allowing for their synthesis at a controlled size range of 1 to 500 nm. When combined with other biotechnology tools such as bioinformatics, imaging, and systems biology, nanotechnology holds great promise to address challenges faced in the field of drug development and delivery," explains Swai.

As this project is working towards a technology platform it may not only be applicable to TB drug delivery but, once optimised, could potentially be used for delivery of other drugs, including those for cancer, HIV, biological actives, pain in long term illness, malaria, plant extracts (lead compounds) and many more.

The project has gained recognition both nationally, where the CSIR has formed a TB consortium with three universities, eight local research institutes, and internationally, with a number of universities and research

institutions. These include the University of Nottingham, the University of London, Cardiff University in the UK, Ecole Polytechnique Federale de Lausanne (EPFL) in Switzerland, the University of Colorado Health Science Centre in the USA, the National Jewish Medical and Research Centre and Aktiv-Dry Pharmaceuticals in the USA as well as the Post Graduate Institute of Medical Education and Research in Chandigarh, India.

Besides collaborations with these international institutions, the CSIR's TB project has also attracted significant interest from the World Health Organization, TB Global Alliance, the European Union and the India/Brazil/South Africa (IBSA) partnership.

Swai has now been invited to join the Developing Countries Coordinating Committee (DCCC), an independent advisory body to the European and Developing Countries Clinical Trial Partnership (EDCTP), which, in turn, forms part of the EU FP6 for research and technological development. She has also initiated a drug delivery platform for lead compounds (traditional plant extracts) against malaria, HIV, cancer and other neglected diseases with participants from leading research institutions in IBSA.

"I cannot wait to see our TB drug delivery technology, now in development, being commercialised and used every day to improve the management and quality of life of TB patients. I can also see this technology being applied in future for delivering a number of drugs for a number of other illnesses," concludes Swai. – Petro Lowies

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Kobus Labuschagne,  
national coordinator  
of SIMBA 2

# SIMBA 2

PROMOTES ROAD TRANSPORT THROUGH COLLABORATION

**THE NEED TO IMPROVE ROAD SAFETY IS RECOGNISED AS A TOP PRIORITY. SOME 1,2 MILLION PEOPLE DIE AND 10 MILLION ARE INJURED IN ROAD ACCIDENTS PER YEAR WORLDWIDE. EVERY YEAR, SOUTH AFRICA SEES ABOUT 498 000 TRAFFIC ACCIDENTS, 46 500 OF WHICH ARE SERIOUS INJURIES. THE DEATH TOLL ON OUR ROADS AMOUNTS TO 13 000 PEOPLE PER YEAR, INCLUDING 5 300 PEDESTRIANS.**

SIMBA 2, an international initiative aimed at increasing safety, mobility and transport efficiency, brings together partners from the European Union (EU) and South Africa, India, Brazil, China and Russia. A collaboration network is being established to bring together key players in the two areas of intelligent transport systems (ITS) and infrastructure development from the EU and these countries.

"This initiative will endeavour to support R&D activities aimed at increased road safety, mobility and transport efficiency, the improvement of road and transport network management and will encourage research on appropriate pavement design," explains Kobus Labuschagne, South Africa's national coordinator of SIMBA 2.

"This is a funding initiative within the EU's FP7, and it is intended to encourage mutual technology transfer among the respective participants while the European Commission (EC) provides the partnering developing countries with international learning and col-

laboration opportunities," he says. ERTICO in Brussels manages the overall SIMBA 2 project.

As a supporting action, SIMBA 2 also facilitates involvement among South African stakeholders to explore opportunities for possible collaboration with partnering EU countries.

In the local ITS expert group, the CSIR is currently joined by the University of Cape Town, the University of Pretoria and siZoma, an ITS company from Gauteng. International partners include IRIS Global from the UK and DTV consultants in the Netherlands. The infrastructure development expert group currently consists of the CSIR and its strong partner institution, the Federation of European Highway Research Laboratories (FEHRL) in Brussels.

"Local capacity building, including at transport-related line government departments, is one of the key envisaged focuses of SIMBA 2's South African drive. For example, partner countries may provide training content in the

field of ITS to be adapted to local circumstances," comments Labuschagne.

"SIMBA 2 creates the opportunity for South Africa to further grow as a global player in transport infrastructure, transport planning, traffic management and safety engineering R&D. In addition, the technologies we need for infrastructure upgrades in anticipation of 2010 will strengthen our future economy and leave a legacy of expanded and improved infrastructure," he says.

Once the expert groups have thrashed out possible topics for collaborative research, opportunities for research funding may be pursued by responding to the respective EU FP7 calls for proposals. "We are confident that participating countries and respective participating entities will join in discussions to come up with solid suggestions for collaborative transport R&D," concludes Labuschagne.

- Hilda van Rooyen

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# RECENTLY FEATURED

THE FOLLOWING ARE ADDITIONAL PROJECTS WHERE THE CSIR PROVIDES CROSS-BOUNDARY EXPERTISE. THESE PROJECTS HAVE BEEN COVERED IN RECENT EDITIONS OF THE SCIENCESCOPE AND ONLY BRIEF DETAILS ARE MENTIONED HERE.



## COMBINING SATELLITE NAVIGATION AND SATELLITE COMMUNICATION

During 2007 and 2008 the CSIR undertook a European Union FP6 project called 'African Satellite communication and Galileo Applications' (AFSAGA) with European partner Thales Alenia Space. The purpose of this project was to analyse the potential applications that could be derived through a combination of Galileo and satellite communications in South Africa and the whole Southern African Development Community. *ScienceScope, Volume 3, Number 2, October 2008*



## FROM SPACE-BASED INFORMATION TO DISASTER INFORMATION

The Integrated Risk Management for Africa (IRMA) project is aimed at developing and implementing an ICT platform to manage natural and environmental risks in Africa in a coordinated manner. The sensor web is an emerging technology concept that can leverage space-borne earth observation sensors to enhance the tempo of disaster response. IRMA will deliver an open distributed platform that integrates resources, such as sensor networks, remotely-sensed data and services, to provide information related to all phases of the disaster management cycle to end users. *ScienceScope, Volume 3, Number 3, October 2008*



## ADVANCING ICT FOR DISASTER RISK MANAGEMENT IN AFRICA

The Meraka Institute of the CSIR forms part of EU FP7, the 'Advancing ICT for DRM in Africa' (AIDA) project. AIDA is aimed at acquiring and sharing knowledge about affordable information and communications technology solutions in Africa, with the aim of reducing the risk of natural disasters and improving the capacity to respond to disasters. *ScienceScope, Volume 3, Number 2, October 2008*

## US-SA RESEARCH IN PAVEMENT ENGINEERING

Collaboration in pavement engineering research has been ongoing between the CSIR, the Universities of California at Davis and Berkeley and Dynatest Inc from the mid 1990s. The California Department of Transportation funds the research, the latest contract of which runs until 2011. The research programme makes use of the CSIR-developed heavy vehicle simulator (HVS), a road-testing machine that simulates the damage caused by heavy traffic to road structures. The collaboration includes the regular exchange of staff between the CSIR and its research partners. The success of the HVS research programme has led to the export of the technology platform and equipment to China, Finland/Sweden, India and the USA. *ScienceScope, Volume 3, Number 3, January 2009*



## INVESTMENT CASTING OF TITANIUM

The CSIR has an ongoing working agreement with US aeronautical company Boeing Phantom Works (BPW), with specific interest in titanium products. From time-to-time BPW makes one of their specialist consultants available to work with CSIR researchers. Up to now, most of the work centred around the investment casting of titanium as well as the semi-solid metal casting of light metals. [\*ScienceScope, Volume 3, Number 3, January 2009\*](#)

## BENCHMARKING AND IMPROVING SOUTH AFRICA'S FOUNDRY INDUSTRY

The National Foundry Technology Network (NFTN), which was established and is hosted by the CSIR, is using an Australian partner (CAST) to help benchmark South Africa's high pressure die-casting industry against key international companies. The NFTN does the benchmarking within South Africa while CAST uses the data to benchmark the South African industry against that of Australia, Japan and North America. The collaboration also has a performance improvement leg to it, called the Lead Expert Access Programme (LEAP) funded by the Advanced Manufacturing Technology Strategy (AMTS). Through LEAP South Africa's foundry industry can gain access to much needed international technical expertise which assists in improving its performance. [\*ScienceScope, Volume 3, Number 3, January 2009\*](#)

## MODEL STUDIES UNDERTAKEN FOR KHALIFA PORT

Extensive physical model studies were undertaken in the CSIR's hydraulics laboratory in Stellenbosch for the development of a multi-billion dollar port at Khalifa in the United Arab Emirates. The CSIR was contracted by Halcrow, an international port design consultant to carry out the physical model studies. The Khalifa port is located between the cities of Abu Dhabi and Dubai and forms part of one of the largest multi-purpose maritime facilities in the world, covering an area of 22 km<sup>2</sup>. [\*ScienceScope, Volume 3, Number 3 January 2009\*](#)

## KEEPING AN EYE ON THE SKY

The CSIR has a long track record of collaboration with leading space agencies and companies. The station has provided launch and orbital support for all CNES space missions within its coverage, including missions for other agencies supported by CNES since the 1980s. In October 1997, the CSIR won a competitive bid for a long-term contract with Hughes Space and Communications to provide transfer orbit services (TOS) in the Ku/DBS bands. For the past two years, Intelsat has emerged as the CSIR's biggest client. Since 1982 more than 280 successful launch support operations have been performed, while tracking, telemetry and command (TT&C) supports have been provided on a continuous basis for polar orbiting and geostationary satellites. [\*ScienceScope Volume 3, Number 2, October 2008\*](#)

## BIOSCIENCES IN SUPPORT OF THE EU'S FP6

Novel biotechnology techniques, processes and skills have allowed CSIR biosciences researchers to make significant contributions to a range of EU FP6 projects addressing health and nutrition issues.

The **Reproducing Food Processing Waste project** focused on exploiting whole waste co-products from food processing. Here the CSIR made inputs to improve the protein content of brewer's spent grain and later enriching that protein to be used in formulation for aquaculture feed.

**Novel Q** looks at sourcing proteins from brewer's waste to create edible film for food preservation.

The **Develonutri and Safefoods projects** both address nutrition – one looking at optimising the nutritional value of crops and crop-based foods while the other seeks to promote awareness of food safety and risk analysis practices for foods production.

Structural biology researchers are investigating glutamine synthetase as a potential antibiotic target for the **New Medicines for Tuberculosis programme**. In the **European Microbides Project**, new microbicides for the prevention of HIV infection are investigated and developed. [\*ScienceScope Volume 2, Number 1, April 2007 & Volume 2, Number 3, December 2007\*](#)

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