South Africa-Japan Cooperation in Science and Technology

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Foreword South African Minister of Science and Technology

"As we celebrate a decade of formal cooperation in science and technology between South Africa and Japan, we should not lose sight of the fact that the partnership between our countries is much older than that. The agreement signed in 2003 was a formal recognition of a partnership that was already well established."

Science and technology are powerful instruments for growth and development, enhancing economic competitiveness and the quality of life of citizens. South Africa's National Development Plan makes the observation that the potential of technology is huge and still largely untapped in Africa. Recognising this imperative, South Africa endeavours to develop human capital for science, technology and innovation to meet the needs of society and enhance its knowledge-generation capacity. International cooperation and science and technology partnerships are crucial in achieving these goals. The cooperation between South Africa and Japan is an excellent example of a "North-South" relationship that can be leveraged to benefit both countries and their peoples.

As we celebrate a decade of formal cooperation in science and technology between South Africa and Japan, we should not lose sight of the fact that the partnership between our countries is much older than that. The agreement signed in 2003 was a formal recognition of a partnership that was already well established.

However, the 10th year of our formal partnership in science and technology is an opportunity to take stock of our achievements to date, and to map out the future for our cooperation. This book provides an overview of our joint accomplishments, while looking at some of the promising areas that will take our collaboration forward.

The strong bilateral relations between South Africa and Japan in science and technology are evident in the range of activities that have taken place since the signing of a bilateral agreement in 2003. The two countries have invested more than R85 million (over R72 million contributed by Japan) in more than 50 joint research projects and other programmes that have provided South African researchers, students and scientists with access to Japanese expertise and science facilities.

As far as partnership in human capital development is concerned, there are various exchange programmes and training schemes for young researchers. The Hitachi Scholarship Programme, one of the higher profile programmes, has benefited engineers from South Africa since 2009, and there are currently 24 university-to-university memoranda of understanding that have been signed, most recently ones between the Tshwane and Nagaoka Universities of Technology, and between North-West University and Hokkaido University.

To promote science and technology among the youth, Japan has dispatched a number of volunteers to various primary schools in South Africa to improve the quality of mathematics and science education the learners receive, and has placed Japanese scientists in science centres across the country to assist the centres and transfer knowledge. There is also cooperation on the development of education materials, and the creation of a database for regional assistance.

The areas of research cooperation between the two countries include life sciences, the environment and climate change, astronomy and space sciences, energy research and technology, material sciences (new and advanced), and nanotechnology. The scientific output in these areas includes more than 700 papers co-authored by South African and Japanese scientists, published in scientific journals or presented at academic conferences.

The science and technology partnership between South Africa and Japan is indeed something to be celebrated. Our Department of Science and Technology is committed to growing and strengthening cooperation with Japan, and has placed senior science and technology representatives in Tokyo to ensure optimal benefit from the relationship.

We appreciate our friendship with the government and the people of Japan, and look forward to many more years of fruitful and mutually beneficial partnership.

Ms GNM Pandor
Minister of Science and Technology
Republic of South Africa

Foreword Ambassador of Japan in South Africa

"Bilateral cooperation in science and technology between Japan and South Africa has been growing steadily, particularly since the two countries concluded the Agreement on Science and Technology Cooperation in August 2003."

I am very glad that the cooperation in the field of science and technology between the Republic of South Africa and Japan is highlighted in this coffee table book.

Bilateral cooperation in science and technology between Japan and South Africa has been growing steadily, particularly since the two countries concluded the Agreement on Science and Technology Cooperation in August 2003. To cite one of the good examples of cooperation – 50 joint research projects have taken place among Japanese and South African government research institutions and academic institutions since 2003.

Cooperation between the two countries in the science and technology field has been periodically reviewed at the Science and Technology Joint Committee Meetings. Japan and South Africa reviewed their cooperation to improve the situation further at the Fourth Science and Technology Joint Committee Meeting, which was held in Tokyo in October 2012. Japan has welcomed South African ministerial visits to Japan on the occasion of the Science and Technology in Society (STS) Forum.

In addition to, or on a parallel with the above-mentioned joint research projects, more than 20 Japanese universities have cooperative frameworks with South African universities and research institutions, including Nagaoka University of Technology, which signed a Memorandum of Understanding (MoU) with the Tshwane University of Technology in August 2013 and the University of Hokkaido, which signed an MoU with North-West University in 2014. I strongly believe that we can expand our bilateral science and technology cooperation through such cooperative frameworks.

Japanese businesses have also been playing a positive role, particularly in technology transfer in South Africa. As an example, more than 15 South African engineers have been sent to Japan for technical

training under the DST-Hitachi Scholarship Programme since 2009. Given the high level activities in the science and technology field in both counties, there will be a number of areas for further cooperation between the two countries.

I would also like to emphasise that the Japan International Cooperation Agency (JICA) has contributed significantly in various ways to cooperation in the area of science and technology between Japan and South Africa. This cooperation includes, since 2004, the dispatch of Japanese experts to the Department of Science and Technology (DST) for three year stints and more recently to the South African National Space Agency (SANSA), the dispatch of Japanese volunteers to science centres in South Africa and joint research projects through the Science and Technology Research Partnership for Sustainable Development (SATREPS) which targets global issues. The Embassy of Japan in South Africa will continue to support and encourage JICA's activities in science and technology.

Finally, I would like to take this opportunity to thank our South African colleagues at DST, NRF, JICA, JSPS, JST, as well as the academics and researchers in both South Africa and Japan for their contribution to the promotion of science and technology cooperation between the two countries. I hope that the cooperation between the two countries in the area of science and technology will be further strengthened.

Mr Yutaka Yoshizawa
Ambassador of Japan

South Africa-Japan S&T Cooperation: an overview

In August 2003, an Agreement on Scientific and Technological Cooperation was signed, formalising the science and technology (S&T) relationship between South Africa and Japan.

In the decade since, South Africa and Japan have developed a very good relationship in the scientific and technological field. There have been a number of exchange visits by political leaders, officials and scientists from both countries. Ministerial visits from South Africa to Japan have been undertaken by Dr Ben Ngubane in 2003, Dr Mosibudi Mangena in 2005, 2007 and 2008, Ms Naledi Pandor in 2010 and 2014, and Mr Derek Hanekom in 2013. Japanese Minister Hon. Tasuo Kawabata visited South Africa in 2010.

The commitment of both countries to strengthening bilateral relations in the fields of S&T is evident in the range of bilateral activities that have taken place since the signing of the agreement in 2003. Cooperation exists through joint research and development (R&D) projects on specific research areas by means of calls for proposals as well as technical cooperation through official development assistance (ODA). All projects and activities mentioned under the S&T cooperation strongly support human capacity development (HCD) and knowledge and technology transfer.

South Africa and Japan have enjoyed cordial science and technology bilateral relations since the signing of the Science and Technology Cooperation Agreement in 2003. Most importantly, both countries aim to advance scientific research through funding joint activities, providing opportunities for young researchers, promoting research exchange in scientific fields to achieve sustainable growth and reinforcing on-going research activities.

Over 50 joint projects have been undertaken between the two countries over the past decade, covering areas such as life sciences; biotechnology; nanotechnology; the environment; climate change; space sciences; and material sciences, among others.

Bilateral activities

In addition to the bilateral agreement of 2013, the South African National Research Foundation (NRF) signed memoranda of understanding (MoU) with two Japanese funding agencies, namely the Japan Society for the Promotion of Science (JSPS) in 2005, and the Japan Science and Technology (JST) Agency in 2008 for the purpose of managing joint research projects between the two countries.

Furthermore, there are currently 24 university-to-university MoUs (including faculty level MoUs) on cooperation that have been signed between South African and Japanese universities. The most recent MoU to be signed was between the Tshwane University of Technology and the Nagaoka University of Technology in August 2013 and the North-West University and the Hokkaido University in February 2014. There are also three university-to-research institution agreements that have been signed between Japanese universities and South African research institutions.

Development cooperation

The cooperation between South Africa and Japan on official development assistance (ODA) is mainly on technical cooperation through the Japan International Cooperation Agency (JICA). From 2007 to 2011, a technical assistant was dispatched to the DST from Japan, with the aim of assisting the DST with capacity development, and guiding the advancement and implementation of projects and programmes in this area. Under the SA-JICA programme, the initiatives listed below have taken place since 2008.

- Productivity training: In partnership with JICA-SA, four training courses were implemented between 2008 and 2010 in partnership with the Tshwane University of Technology (TUT), which included the participation of three Japanese companies: Toyota, Nissan and Hitachi. This project was subsequently transferred to the Department of Higher Education and Training (DHET) for roll out to all universities of technology.
- Science centre volunteers: The Japan Overseas Cooperation Volunteers (JOCV) programme – which dispatches trained and qualified professionals in a variety of disciplines to support and provide technical assistance to organisations around the world – has dispatched 15 volunteers to five South African science centres to provide skills development support, assist with exhibits and facilitate workshops for educators and others.
- JICA/JST S&T Research Partnership for Sustainable Development (SATREPS): SATREPS is a Japanese government programme that promotes international joint research and provides competitive research funds for science and technology projects. Since 2010, SATREPS has overseen three major joint research projects in South Africa.
- JICA Earth Observation Technical Expert: The Japan International Cooperation Agency (JICA) has dispatched an advisor to the South African National Space Agency (SANSA) to assist in implementing an earth observation programme that makes use of data gathered by a Japanese satellite for disaster monitoring and surveillance of unidentified ships in South African waters.

> “Given the high-level activities in the science and technology field in both countries, there will be a number of areas for further cooperation between the two countries”

SA and Japan celebrate 10 years of successful cooperation in science and technology

In 2014, South Africa and Japan celebrated 10 years of successful science and technology (S&T) relations, which saw over R85 million invested in about 50 research and development projects between the two countries.

On 29 July 2014, the South African Department of Science and Technology co-hosted a reception with the Embassy of Japan to celebrate the tenth Anniversary of Science and Technology Cooperation between South Africa and Japan.

Speaking at the ceremony, the Deputy Minister of Science and Technology, Zanele kaMagwaza-Msibi, said: “South Africa and Japan have made significant strides in intensifying support for basic fundamental and applied research, development and innovation over the past decade.” The Deputy Minister expressed her gratitude to all the researchers and officials who had served their countries and the partnership with pride.

Among the highlights of this partnership is the DST-Hitachi Scholarship Programme, which has benefited more than 10 South African engineers since 2009. The engineers spend three months at a time visiting Hitachi (the Japanese multinational corporation specialising in high-technology equipment including power) learning gas and steam-turbine engineering.

In 2013, Tshwane University of Technology and Nagaoka University of Technology signed a memorandum of understanding promoting student exchanges to contribute to the development of higher education and research in South Africa. It is expected that research collaboration will be enhanced through such cooperation.

“It is our wish that the momentum, energy and drive of these researchers and the responsibilities borne by the officials be a motivation for enthusiastic and continued advancement of our partnership and good working relationship with your office and in Japan,” said the Deputy Minister to the Ambassador of Japan, Yutaka Yoshizawa.

“Given the high-level activities in the science and technology field in both countries, there will be a number of areas for further cooperation between the two countries,” said Ambassador Yoshizawa, expressing his wish that the cooperation between South Africa and Japan would grow from strength to strength.

SOUTH AFRICA

Country overview

South Africa lies at the southernmost tip of Africa with its beautiful golden beaches and stretches of wild coastline extending 2,798 kilometres along the Atlantic ocean on the west and Indian ocean on the east. Its mountain ranges, savannah, tropical jungles, African bush, rivers, lakes and oceans are home to a proliferation of land and marine wildlife.

South Africa is the third most biodiverse country in the world. It is home to 10% of the world's plants and 7% of its reptiles, birds and mammals. Similarly unique is that South Africa is one of only six countries globally with an entire plant kingdom within its borders. It also houses eight major terrestrial biomes.

The marine life is as diverse, mostly because of the contrast between the two oceans that meet at the southern tip of Africa. These water masses make the region one of the most oceanographically heterogeneous in the world. At least 12% of the coastal species known worldwide are found only in South African waters.

South Africa is the 25^{th}-largest country in the world by land area, covering slightly more than 1.2-million km^2. To the north lie the neighbouring countries of Namibia, Botswana and Zimbabwe; to the east are Mozambique and Swaziland; and within it lies Lesotho, an enclave surrounded by South African territory. To the south lie the small sub-Antarctic archipelago of the Prince Edward Islands, consisting of Marion Island (290 km^2) and Prince Edward Island (45 km^2) that are part of South Africa.

South Africa has a diverse population with a variety of cultures, languages and religions. The African population, constituting 79,3% of the total population, is in the majority, with white and coloured people each presenting 8,9% of the total population, followed by the Indian/ Asian population at 2,5%.

The South African constitution recognises 11 official languages with equal status, which is among the highest number of any country in the world. isiZulu is the most common home language spoken by nearly a quarter of the population, followed by isiXhosa, Afrikaans, Sepedi, English, Setswana and Sesotho. The remaining languages (SiSwati, Tshivenda, Xitsonga and isiNdebele) are each spoken by less than 5% of the population. English is mainly used as the language of business, commercial transactions and science.

All ethnic and linguistic groups have political representation in the country's constitutional democracy, which comprises a parliamentary republic and nine provinces. South Africa is often referred to as the "Rainbow Nation," a term coined by Archbishop Emeritus Desmond Tutu and later adopted by then-President Nelson Mandela.

The economy

South Africa is ranked as an upper-middle income economy by the World Bank, and is considered to be a newly industrialised country. Its economy is the second largest in Africa, and the 28th-largest in the world. South Africa's GDP in 2013 was $350.6 billion.

In August 2013, South Africa was ranked as the top African Country of the Future by FDi magazine based on the country's economic potential, labour environment, cost-effectiveness, infrastructure, business friendliness, and Foreign Direct Investment Strategy.

Principal international trading partners of South Africa – besides other African countries – include Germany, the United States, China, Japan, the United Kingdom and Spain. The South African Government has demonstrated its commitment to creating a favourable investment climate with its introduction of the GEAR (Growth, Employment and Redistribution) strategy. The Government is open to, and encourages, foreign investment, which it views as a means to drive growth, improve international competitiveness and obtain access to foreign markets. Virtually all business sectors are open to foreign investors and there are almost no restrictions on the form or extent of foreign investment.

The South African property market has registered an exceptional performance over the past number of years. The South African agricultural industry contributes around 10% of formal employment, relatively low compared to other parts of Africa, as well as providing work for casual labourers and contributing around 2.6% of GDP for the nation.

The commercial fishing industry is a valuable contributor to the economy. The dairy industry is also an important employer with 4 300 milk producers employing about 60 000 farm workers and indirectly providing jobs to some 40 000 people. The electronics industry in South Africa is growing at a rate above expectations and tourism is also one of the fastest growing sectors of South Africa's economy.

The mining industry is the country's biggest employer, with around 460 000 employees and another 400 000 employed by the suppliers of goods and services to the industry. The country supplies about 80% of the world's platinum and is the world's second largest producer of gold. South Africa's chemicals industry, including fuel and plastics fabrication as well as pharmaceuticals, is the largest of its kind in Africa, and has been identified by the government as a key driver of economic growth.

Johannesburg, Pretoria, Cape Town, Port Elizabeth and Durban are the most developed areas. However, areas such as Mossel Bay to Plettenberg Bay, the Rustenburg and Nelspruit areas, Bloemfontein, the Cape West Coast, and KwaZulu-Natal's North Coast amongst others are experiencing rapid growth.

Prehistoric finds

South Africa contains some of the oldest archaeological and human fossil sites in the world. Extensive fossil remains have been recovered from a series of caves in Gauteng Province. The area is a UNESCO World Heritage site and has been termed the Cradle of Humankind. The sites include Sterkfontein, which is one of the richest hominin fossil sites in the world. Other sites include Swartkrans, Gondolin Cave Kromdraai, Coopers Cave and Malapa.

The first hominin fossil discovered in Africa, the Taung Child, was found near Taung in 1924. Further hominin remains have been recovered from the sites of Makapansgat in Limpopo, Cornelia and Florisbad in the Free State, Border Cave in KwaZulu-Natal, Klasies River Mouth in the Eastern Cape and Pinnacle Point, Elandsfontein and Die Kelders Cave in the Western Cape. These sites suggest that various hominid species existed in South Africa from about three million years ago starting with *Australopithecus africanus*. These were succeeded by various species, including *Australopithecus sediba, Homo ergaster, Homo erectus, Homo rhodesiensis, Homo helmei* and modern humans, *Homo sapiens*. Modern humans have inhabited Southern Africa for at least 170,000 years.

Science and technology

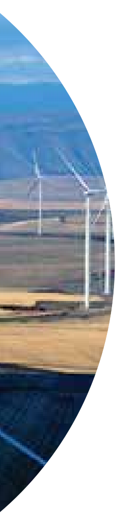
Several important scientific and technological developments have originated in South Africa. The first human-to-human heart transplant was performed by cardiac surgeon Christiaan Barnard at Groote Schuur Hospital in December 1967, Max Theiler developed a vaccine against yellow fever, Allan McLeod Cormack pioneered x-ray computed tomography, and Aaron Klug developed crystallographic electron microscopy techniques. With the exception of that of Barnard, all of these advancements were recognised with Nobel Prizes. Sydney Brenner won most recently, in 2002, for his pioneering work in molecular biology.

Mark Shuttleworth founded an early Internet security company Thawte, that was subsequently bought out by world-leader VeriSign. It is the expressed objective of the government to transition the economy to be more reliant on high technology, based on the realisation that South Africa cannot rely on its mineral wealth in perpetuity.

South Africa has cultivated a burgeoning astronomy community. The country hosts the Southern African Large Telescope (SALT), the largest optical telescope in the southern hemisphere. On 25 May 2012 it was announced that hosting of the SKA Telescope will be split over both the South African and the Australia/New Zealand sites. After having completed the 7 dish Karoo Array Telescope, South Africa is currently building the 64 dish MeerKAT, which will be the largest radio telescope in the world until the Square Kilometre Array is built.

Education

South Africa has a three-tier system of education starting with primary school, followed by high school and tertiary education in the form of (academic) universities and universities of technology. Public universities in South Africa are divided into three types: traditional universities, which offer theoretically oriented university degrees; universities of technology, which offer vocational oriented diplomas and degrees; and comprehensive universities, which offer both types of qualification. There are 23 public universities in South Africa: 11 traditional universities, six universities of technology and 6 comprehensive universities.



South Africa

Population

2014 estimate:
54,002,00

2011 census:
51,770,560

Largest city

Johannesburg

JHB

Capitals

Pretoria *(executive)*
Bloemfontein *(judicial)*
Cape Town *(legislative)*

Official languages

Eleven

11

Currency

South African Rand
(ZAR)

R

Area

1,221,037 km^2

Internet TLD

.za


JAPAN

Country overview

Japan is an island nation situated off the eastern seaboard of the Eurasian continent in the northern hemisphere. The country is located between approximately 20 degrees to 45 degrees north latitude and stretches over 3,200 kilometres. It consists of the main islands of Hokkaido, Honshu, Shikoku, Kyushu and Okinawa, and more than 6,800 smaller islands of varying sizes. Its surface area totals approximately 380,000 square kilometres, a figure equivalent to 0.3 percent of the global land mass.

Since the Japanese archipelago is located in a zone of relatively young tectonic plate movement, it is particularly prone to various physiographical phenomena. Therefore, the number of earthquake occurrences is quite high there, and so is the proportion of active volcanoes. The land is full of undulations, with mountainous regions including hilly terrain accounting for about three-quarters of its total area.

Forestland and fields account for the largest portion of the nation's surface area. There are approximately 250,000 square kilometres of forestland and fields (which equates to 67 percent of the nation's surface area), followed by approximately 50,000 square kilometres of agricultural land (12 percent). Together, forestland, fields and agricultural land thus cover approximately 80 percent of the nation. There are approximately 20,000 square kilometres of building land (5 percent).

The Japanese archipelago has a temperate marine climate, with four distinct seasons, an annual average temperature of between 10 to 20 degrees centigrade, and annual precipitation of 1,000 to 2,500 millimetres. Japan typically experiences hot, humid summers and cold, dry winters.

Japan's total population in 2013 was 127.30 million. This ranked tenth in the world and made up 1.8 percent of the world's total. Japan's population density measured 343.4 persons per square kilometre in 2010, ranking seventh among countries with a population of 10 million or more.

The economy

Japan had a GDP of $4.9 trillion (nominal) in 2013 (World Bank), making it the third largest economy in the world after the United States and China. Japan specialises in high technology such as the manufacture of cars and electronics, and is a world leader in the fields of nanotechnology and the environment.

At the start of 2008, the Japanese economy was faced with a standstill in its path to recovery as private consumption and investments in plant and equipment fell flat and so did production. This occurred against the backdrop of soaring crude oil and raw material prices and repercussions from the American subprime mortgage loan problems that, since mid-2007, rapidly clouded future prospects for the world economy. In addition, the bankruptcy of the major American securities firm Lehman Brothers in September 2008 (the "Lehman shock") led to a serious financial crisis in Europe and the U.S.A. Japan was also affected by the yen's appreciation and the sudden economic contraction in the U.S.A. and other countries. As the economy continued to recover with foreign demand and economic measures after April 2009, the government defined March 2009 as the trough of the economic cycle.

Subsequently, the Japanese economy came to a standstill starting around October 2010. In early 2011, however, it began to rally. The Great East Japan Earthquake that took place on March 11, 2011, and the nuclear power plant accident it caused weakened the economic recovery.

In order to achieve an early end to deflation and break free of economic stagnation, the Government of Japan set forth its "three-arrows" strategy (also known as "Abenomics") in January 2013. The first "arrow" is "aggressive monetary policy". The Bank of Japan (BOJ) made it clear that it would set a consumer price index annual growth rate of two percent as a "price stabilisation target." The BOJ also introduced "quantitative and qualitative monetary easing" to double the monetary base over two years. The second "arrow" is "flexible fiscal policy". An emergency economic stimulus package with a scale of approximately 10 trillion yen was developed. The third "arrow" is "a growth strategy that promotes private investment". Efforts are being made in growth strategies such as encouraging investments by private corporations based on easing of regulations. Based on this, economic conditions have turned toward recovery, as exemplified by an exchange rate that has shifted toward a weakening of the yen, and significant increases in stock prices. Changes have also been observed in the prolonged situation of deflation.

Science and technology

Japan's expenditure on research and development (R&D) ranks with that of major countries. Researchers in the fields of science and technology (including social sciences and humanities) as of the end of March 2013 totalled 835,700. The total R&D spending in fiscal 2012 amounted to 17.3 trillion yen, a decrease of 0.3 percent from the previous fiscal year.

As of the end of March 2013, the number of researchers amounted to 481,400 persons in business enterprises, 39,000 persons in non-profit institutions and public organisations, and 315,200 persons in universities and colleges. In terms of R&D expenditures in fiscal 2012, business enterprises spent 12.2 trillion yen (70.2 percent of total R&D expenditure), non-profit institutions and public organisations spent 1.6 trillion yen (9.2 percent), and universities and colleges spent 3.6 trillion yen (20.6 percent).

Universities and colleges spend more than 90 percent of their R&D expenditure on natural sciences for basic research and applied research, while business enterprises allocate over 70 percent for development purposes.

Based on the Science and Technology Basic Law that was promulgated and enforced in 1995, the Japanese government has formulated a Basic Plan since fiscal 1996, and has promoted science and technology policies. Currently, the Fourth Science and Technology Basic Plan (fiscal 2011 to fiscal 2015), which has recovery and reconstruction from the Great East Japan Earthquake as one of its main pillars, is being initiated. Within R&D spending in fiscal 2012, the funding used for the three fields the government should address as priority issues set in the Fourth Science and Technology Basic Plan consisted of 792.6 billion yen towards "Promotion of Life Innovation," 560.8 billion yen towards "Promotion

Green Innovation," and 86.8 billion yen towards "Recovery and Reconstruction from the Great East Japan Earthquake." Among these, R&D spending for "Recovery and Reconstruction from the Great East Japan Earthquake" increased by 34.8 percent as compared to the previous fiscal year.

Approximately 90 percent of the 481,400 researchers at business enterprises at the end of March 2013, or 426,700 persons, were in the manufacturing industries; the largest number was in the information and communication electronics equipment industry, followed by the motor vehicle, parts and accessories industry, then by the business oriented machinery industry. In terms of R&D expenditures in fiscal 2012, of 12.2 trillion yen spent by business enterprises, 10.7 trillion yen was spent by manufacturing industries. The motor vehicle, parts and accessories industry spent the most, followed by the information and communication electronics equipment industry, then by the drugs and medicines industry.

Education

Japan's primary and secondary education is based on a 6-3-3 system: 6 years in elementary school, 3 years in lower secondary school, and 3 years in upper secondary school. The period of compulsory schooling is the 9 years at elementary and lower secondary schools. Higher education institutions are universities, junior colleges, and colleges of technology. Other education establishments include kindergartens, which provide pre-school education, and schools for special needs education. There are also specialised training colleges and miscellaneous schools for a wide range of vocational and other practical skills learning. Given the nearly 100 percent upper secondary school entrance rate, the School Education Act was amended in 1998 to authorise combined lower and upper secondary schooling, which began at some lower and upper secondary schools in 1999.

Sources:
Statistical Handbook of Japan 2014, Statistics Bureau, Ministry of Internal Affairs and Communications, Japan http://www.stat.go.jp/english/data/handbook/index.htm

World Bank: (http://data.worldbank.org/indicator/NY.GDP.MKTP.CD)

Japan

Population

2014 estimate: 126,434,964

2011 census: 128,056,026

Largest city

Tokyo

TYO

Capital

Tokyo

Official language

Japanese

1

Currency

Japanese yen (¥) JPY

Internet TLD

.jp

Area

Approximately 380,000 km^2

Joint areas of cooperation

JST-NRF/JSPS-NRF agreements

Overview

In South Africa, the National Research Foundation (NRF) is responsible for promoting science and technology collaboration on behalf of the Department of Science and Technology (DST), while the Japan Society for the Promotion of Science (JSPS) and the Japan Science and Technology Agency (JST) are responsible for promoting science on behalf of Japan. The NRF and the JSPS entered into a memorandum of understanding (MoU) in 2005, following the 2003 agreement on cooperation in science and technology signed between the two countries. The implementation of the NRF/JSPS MoU led to eight annual cycles of calls for joint research funding between the two countries.

On 22 July 2008, the NRF signed another inter-agency bilateral agreement with the JST, on cooperation in science and technology under the Strategic International Research Cooperation Programme (SICP). This MoU was aimed at the joint funding of South Africa-Japan collaborative research. Within the framework of this agreement, the NRF and JST announced and published three joint calls for proposals from interested researchers. The programme is structured as a collaboration between JST, which provides competitive research funds for science and technology projects, and JICA. From 2005 to 2013, about 25 projects were funded under the NRF-JSPS programme, while 11 projects were funded under the JST-NRF programme from 2009 to 2013.

JST-NRF/JSPS-NRF agreements:

- To contribute to scientific advancement in both countries through the funding of joint research activities in specified research fields.
- To provide opportunities for young researchers from both countries to meet and interact.
- To contribute meaningfully to research capacity development.

- To strengthen scientific cooperation between South African and Japanese researchers.
- To promote research exchange in scientific fields which both sides consider important in order to achieve sustainable growth.

Joint areas of cooperation

As per joint decision by the DST, the Japanese Ministry of Science and Technology (MEXT), the NRF, the JSPS and the JST, proposals within the following sub-disciplines have in the past years been regarded as priority areas of cooperation: all natural and social sciences, including the humanities; engineering; biotechnology; information and communication technology; infectious diseases; new and advanced materials; and life sciences. Life sciences are defined as all sciences that have to do with living organisms such as plants, animals and human beings, and encompassing scientific sub-disciplines such as biotechnology, biochemistry, cell biology, biomedical technologies, biomedical devices, genetics and molecular biology, among others. Priority areas within the field of life sciences include nanotechnology (e.g. DNA chips, biological nano-machines, nano-medicine and nano-biotechnology research).

Within the past ten years, South African and Japanese researchers have strengthened relations and collaboration by hosting activities such as researcher exchanges, jointly organised conferences, symposia, workshops, exhibitions and training courses. The joint research projects have advanced into world-class research discoveries aimed at improving the lives of the citizens of both countries and the world at large. The projects are as follows:

SATREPS Programme

Overview

The Science and Technology Research Partnership for Sustainable Development (SATREPS) is a Japanese government programme that promotes international joint research targeting global issues. The programme is structured as a collaboration between JST, which provides competitive research funds for science and technology projects, and JICA. In August 2010, a five-year joint research project on Observational Studies in South African mines to mitigate seismic risks and a three-year joint research project on “Prediction of Climate Variation and its Application in the Southern African Region” were adopted under SATREPS. In 2014, a five-year project on the establishment of early-warning systems for infectious diseases in Southern Africa, incorporating climate predictions, started.

JST-NRF Programme

Fighting TB: Staying ahead of the game

Participating institutions

- South Africa: International Centre for Genetic Engineering (ICGEB) and Biotechnology, hosted at the University of Cape Town (UCT).
- Japan: Riken Biotechnology Resource Centre.

Mycobacterium tuberculosis (*Mtb*) is a pathogenic (disease-causing) bacterial species in the family *Mycobacteriaceae* and the causative contributing agent of most cases of tuberculosis (TB). *Mtb* is a highly successful pathogen with one third of the human population currently infected. Annually, eight million people become ill with TB, and two million people die from the disease worldwide. South Africa is burdened by one of the worst epidemics in the world and is currently ranked third among the high TB burden countries by incidence (WHO Global TB report 2013).

Mtb lives within macrophages and exquisitely weakens the cellular immune response by moulding the transcriptional landscape of the host macrophage for evasion, while at the same time avoiding classical activation of macrophages (caMphs), which would eradicate them effectively due to their efficient nitric oxide killing effector functions in mice. This subverting strategy is key for *Mtb* survival – with the involved mechanisms not well understood.

Macrophages are versatile cells that play many roles. As scavengers, they rid the body of worn-out cells and other debris. Along with dendritic cells, they are foremost among the cells that present antigens, a crucial role in initiating an immune response.

In 2010, a formal collaboration started between the laboratory of Dr Harukazu Suzuki of Riken BioResource Centre, Japan (an expert in molecular biology, genomics and bioinformatics) and the laboratory of Professor Frank Brombacher (an expert in immunology, infectious diseases and genetically engineered animal models) at the UCT and the ICGEB, South Africa. Premising their work on mouse models, the team studied the body's immune system; how it works, regulates its activities, and how it responds to TB. The aim was to decipher how major regulatory networks in the macrophage host cell, which are targeted by *Mycobacterium* evasion mechanisms, influence the immune system and defence of the organisms.

The approach was a genome-wide expression analysis on macrophage activation and *Mtb* perturbation. (Perturbation in biology is an alteration of the function of a biological system, induced by external or internal mechanisms).

It was also in 2010 that the first funding successes emerged, with a grant sponsored by the NRF programme on National Bioinformatics Functional Genomics (BFG). The BFG is a DST contract-funded programme whose aim is to support bioinformatics applications in biotechnology projects in line with national priorities. The strategic aim of this programme is to support the development of human capacity and to create bioinformatics and functional genomics skills which would be applicable to biosciences initiatives and projects in alignment with national priorities as set out in the *South African Biotechnology Strategy* and the *Ten Year Innovation Plan*.

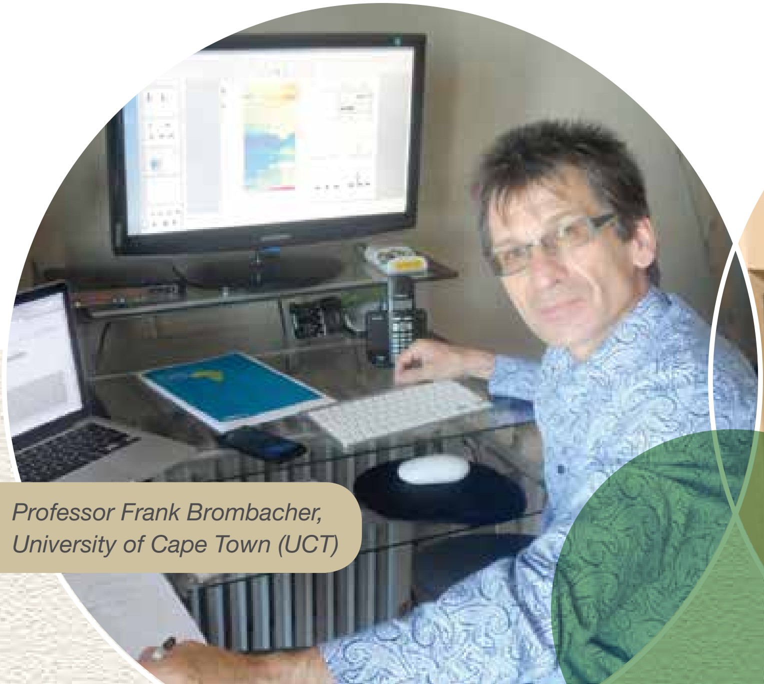
Suzuki and Brombacher's three-year project (2010 to 2013) looked into genome-wide transcriptomics to identify drug/vaccine candidates against TB.

Transcriptomics is the study of the transcriptome – the complete set of RNA transcripts that are produced by the genome, under specific circumstances or in a specific cell – using high-throughput methods, such as microarray analysis. Comparison of transcriptomes allows the identification of genes that are differentially expressed in distinct cell populations, or in response to different treatments. Transcriptomics is an emerging and continually growing field in biomarker discovery for use in assessing the safety of drugs or chemical risk assessment.

They managed to secure funding from the NRF's Competitive Programme for Rated Researchers as well. This is a discipline-based funding instrument which principally supports basic research as the foundation of knowledge production.

In parallel, the team secured Special Coordination Funds for Promoting Science and Technology from the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT) in the same year.

"Moreover, we were able to integrate our transcriptomics project into the FANTOM5 Consortium by OMICS, RIKEN Yokohama, which enabled us to perform the deepest large-scale expression analysis using Cap Analysis of Gene Expression (CAGE) and Next Generation Heliscope Sequencers. This exposed us to the newest bioinformatic tools," adds Prof. Brombacher. This research was done through a collaborative research agreement between RIKEN and UCT in November 2010.



Professor Frank Brombacher, University of Cape Town (UCT)

Thereafter, the team was able to add several additional grants to the project, allowing them to get closer to their long-term goal of rational host-directed drug targeting against TB.

These included:

- A CIDRI/Wellcome Trust, UK 'postdoctoral grant' in 2010.
- An ICGEB equipment grant on 'quantitative PCR analysis' in 2010.
- A UCT and South African National Equipment Programme grant for a 'BSL3 Inhalation and RNA Extraction System for a *M. tuberculosis* drug targeting platform' in 2011.
- A grant from the National Bioinformatics Functional Genomics programme (NBIG) for 'Transcriptomics to identify drug and/or vaccine candidates against tuberculosis' running from 2013 to 2015.
- A Japan (JST)/ South African research cooperation on '*Protective & subversive mechanisms of macrophage genes in M. tuberculosis*', running from 2014 to 2016.

Moreover, this programme provides a subsequent source for new hypotheses and publications – including a paper published in *Nature Genetics* in 2009, one in *PLOSONE* in 2013, a publication in *Nature* and one in the *Journal of Infectious Diseases* in 2014, as well as another two in a revision to be published in *Science* and *PLOSONE* respectively. Another article has been submitted to *PNAS*.

The programme has produced three workshops – one in Yokohama, Japan in 2012 and two in Cape Town, South Africa in 2012 and 2014 respectively.

No programme is complete without a research capacity building element and student exchanges and student graduations are seen as the highlights of this project. During April and May 2011, a contingent of Japanese students travelled to Cape Town and in March 2012, a South African contingent of students travelled to Yokohama. Three students have graduated during the course of this programme. Suraj Parihar, a PhD-student from India, graduated in 2012. Simphiwe Hlungwane of South Africa graduated with a BSc(Med)(Honours) in 2013, while Erin Logan of South Africa earned her BSc(Med)(Honours) in 2012.

FANTOM is an international research consortium established by Dr Yoshihide Hayashizaki and his colleagues in 2000 to assign functional annotations to the full-length cDNAs that were collected during the Mouse Encyclopedia Project at RIKEN. FANTOM has since developed and expanded over time to encompass the fields of transcriptome analysis. The object of the project is moving steadily up the layers in the system of life, progressing thus from an understanding of the 'elements' - the transcripts - to an understanding of the 'system' - the transcriptional regulatory network, in other words the 'system' of an individual life form.

The Riken, UCT and ICGEB *Mtb* programme has enormous potential for bioinformatic and immunological research, for building human and technological capacity and long-term cooperation between South Africa and Japan. The project has great potential for networking with other interested researchers.

JSPS-NRF Programme

Properties, applications and benefits of rooibos and honeybush plants

Participating institutions

- South Africa: Agricultural Research Council (ARC) and Medical Research Council (MRC).
- Japan: Tokyo University of Agriculture and Technology (TUAT).

An exciting cooperation programme investigating the properties and chemistry of the rooibos and honeybush plants, which are indigenous to South Africa, has already produced some promising results. These plants are both used in unique South African herbal teas.

The research team has found evidence of the anti-diabetic effects of rooibos and green rooibos extracts by using cultured cells. In addition, the photoprotective properties of rooibos and honeybush extracts have been elucidated by the collaboration and it appears that these extracts can potentially be used in sun protection products for the skin.

Professor Yutaka Miura of the Laboratory of Nutritional Physiochemistry and Professor Yoshihiro Nomura of the Scleroprotein and Leather Research Institute at the TUAT, have been collaborating with Professor Lizette Joubert of the ARC and Dr Christo Muller of the MRC for four years. The funding for the project is sourced from a joint NRF/JSPS research fund.

Polyphenols are organic chemicals and water-soluble compounds. The major polyphenol in rooibos, aspalathin, was shown to be responsible for its anti-diabetic effects and other polyphenols in the extracts also showed the interesting effects on diabetic animal models. The synergy among polyphenols in rooibos extracts was also elucidated by the research.

Anti-diabetic effects of rooibos

Both rooibos extracts and aspalathin showed their anti-diabetic effects by augmenting insulin-independent glucose uptake, cancelling insulin resistance and protecting pancreatic-cells. The joint research team is now investigating the more precise mechanism for the action of rooibos and aspalathin by transcriptomic or metabolomics analyses and the effect of aspalathin on a diabetic monkey model.

> Transcriptomics, as the global measure of gene expression, has been well developed through microarray technology. Metabolomics refers to the systematic identification and quantification of the small molecule metabolic products (the metabolome) of a biological system (cell, tissue, organ, biological fluid, or organism) at a specific point in time. Mass spectrometry and nuclear magnetic resonance spectroscopy are the techniques most often used for metabolome profiling. Source: http://www.nature.com/subjects

These results are expected to give higher value to rooibos or rooibos extracts, which leads to the wider utilisation of rooibos in health beverages or neutraceuticals.

Photoprotective properties of rooibos and honeybush extracts

The skin protecting effects of rooibos and honeybush extracts hold great promise. By using ultra violet-irradiated hairless mice models, rooibos and honeybush extracts suppressed skin inflammation and increased the skin barrier system. The major polyphenol in honeybush, mangiferin, showed a remarkable skin protecting effect in animal models and suppressed inflammation in skin cells, such as fibroblasts and keratinocytes, which have been cultured *in vitro*.

These results suggest possibilities that rooibos and honeybush can be utilised in cosmetics or neutraceuticals. Because there are many honeybush species, the researchers are now screening for the best honeybush species for this purpose. The outlines and general objectives are illustrated in Figure 1.

Capacity building and training

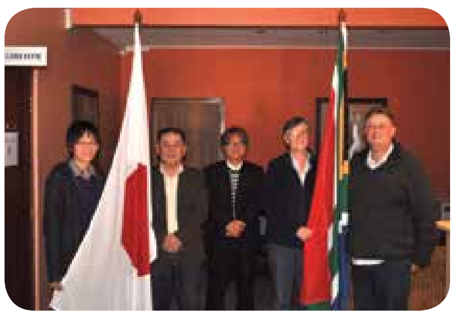
An essential part of this research collaboration is the training of young investigators, which is also encouraged. During the four-year collaboration, a South African post-doctoral fellow and a South African doctoral student visited Japan and exchanged scientific and experimental information, along with mutual cultural communication regarding ethnic behaviour and conduct. A doctoral student and two masters course students from Japan have in turn visited South Africa where they learned experimental techniques and were exposed to South African culture.

These experiences assist in deepening mutual understanding within the research collaboration. The young Japanese students said their visit made a profound impression on them.

This joint research collaboration has produced plenty of innovative knowledge about rooibos and honeybush, especially their health-promoting effects, but it has also resulted in a deeper, mutual understanding of the South African and Japanese cultures.

The results obtained by this collaboration can render these unique herbal teas more valuable and lead the way to their possible use in neutraceuticals and/or functional foods. Both parties have expressed a wish to expand their collaboration in the future and to contribute to further mutual understanding and development of the citizens of South Africa and Japan.

Prof. Yutaka Miura (left) and Prof. Yoshihiro Nomura (centre) of TUAT with Prof. Lizette Joubert of the ARC during a visit to the project's honeybush nursery



The members of the joint research project at the MRC

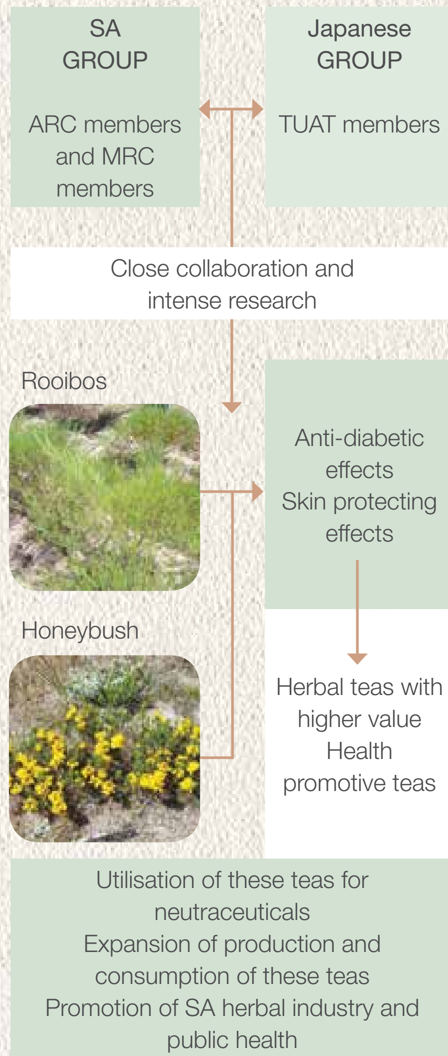


Figure1. The outline and general objective of the collaboration

SATREPS (JICA-JST-DST) Programme

Infectious diseases early warning system developed for Southern Africa

Participating institutions

- South Africa: Applied Centre for Climate and Earth Systems Science (ACCESS) at the Council for Scientific and Industrial Research (CSIR), Universities of Limpopo, Cape Town, Western Cape and Pretoria, the Medical Research Council (MRC) and the Department of Health, Limpopo.
- Japan: Nagasaki University and the Japan Agency for Marine-Earth Science and Technology (JAMSTEC).

Led by the Nagasaki University in Japan, a new Science and Technology Research Partnership for Sustainable Development (SATREPS) project was launched in May 2014. The five-year project is aimed at developing an infectious diseases early warning system for Southern Africa incorporating climate predictions in the region (iDEWS).

Although the Japan International Cooperation Agency (JICA) concerns itself with economic growth, its efforts would be futile if it ignored factors affecting human survival, especially given that earth has become fragile due to rapidly changing environments extending to climate variations. Nevertheless, living in the 21st century has its advantages. This includes access to resources such as sophisticated technology and highly skilled experts, which improves JICA's ability to mitigate the impact of climate variations, allowing us some control over nature's forces.

The new project, titled *Establishment of an Early Warning System for Infectious Diseases in Southern Africa, incorporating Climate Predictions in South Africa*, was selected as one of ten from 98 proposals received globally. Given the wealth of experience which Nagasaki University has accumulated on infectious diseases in Africa, the project is expected to produce significant results through a large-scale fusion of South African and Japanese researchers.

The Department of Science and Technology (DST), as the lead agency on the South African side, coordinates technical input from both the national and provincial (Limpopo) health departments. The local research consortium is led by the ACCESS, with input from the CSIR, the universities of Limpopo, Cape Town, Western Cape and Pretoria, the MRC and the Department of Health, Limpopo.

Disease early warning systems are management tools to predict the occurrence of epidemics of infectious diseases. Climate-based early warning systems have been developed for tropical diseases such as malaria, whose transmission is sensitive to environmental conditions. Early warning systems are also instruments for communicating information about impending risks to vulnerable people before a hazardous event occurs, thereby enabling actions to be taken to mitigate potential harm, and sometimes, providing an opportunity to prevent the hazardous event from occurring. Early warning systems are routinely used for hazardous natural events such as hurricanes and volcano eruptions. In contrast, until recently, very little attention has been paid to the development of such systems for infectious disease epidemics.

Working groups ensure participatory process

To attain project goals in accordance with the agreed operational plan, six thematic working groups were established, with members from both the South African and Japanese sides serving in these groups in order to ensure a participatory process. Themes include malaria and vector ecology, pneumonia and diarrhoea research, environmental risk assessment, disease transmission models, climate prediction systems, and social links.

The project aims to develop a good practice model for climate-based early detection of infectious diseases such as malaria, pneumonia and diarrhoea. Although the project targets the lowveld area of Limpopo as pilot, given the high prevalence of these diseases in the province, project outcomes could be applied to other parts of the country if proven successful.

The project succeeds the first ever SATREPS project launched in South Africa, which looked at climate variations and its application in Southern Africa. The project utilised the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) Earth Simulator, dubbed Japan's "supercomputer", to replicate an artificial Earth to forecast climate variations up to a year in advance. An impressive pool of resources established a multi-model ensemble system, and applied the newly-developed SINTEX-F model for capacity enhancement on seasonal climate prediction. Besides scientific outcomes, the project fostered a network of researchers, and empowered a younger generation of researchers.

A formidable force is assembled

The partnership between South Africa and Japan, and the project team comprising reputable individuals and organisations, make a project of this kind a formidable force. Moreover, this is a rare opportunity for all project stakeholders to align their respective mandates to the significant mandate of infectious diseases control. As will be reaffirmed by the project's findings, early detection of health risks for timeous and appropriate measures is invaluable within the larger development agenda.

The outbreak of Ebola in the western parts of Africa early in 2014, which saw the international development community forging efforts to address this crisis, is an example of how stakeholders could work together to mitigate the impact of diseases in pursuit of saving lives. Although the project focuses only on malaria, pneumonia and diarrhoea, for which the prevalence is more common but not as severe as other diseases seen in Africa, of note Ebola, it nevertheless factors in the damage which could be caused by not being prepared for outbreaks.

Dr Phil Mjwara, Director-General of Science and Technology, speaks at a symposium held at the DST in Pretoria in August 2014, during which he welcomed iDEWS, which he believes would complement South Africa's initiatives to improve the public health sector.

The project will bring together researchers from a wide range of disciplines to use state-of-the-art technology to address fundamental health problems. The project will also serve as a foundation for adaptations that society needs to make to protect the health of current and future generations against extreme weather events associated with climate change. Hence, both the South African and the Japanese partners are commended for recognising this initiative as an invaluable one, and for facilitating the sharing of experience and good practice.

Signing the project's MM, in essence "sealing the deal", are project counterpart representatives Lisa Du Toit, Director of Development Partnerships at DST, Dr Neville Sweijd, Acting Director at ACCESS, Prof. Noboru Minagawa, Lead Researcher at the Nagasaki University, and Hiroyuki Kinomoto, Chief Representative of the JICA South Africa Office.

Overcoming seismic risk for sustainable, safe South African deep gold reserves

Participating institutions

- South Africa: University of the Witwatersrand, CSIR and Council for Geoscience (CGS).
- Japan: Kyoto University, Ritsumeikan University, the University of Tokyo, Geological Survey, Tohoku University, Kagoshima University, Tono Research Institute of Earthquake Science, Nagoya University, Kanazawa University and Hokkaido University.

Gold mining, one of the most important industries in South Africa, has over the past century directly employed hundreds of thousands of people. To this day, the industry represents 18% of South Africa's gross domestic product. However, gold production in South Africa has decreased sharply in recent years. Although eight of the ten deepest mines in the world reside in a particular region of South Africa, large ore resources remain in highly stressed pillars or at depths reaching four kilometres and more. Rockbursts pose a risk to workers in overstressed mines such as the deep gold mines in the Witwatersrand Basin of South Africa. The rockface temperatures at these depths can reach 60˚C.

At this depth, temperature is not the only major concern. The valuable ore can only be mined if the risk posed by seismicity is overcome.

This challenge has given rise to the first Japan Science and Technology Agency (JST)-Japan International Cooperation Agency (JICA)-Science and Technology Research Partnership for Sustainable Development (SATREPS) project titled Observational studies in South African mines to mitigate seismic risks (2010-2015) among JST, JICA and DST. The project was launched in August 2010 to address the risks posed by both tectonic and mining-related earthquakes. The aims of this five-year project are:

- To learn more about earthquake preparation and triggering mechanisms by deploying arrays of sensitive sensors within rock volumes where seismic activity is likely to be induced or triggered by mining.
- To learn more about earthquake rupture and rockburst damage phenomena by deploying robust, strong ground motion sensors close to potential fault zones and on stope hanging walls.
- To upgrade the South African surface national seismic network in the mining districts.
- To transfer technology and build capacity in South Africa.

Japanese seismologists are eager to monitor the rock mass in close proximity to earthquake hypocentres to gain a detailed understanding of preparation and rupture processes to mitigate hazards of huge natural earthquakes, such as the 2011 M_w 9.0 great Tohoku earthquake.

Japanese scientists have long been active within some of the deepest mines in South Africa, carefully studying and monitoring seismic activities underground. It has been shown that seismic events can be recorded at a close range within the mines, and that under certain conditions, the location and size of seismic events can be foreseen. The deep gold mines of South Africa are uniquely suitable for such research, and with the scientific understanding obtained, scientists will be able to better understand seismic mechanisms and advance their efforts to forecast seismic events.

It is for these purposes that the South African-Japanese collaborative research work on mining-induced seismicity at deep levels in South African gold mines started in 1992. The efforts were undertaken with the endorsement of the International Association of Seismology and Physics of Earth's Interior in 1991 and were funded by the Japan Science Promotion Society (JSPS) as part of the agreement between the University of the Witwatersrand and Kyoto University.

In the ensuing decades, South African gold mines have offered Japanese seismologists indispensable earthquake research fields. These efforts were funded by JSPS. They included the Observation and Research Program for Prediction of Earthquakes and Volcanic Eruptions (Ministry of Education, Culture, Sports and Technology), Ritsumeikan University, and the 21st Century Center of Excellence Program of Tohoku University. Building on previous and on-going activities, the SATREPS project Observational Studies in South African Mines to mitigate Seismic Risks (2010-2015) enhanced Japanese-South African collaboration significantly.

The Mponeng Mine stress measurement team after a hard day's work. Rockface temperatures can reach 50°C and the mine pumps slurry ice underground to cool the tunnel air to below 30°C. A return trip from the surface to the measurement site at the bottom of the mine takes over an hour.

Seismic damage in a mine puts lives at risk. The knowledge gained during the course of the project and the new infrastructure installed will contribute to efforts to improve seismic hazard assessment and mitigate the rockburst risk.

Academic collaboration over the years has involved Ritsumeikan University, the Tokyo University, Geological Survey, Tohoku University, Kyoto University, Kagoshima University Tono Research Institute of Earthquake Science, Nagoya University, Kanazawa University, and Hokkaido University on the Japanese side, and the CSIR, University of the Witwatersrand and Council for Geoscience on the South African side.

Private sector involvement has included companies such as Techno Sugaya, Akema Boring, 3D Geoscience and Home Seismo on the Japanese side, and ISS International (now the Institute of Mine Seismology), Anglogold Ashanti, Goldfields, Sibanye Gold, First Uranium, Gold One, Simmer & Jack, DRD Gold, Harmony, Seismogen, Open House Management Solutions and Groundwork on the South African side.

Input resources and Japanese technologies

During the period under review, more than 100 researchers and mine rock engineers have been collaborating. From 2010 to 2014, 36 JICA short-term experts resided in South Africa. Since 2009, a comparable number of Japanese researchers and graduate students furthermore visited South Africa for research activities in other projects.

JSPS funding provided an opportunity where more than 80 holes, with a total length of 2.8 km, were drilled underground at depths of up to 3.4 km. Some of these were probed with a borehole scope to identify the target earthquake faults. JICA donated over 100 sensitive instruments that were installed to detect very small earthquakes and subtle rock mass deformation to delineate earthquake preparation and strong motion generation.

On the surface, JICA handed over ten strong motion seismometers to expand the Council for Geoscience's South African National Seismograph Network (SANSN) in the far West Rand. JICA also donated a Japanese automatic hypocentre location system, which was implemented not only in the far West Rand but also in Klerksdorp and the central Rand districts. Prior to 2010 there were only a few stations in these districts, whereas now there are more than 50 fundamentally enhanced stations. Japanese tools that demonstrate a stress measurement technique were also donated by JICA and a practitioner was sent to South Africa by JST to transfer the technology skills.

Enhanced seismic monitoring delivers unprecedented outcomes

Deep-level gold mines deploy their own in-mine seismic monitoring systems – typically a few series of geophones at intervals of about 500 m. These systems can pick up earthquakes down to about one metre in size (Mw=about minus two). Based on the monitoring, routine seismic hazard assessment schemes are conducted.

These in-mine seismic networks cannot however achieve the very fine delineation of rupture planes that are caused by smaller seismic events. Japanese researchers therefore deployed dense networks consisting of many acoustic emission (AE) sensors at an experimental site. Although the extent of the AE network was limited, the network could detect seismic events much smaller (several centimetres in size; Mw=about minus four) than the in-mine seismic system could detect. They successfully delineated very small earthquakes in planer clusters as well as their evolution in time and space. They also successfully found the difference in seismological characteristics between the newly generated fractures ahead of stopes and those moving with the advance of mining faces and those staying on existing geological structures.

Drilling into the M2 hypocentre, the AE monitoring successfully delineated a seismic rupture plane of an M2 earthquake (about 100 m across) at one of the experimental sites. This enabled an ambitious drilling attempt to intersect the hypocentre of the M2 event. Rock mass in the hypocentral area was investigated in detail. The stress and strength of the rock mass around the hypocenter was successfully estimated.

A Japanese technique enabled stress measurements in a range of depths and stresses significantly larger than those in previous measurements: Knowing the stress in the rock mass is critical in evaluating the seismic hazard. However, there have been no published results of stress measurements measured at depths beyond 2.7 km from the surface or under a maximum principal stress greater than about 90 MPa in South Africa. The Japanese technique enabled measurements beyond this range (down to 3.4 km from surface and the maximum principal stress up to 146 MPa, corresponding to the expected virgin stress at 5km depths).

Japanese sensitive strain monitoring: Forerunning strain change was clearly recorded prior to a seismic event. Japanese strainmeters were sensitive and stable enough to allow the calibration of stress modelling for the case where the non-linear effect prevails. Dynamic strain changes were also clearly recorded for a great remote earthquake (Mw>8) and local large events (3<M<6) that would allow for discussions on the source process and site response.

The M5.5 on 5 August 2014 and significant events in the same month: A M5.5 (CGS), one of the large events in the history of South African earthquakes, took place near Orkney on 5 August 2014. In the same month some larger events also took place in the Far West Rand area. These events were too strong to be fully recorded by nearby stations in the in-mine seismic network. However, they were successfully recorded both by the CGS SANSN on the surface and the SATREPS underground strainmeters, which will allow the researchers to discuss the cause of the events, to delineate detailed rupture processes and to improve the prediction accuracy of surface strong ground motion.

Human resource development

On the Japanese side, three researchers were promoted to positions as a professor and associate professors respectively, two graduate students obtained PhDs and seven students earned their MSc degrees. On the South African side, three young scientists had the opportunity to spend a short period of time on training in Japan, two obtained MSc degrees and two are expected to obtain PhD degrees in the near future. Five South African underground technicians were extensively trained to manage projects in several gold mines, which included drilling, installation, and monitoring.

Current key deliverables/outputs (and targets) of the project for 2014

- Monitor acoustic emissions and the deformation of the rock mass associated with mining at research sites in three deep gold mines: Cooke 4 Shaft (previously Ezulwini), Hlanganani Shaft of the Kloof-Driefontein Complex (KDC), and Moab Khotsong.
- Monitor seismicity using the network of ten surface seismic stations established in the Far West Rand.

Project plan

The main components of the project are:

- Investigation of the properties of the source rock through on-site observation, sample collection and laboratory analysis.
- Sensitive studies of the preparation zone of impending earthquakes, through the installation of sensors, collection and analysis of data.
- Hazard assessment, through the integration of mining, rock property, rock deformation and seismicity data.
- Strong motion studies of ground motion and dynamic stress changes that accompany rupture, through the installation of sensors, collection and analysis of data.
- Upgrading of the South African National Seismograph Network (SANSN) by installing a ten-station surface network in the far West Rand, and the Kinemetrics Antelope analysis system that enables quicker processing of seismic data.

In general, the plan was to install instruments and conduct background monitoring during the first two and a half years of the project (August 2010 – December 2012); and collect data during the next two years (2013 and 2014) as mining takes place in the vicinity of the target faults. Data processing, analysis and interpretation will take place throughout the project, but will intensify during 2014 and 2015.

Project activities

- Acoustic emission sensors, strain meters and tiltmeters have been installed and data is being collected, processed and analysed.
- Two members of the South African team (Thabang Kgarume of CSIR and independent consultant Dr Steve Spottiswoode) spent November 2012 in Japan. Tawanda Zvarivadaza and Dr Halil Yilmaz, both from the School of Mining Engineering at the University of the Witwatersrand, visited Japan in 2013. The aim of the visits is to transfer knowledge and technology.
- The ten-station surface network has been installed, Vs30 site surveys have been conducted, and data is being collected.
- Geological and fracture mapping has been carried out in stopes.

Project research outputs from 1 November 2012 to 31 January 2014:

- Two papers were published in international journals.
- 13 peer-reviewed papers were published in the proceedings of international conferences held in Japan, Sweden, Russia and South Africa.
- One invited talk was presented to a South African professional society.
- Seven other talks presented at conferences in South Africa, Australia, Austria and Pakistan.

Impact(s) of the project

The risk posed by seismicity in South African mines is exemplified by an accident that occurred at Harmony's Doornkop Mine, 30 km west of Johannesburg, on the afternoon of Tuesday 4 February 2014. According to company announcements and press reports, a M2.4 seismic event triggered a rockfall in mine workings some 1700 m below surface that damaged water and level haulage. It is speculated that the fire was ignited by the damaged electrical cables. Rescue teams were immediately dispatched underground, but access to the affected area was being hampered by smoke and the fall of ground. Most workers were brought to the surface shortly after the incident. By late Tuesday evening 18 miners were missing. One miner was rescued around 22h00. Around 07h00 on Wednesday morning eight workers were found unharmed in a refuge bay and brought to the surface. The bodies of the missing nine workers were subsequently found. This is the worst accident in a South African mine since July 2009, when nine workers were killed by a fall of ground on a platinum mine.

The project draws on over a century of South African and Japanese research experience with respect to mining-related and tectonic earthquakes, respectively. The Japanese collaborators devoted a significant amount of effort to the adaptation and application of advanced Japanese technologies to the mining environment, notably:

- Laboratory techniques to detect rock fracturing at the onset of rock mass instability.
- Exceptionally sensitive sensors that were originally developed to monitor natural earthquakes and crustal deformation.
- Techniques to measure rock stress.

South African technicians, practitioners and scientists have been trained to use these technologies for routine monitoring and research in South African mines. It is anticipated that the knowledge gained during the course of the project and the new seismic monitoring infrastructure that has been installed will improve seismic hazard assessment methods in South African mines and mitigate the rockburst risk. It is also anticipated that new knowledge of earthquake physics will contribute to mitigate the risks posed by tectonic earthquakes.

JICA-DST Technical Cooperation

Knowledge-based economies depend on good earth observation

South Africa's Ten-Year Innovation Plan identifies earth observation as one of the disciplines of strategic importance to South Africa. Earth observation has the potential to contribute to key outcomes of government that include monitoring of sustainable human settlements, natural resources and environmental management, rural development and infrastructure assessment, climate change, and health and disaster management. As South Africa seeks to move away from a resource-based economy into a more knowledge-based economy, there is an increased dependence on decision-support systems that use earth observation information.

South Africa's advances and ambitions in space science and technology warrant co-ordination, and as such the DST established the South African National Space Agency (SANSA) to implement this process, driven by the department's national space strategy.

SANSA's mandate revolves around promoting the peaceful use of space and supporting the creation of an environment conducive to industrial development in space technology. The agency fosters research in space science, communications, navigation and space physics. It advances scientific, engineering and technological competencies and capabilities through capital development outreach programmes and infrastructure development. SANSA also fosters international cooperation in space-related activities.

JICA's expert, Mr Yoshikawa and SANSA's Earth Observation Team

> "...there are many possibilities to explore, including the opportunity to support each other in areas such as the tracking of satellites, downloading of observation data, offering a reference station for the navigation satellites and so on."

Given the aforementioned, DST and the Japan International Cooperation Agency (JICA) entered into an agreement to implement a bilateral technical cooperation project titled Earth Observation Advisor, aimed at strengthening the human capacity of SANSA officials and other related public institutions for earth observation.

The three-year DST-JICA Earth Observation Advisor project commenced in September 2014. JICA has sent an advisor to SANSA to assist in implementing the programme. This is the first JICA advisor to be dispatched to a foreign space agency. In this regard, the project would serve as foundation to build a new and deeper relationship in space-related matters between South Africa and Japan.

Geographically, Japan and South Africa are located at the very opposite ends of the earth. However, there are many possibilities to explore, including the opportunity to support each other in areas such as the tracking of satellites, downloading of observation data, offering a reference station for the navigation satellites and so on.

Furthermore, JAXA and the Japanese space industries have expressed a willingness to contribute to the implementation of the National Space Strategy of South Africa. They are looking at possible assistance in developing satellites and earth observation mission equipment, as well as providing assistance with launches and ensuring that applications materialise and are subsequently industrialised.

HITACHI-DST Programme

Intensive training programme for South African engineers

One of the flagships of the ten years of successful science and technology cooperation between South Africa and Japan is the DST-Hitachi Scholarship Programme, which provides young South African engineers with advanced, on-the-job training. The objective of this programme is to enhance the capacity of South African engineers in the areas of power transmission and distribution, in support of the country's social infrastructure development programme.

Since its inception in 2009, a total of 16 recipients have jetted off to Japan for several months of extensive training. The engineers gained an overview of the Japanese market, learned about basic and advanced technologies and obtained insights into Hitachi's operations. In addition to this on-the-job training, the candidates visited other Japanese facilities too, where they gained first-hand knowledge of how these facilities are operated and maintained.

The most recent intake of three candidates took place in August 2014.

In addition to the on-the-job training at Hitachi factories and visits to Japanese power utilities, the three-month scholarship will provide a Japanese introductory course at The Overseas Human Resources and Industry Development Association (HIDA).

Joint seminars on policy, programmes, technologies and interventions

The DST-Hitachi Scholarship Programme has been of great mutual benefit and as a result, a third memorandum of understanding between the two parties was signed in August 2012 to continue the scholarships programme and to roll out joint seminars to be held bi-annually on strategic topics relevant to South Africa's National Development Plan.

The DST and Hitachi will co-host the seminars to create a platform for knowledge sharing in areas such as infrastructure development, energy, water, as well as information and communication technologies, among others. The first seminar took place in September 2013 at the DST and focused on global lessons from Hitachi on implementing large-scale infrastructure projects. The second seminar, held in April 2014, looked at how to capacitate water and sanitation departments at municipalities. The seminars are designed as knowledge sharing platforms on policy, programmes, technologies and interventions.

Success stories

Rendani Munzhedzi: Quality of Supply Engineer

Impact on career

"The scholarship surprisingly opened my eyes to the South African electricity industry. This is because I started making comparisons, and thereby started to learn more about the industry in my own country. On my return, I started to better understand the constraints of our network, particularly the challenges that we face in terms of Quality of Supply, which Japan does not have because of their strong network."

Personal development

"I was exposed to the Japanese work ethic, which is focused on disciplined execution of all tasks, at all levels. The Japanese culture was refreshing to experience, and also made me appreciate the diversity of South Africa. I was particularly impressed with the pride that the Japanese showed in their culture and history."

Coenrad Ehlers: Turbine Engineer, Rotek Industries

Impact on career

"The scholarship content was comprehensive in the sense that Hitachi's technology for the whole energy cycle was discussed. This knowledge helped me to better understand the relationships and interdependencies between the various energy systems and the adverse effects that one's actions could have on other systems. Hitachi's Smart technologies and renewable technologies helped me to realise the potential that we have in South Africa and increased my appetite for innovation in these fields. Overall, the scholarship has helped me to think more critically and at the same time more 'outside of the box', when it comes to energy solutions. The scholarship has also helped me to understand the potential that Hitachi (now Mitsubishi Hitachi) has as a major player in the energy sector."

Personal development

"The scholarship was an opportunity to visit a part of the world that I have never seen before. Japan is a beautiful country and is well-developed and clean throughout. The Japanese people are friendly, disciplined, accommodating and extremely helpful. The cultural differences were big in some cases and smaller in others, but all in all the scholarship gave me the opportunity to soak up the Japanese culture and to learn from the Japanese people. Throughout the visit I also realised the positive impact that a well-developed public-transport system has on the economy and the morale of people in general. We were never delayed due to transportation being late in Japan. Amazing! I will visit Japan again any day, hopefully sooner rather than later."

Tembela Mpeta: Project Supervisor

Impact on career

"I was awarded a scholarship by DST in partnership with Hitachi and Eskom to study through the Association for Overseas Technical Scholarship (AOTS) in Japan. I spent six weeks at the Chubu Kenshu Centre in Nagoya City learning basic Japanese. I also learnt more about leadership, business manner and the characteristics of Japanese companies and in particular Japanese infrastructure-related companies. I also got to visit the Toyota disaster learning centre and Japan's largest coal-burning thermal power station Hekinan. For the next phase of my training, I moved to Babcock-Hitachi's Kure works in Hiroshima for technical training. I underwent intensive technical training on boilers and turbines, as well as on nuclear, solar and wind energy technologies."

Mufunwa Denga: Senior Electrical Engineer

Impact on career

"The scholarship gave me exposure as well as the opportunity to be involved in design projects as I was in an operating and maintenance environment. After the scholarship, I was able to finish compiling my Engineering Council of South Africa report for professional registration and submitted it. I was a technical support engineer prior to the scholarship and was subsequently appointed senior electrical engineer after the scholarship."

Personal development

"The design exposure as well as the manufacturing exposure went a long way towards making my application complete and suitable for consideration. I secured my professional registration and have advanced in my career to become a senior electrical engineer."

Sicelimpilo Zuma: Senior Engineer

Impact on career

"My experience with the DST-Hitachi scholarship cannot be summarised within the confines of any documents. I have been inspired by the dedication and selflessness of the Japanese people. They have proven that the human mind can achieve whatever it desires. The work of the founding father of the Hitachi organisation has shown that one man's vision can improve the lives of many people. I have since studied for my Masters in Engineering Management to gain knowledge of manufacturing and technological developments. I have applied the lessons learnt on the power systems to improve our maintenance strategies. Using kaizen and other principles I have been able to improve the working environment through the teamwork approach."

Hitachi was founded in 1910 by electrical engineer Namihei Odaira in Ibaraki Prefecture. The company's first product was Japan's first 5-horsepower electric induction motor, initially developed for use in copper mining. Odaira's company soon became the domestic leader in electric motors and electric power industry infrastructure. http://hitachi.com/about/corporate/history/

Kaizen (改善) is Japanese for "good change". When used in the business sense and applied to the workplace, kaizen refers to activities that continually improve all functions and involve all employees from the CEO to the assembly line workers. It also applies to processes, such as purchasing and logistics, that cross organisational boundaries into the supply chain. By improving standardised activities and processes, kaizen aims to eliminate waste. Kaizen was first implemented in several Japanese businesses after the Second World War, influenced in part by American business and quality management teachers who visited the country. It has since spread throughout the world and is now being implemented in environments outside of business and productivity.

Future plans

"I am drafting a proposal to establish a working relationship with the Department of Trade and Industry and the Department of Education. I would like to see them introduce applied research, based on reverse engineering, to technical colleges in order to expand manufacturing in local municipalities and to build educational laboratories for every local municipality in South Africa where technology can be experienced and manipulated to build a knowledge economy."

"What my stay in Japan showed me was that it is possible for a nation of people to fight back against any adversity that they may be facing. That if we as a nation can be united in our cause and work in harmony to achieve our developmental goals we can win the battle against poverty, inequality, crime and other ills that effect our society. This is knowledge I intend to use in the future to contribute to the development of South Africa as a whole, in whatever job I may be assigned in future"

Aveshan Venketsamy: Engineer (Turbines)

Impact on career

"The scholarship training involved the design and manufacture of power generation equipment. It also involved aspects of management in the manufacturing sector when it comes to engineering. This training has broadened my knowledge, and it has added great value to my engineering career holistically. It has benefited my decision-making and analysing ability, allowing me to synthesise problems in a critical manner. I have learned to develop solutions with a broader mindset of knowing the in-depth engineering that goes into manufacturing equipment. I had to perform presentations at key points during the scholarship, which involved interaction with the Japanese."

Personal development

"From a cultural perspective, the training provided a platform for interactions with the Japanese people. I learnt about the principles used by the Japanese people in the workplace. This is the main cultural aspect that I brought back to South Africa. Other personal experiences with the country and people have changed me as a person, as they taught me values, especially about paying special courtesy to other people and to your surroundings."

Nhlanhla Rikhotso: Gas Turbine System Engineer

Impact on career

"The scholarship gave me a broad technical overview of power systems and power system behaviour. It enhanced the knowledge of what I already knew, as well as taught me a lot about things I knew very little or nothing of in the power systems arena. As the Gas Turbine Systems Engineer at the Kendal Black Start Facility, I am required to have a good knowledge and understanding of gas turbines and all the accessory equipment that supports its operation. The scholarship extended my knowledge in this area and allowed me to see things (such as gas turbine internals) that I would not ordinarily see. I am also required to have a working knowledge of 'limited bus' power systems as well as 'infinite bus' power systems. The scholarship increased my competence in this specific area by a considerable amount. This puts me in a position to better analyse and solve complex and multidisciplinary engineering problems. The scholarship also broadened my knowledge in a variety of fields such as boiler systems, distributed control systems, air quality control systems and renewables. Overall, the scholarship added a lot to my technical knowledge and has enabled me to be better at my current occupation."

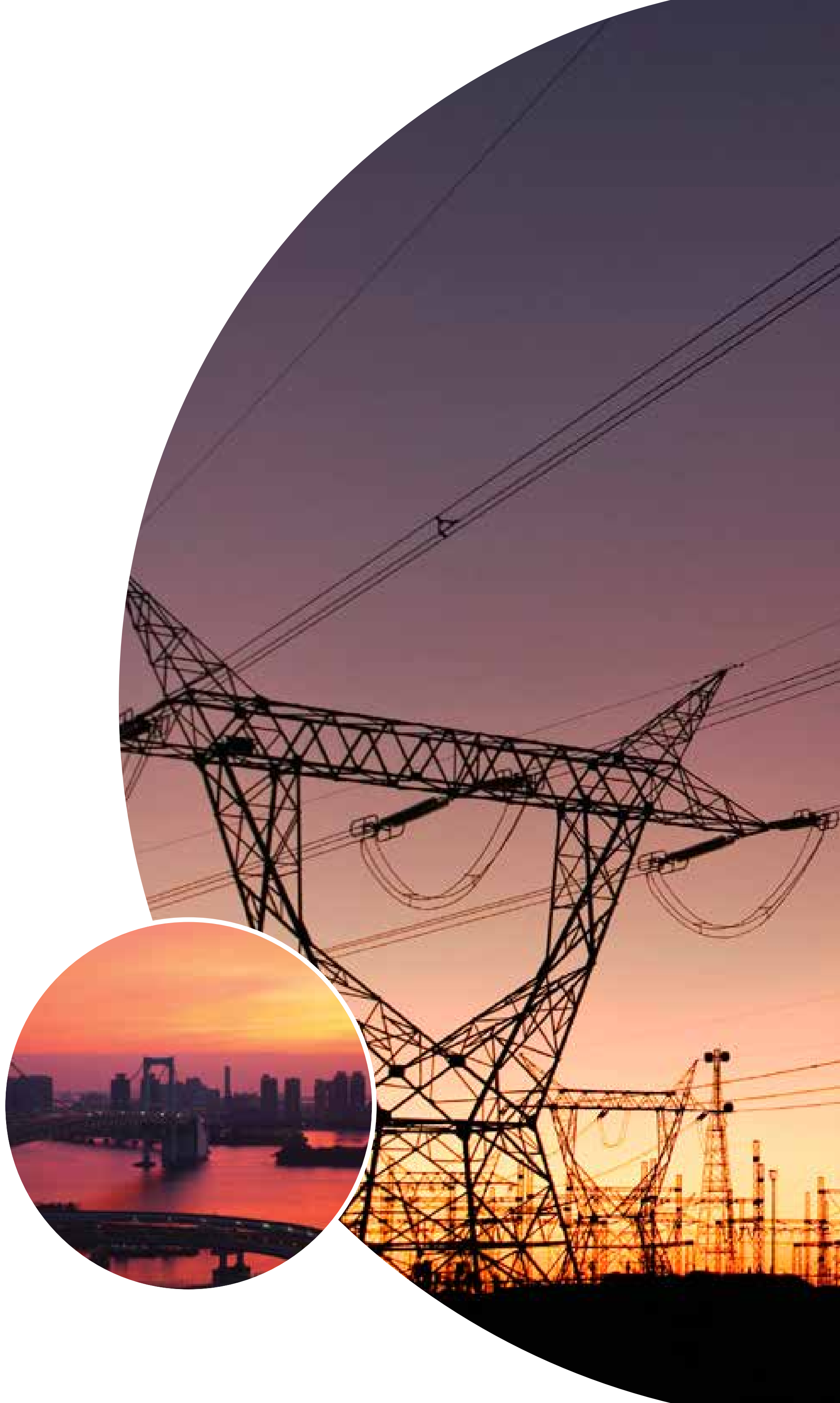
Personal development

"On a personal level, I really enjoyed Japan. I enjoyed the people, the food, the environment and the culture of Japan. I found the Japanese to be very respectful, hardworking, honest and polite. I found the Japanese to have very admirable characteristics from which we as a nation can learn a lot. What I found most impressive was how they, as a nation, fight back when faced with adversity such as earthquakes, tsunamis, torrential rain, lack of natural resources and a lack of space. Although I could not understand most of the Japanese language, I found it easy to 'hear'. I also found that it was becoming easier and easier to learn the language over time. My stay in Japan also showed me what can be done with limited space. I saw how a city can be very large but with a very small area footprint relative to its population. And yet, it still did not seem cramped. My stay also showed me what can be achieved when you have unity and harmony within a society.

Lastly, what my stay in Japan showed me was that it is possible for a nation of people to fight back against any adversity that they may be facing. That if we as a nation can be united in our cause and work in harmony to achieve our developmental goals we can win the battle against poverty, inequality, crime and other ills that effect our society. This is knowledge I intend to use in the future to contribute to the development of South Africa as a whole, in whatever job I may be assigned in future."

Wish

"I would have liked to have a greater component of maintenance training during the scholarship. I would have liked to have participated as an observer in a gas turbine outage for instance. This would have been of much value to me."



Cooperation between universities

Overview

There are 24 memorandums of understanding (MoUs), including faculty level MoUs, between the universities in Japan and the universities in South Africa and three MoUs between Japanese universities and research institutions in South Africa. The MoUs include either student exchange or academic research or both elements.

Some universities in Japan are seeking cooperation with universities in South Africa, because South Africa is renowned for good quality researchers within the African continent. In 2013, the Tshwane University of Technology and the Nagaoka University of Technology signed an MoU that will promote student exchanges and the exchange of academic researchers. More recently, in 2014, the North-West University and the Hokkaido University signed such an MoU for future collaboration. It is expected that research collaboration will be enhanced through such cooperation among Japanese and South African universities.

Examples of university cooperation include:

- Tshwane University of Technology and Nagaoka University of Technology.
- Hokkaido University and North-West University, University of Johannesburg.
- Hiroshima University accepting students from two universities in South Africa.

SA graduates jet off to Hiroshima for biosphere science summer school

Participating institutions

- South Africa: University of KwaZulu-Natal and North-West University.
- Japan: Hiroshima University.

The Graduate School of Biosphere Sciences at the Hiroshima University hosts an annual International Summer School in Biosphere Science to deepen friendships and international academic exchanges with international students and young researchers.

The 2013 summer school was held from 4 to 14 September. During the six-day event, 15 students and researchers from Korea, Taiwan, Indonesia, Thailand and South Africa exchanged ideas, debated, attended workshops and visited research facilities. They also took time off to visit the atomic-bomb dome in Hiroshima Peace Memorial Park, a UNESCO heritage site, to mention but a few.

The South African contingent comprised Tlhompho Gaoshebe, who is enrolled for a master's degree at the University of KwaZulu-Natal (UKZN), and Dr Marizvikuru Manjoro from North-West University (NWU).

On the first day, after the welcoming ceremony, participants visited a farmers' association in the Kouchi-cho area. The international visitors had the opportunity to witness a new industrial trend in Japanese farming systems, in which farmers participate not only in producing agricultural products but also in processing and marketing. The rural communities and farms in Kochi-town are leaders in this so called 'sixth industry'.

On the second and third day, participants had the choice of engaging in one of seven professional programmes: seaweed biology; food physical properties measurement; protein purification and analysis; fish fauna; food preservation technology or functional food. Each group was accompanied by Japanese assistants as they learnt cutting-edge research techniques and skills. The two participants from South Africa joined the food preservation technology programme.

"During a study tour, participants visited the Itsukushima Shrines, Miyajima Island and the Hiroshima Peace Memorial Park to learn about the history of Hiroshima," says Professor Kazuhiko Koike, PhD Graduate of the School of Biosphere Sciences at Hiroshima University, and chairperson of the International Exchange Committee in 2013.

Prof. Koike said that activities culminated in a panel discussion. Some 30 students from the Graduate School of Biosphere Sciences and international participants exchanged views during the discussion. Over two-thirds of attendees presented their research papers on the last day.

To conclude the programme, a heart-warming garden party was held and participants further strengthened their exchanges with the students and professors of the University of Hiroshima.

Tlhompho Gaoshebe from the University of KwaZulu-Natal gives a presentation during the group discussion

Programme work

Farewell

One of Japan's top universities signs agreements with two SA institutions

Participating institutions

- South Africa: University of Johannesburg (UJ) and North-West University (NWU).
- Japan: Hokkaido University.

Hokkaido University has a strong bond with the southern African region and focuses on research-in-action as a theme. This illustrious Japanese university signed its first South African academic exchange agreement with the UJ in 2008. Academic exchanges with the Mafikeng and Potchefstroom campuses of NWU were formalised in early 2014.

Hokkaido University established a regional office at the Department of Disease Control, School of Veterinary Medicine, University of Zambia, in Lusaka, Zambia in 2012 on the basis of a long lasting successful relationship between the Japanese university's Graduate School of Veterinary Medicine and the Zambian university's Samora Machel School of Veterinary Medicine. It is through the Zambian office that the Japanese university maintains its collaborations on the African continent.

Hokkaido University is one of the most prestigious universities in Japan and is ranked as one of the top 100 science and research universities in the world. The institution is considered the 23rd best university in Asia and 138th best university in the world.

As Hokkaido University expands its activities and networks around the world, this regional office supplies information about the university to higher education institutions in the southern African region, including South Africa.

Collaboration between UJ and Hokkaido University matures and intensifies

The relationship between UJ and Hokkaido University is considered a flagship research collaboration between the two countries. The collaboration started six years ago when the UJ Laboratory of Toxicology and the Graduate School of Veterinary Medicine, Hokkaido University got in touch. The teams have done extensive work together looking at biomarkers in order to study contaminants in South African rivers. Procedures have been developed to determine the values of biomarkers. These are used to assess the biochemical and physiological specific chemical contaminants, e.g. growth stimulants and pesticides in the water. Levels of persistent organic pollutants (POPs) are determined in the sediment and fish tissue sampled in the Luvuvhu and Olifants Rivers in the Kruger National Park, as well as the Phongolo River in KwaZulu-Natal. Biomarker responses are interpreted in relation to the concentrations of the contaminants.

The collaborative research programmes between these two parties continue through the surveillance of environmental pollution in South Africa. This highly inspiring programme with the Department of Zoology, at Kingsway Campus, UJ furthermore expanded its research network to NWU.

In addition, the programme organised the *6th International Toxicology Symposium* in Africa to discuss chemical hazards. The symposium was held in Johannesburg in August 2014. The high-profile delegation included participants from the ten African countries and Japan. The symposium developed a platform for the presentation and discussion of important threats caused by chemicals in the mining and agriculture industries.

The South African symposium coordinator was Dr Johan van Vuren of the UJ Ecotoxicology Laboratory. The Japanese symposium coordinators were Dr Mayumi Ishizuka and Dr Yoshinori Ikenaka of the Laboratory of Toxicology, Graduate School of Veterinary Medicine, Hokkaido University.

Golden opportunity for NWU and Hokkaido cooperation

NWU and Hokkaido University signed a memorandum of understanding (MoU) in February 2014, that proposed golden opportunities for academic exchange. The MoU was signed by the former NWU vice-chancellor Dr Theuns Eloff and the Hokkaido University vice-president Professor Ichiro Uyeda.

Cooperation between the NWU and the Hokkaido University will afford students of both universities opportunities to participate in international exchange programmes. This also implies the exchange of faculty members and research fellows, as well as academic material, publications, information, and joint research projects and symposia.

The MoU is the result of a well-established relationship between the NWU and Hokkaido University, which is largely due to the efforts of Professor Victor Wepener of the Potchefstroom Campus' School of Biological Sciences and Professor Nico Smit of the Potchefstroom Campus' Unit for Environmental Sciences and Management.

Hokkaido University was founded in 1876 as Sapporo Agricultural College, Japan's first university to award bachelor's degrees. It later became Hokkaido Imperial University and was recognised as one of the seven Imperial Universities, which were established as the top national universities and research institutes in Japan. Today, Hokkaido University offers educational opportunities across a broad spectrum of disciplines while also engaging in pioneering research. Hokkaido University has 17 graduate schools, the most of any national university in Japan. Hokkaido University's overseas offices will be expanding future global networks. The first Hokkaido University overseas office was established in Beijing, in the People's Republic of China in 2006. The African regional office in Lusaka was the fourth overseas office to be established.

The aim of this symposium was to scientifically discuss the current environmental pollution and toxicological topics in African countries.

The sampling team prepares to undertake surveillance of environmental pollution in South Africa

Universities of technology partner for skills transfer and human resource development

Participating institutions

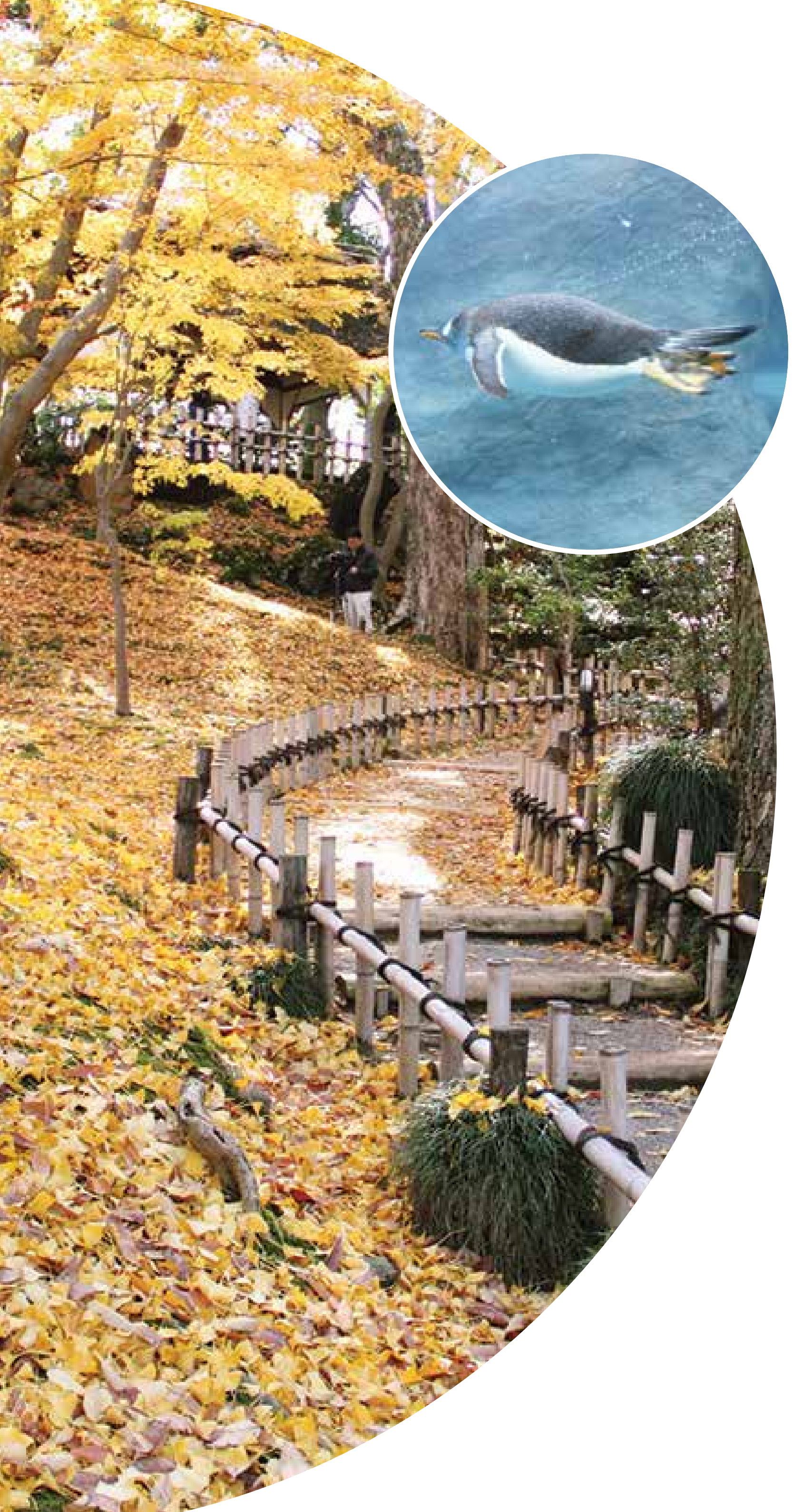
- South Africa: Tshwane University of Technology.
- Japan: Nagaoka University of Technology.

On 23 August 2014, Nagaoka University of Technology (NUT) concluded the Agreement of Academic and Educational Collaboration with Tshwane University of Technology (TUT), which is a key university in engineering education in South Africa.

The Vice-Chancellor and Principal of TUT, Prof. Nthabiseng Ogude and associated faculty members and staff from TUT, as well as Vice President Professor Yoshiki Mikami and Associate Professor Tadachika Nakayama, as the representative of NUT, participated in the signing ceremony. His Excellency Mr Yutaka Yoshizawa, Ambassador of Japan to South Africa, as well as the Chief Representative of the Japan International Cooperation Agency (JICA) South Africa Office, and an official of the South African Department of Science and Technology attended the ceremony.

This is the first time TUT concluded an academic and educational collaboration agreement with a Japanese university and NUT with an African university. A campus tour at TUT confirmed the availability of advanced equipment in the field of practical technique, such as "Monozukuri" (manufacturing technology), security, automobile, as well as electric substrate implementation.

TUT and NUT have a similar basic philosophy, which focuses on "GIGAKU" (technology and science). Both universities agreed to promote the multilateral collaboration through joint research and the development of leading engineers. NUT promotes the reciprocal relationship with partner universities overseas in order to incorporate the energy of such globally growing sectors, as well as to produce global engineers in Japan.



The signing ceremony of the Agreement of Academic and Educational Collaboration between TUT and NUT in August 2013 was attended by representatives from both countries

South African researchers visit NUT (February 2012)

TUT cooperation with Japanese private companies

In partnership with JICA-SA, four productivity training courses were implemented between 2008 and 2010 in partnership with the Tshwane University of Technology (TUT), which included the participation of three Japanese companies: Toyota, Nissan and Hitachi. This project was subsequently transferred to the Department of Higher Education and Training (DHET) for roll out to all universities of technology.

Volunteers spend two years building skills at science centres

Participating institutions

- South Africa: University of Limpopo Science Centre, Vuwani Science Centre, Osizweni Education and Development Centre, FOSST Discovery Centre and Unizul Science Centre.
- Japan: Japan Overseas Cooperation Volunteers Programme.

The Japan International Cooperation Agency (JICA) – through its Japan Overseas Cooperation Volunteers (JOCV) Programme – dispatches trained and qualified professionals in a variety of disciplines to support and provide technical assistance to host organisations.

The JOCV science centres programme has been implemented by JICA since 2007 in collaboration with the Department of Science and Technology (DST). The programme has contributed immensely to the field of science education in South Africa. The volunteers serve in various positions aiding in skills development. This may include, but is not limited to, working as exhibits engineers, science workshop facilitators/educators and even as actors in science puppet shows. This unique and interactive approach to informal science teaching is enjoyed by members of the communities in the areas served by these science centres.

Cooperation through citizen participation: Operated by JICA, the JOCV dispatches Japanese volunteers overseas. Volunteers participate in a wide range of fields such as agriculture, forestry, fisheries, education, health and over 120 technical fields. Some 30 000 volunteers have been dispatched to more than 80 countries since the JOCV was established in 1965. Japanese citizens aged between 20 years and 39 years of age are eligible. The JOCV Senior Volunteers programme for elder citizens of between 40 and 69 years of age, was established in 1990.

The rural community outreach initiatives undertaken by science centres afford the visiting professionals a deeper understanding of the subject and ultimately foster mutually beneficial relations between the two countries. Furthermore, these activities spark an interest in the subject matter itself and evidently improve participants' skills, transferring the knowledge and application thereof.

By 2014, the programme had already dispatched a total of 15 Japanese volunteers to five local science centres, located in four provinces. These are the University of Limpopo Science Centre and the Vuwani Science Centre, both in Limpopo; the Osizweni Education and Development

Centre in Mpumalanga; the FOSST Discovery Centre in the Eastern Cape and the Unizul Science Centre in KwaZulu-Natal.

The two years that each volunteer spends at a science centre are valuable to the centre itself and the communities being served by each science centre. Volunteers contribute to various aspects, among others science awareness and education, informal curriculum support, exhibit building and maintenance, engineering and technology careers awareness.

Highlights of activities per science centre

University of Limpopo Science Centre: As its name implies, this science centre is affiliated to the University of Limpopo and has already hosted three Japanese volunteers. Remarkable work done by these volunteers includes informal curriculum support for maths, science, agriculture and life science; conducting experiments and demonstrations; developing exhibits and using simple and cheap/accessible materials to make exhibits and create other learning tools; assuming the roles of science workshop facilitators and actors in science-focused puppet shows and undertaking outreach activities by taking science and technology to the rural communities of Limpopo. With a focus on curriculum support for maths, science, agriculture and life science at surrounding education institutions, volunteers operate with the objective of intriguing participants, through practical experiences entailing an element of science, which they can relate to even if it is just in a small way. Almost every exhibition in the centre is unique and tailored to offer an experience related to the field of science and technology.

Vuwani Science Centre: Attached to the University of Venda, this science centre has already hosted two volunteers. They interact well with the community during their outreach activities for science awareness, including the annual National Science Week activities. They serve as mentors for learners participating in the science expos by providing guidance for their projects. They moreover conduct activities to support the teaching and learning of mathematics and science in neighbouring schools.

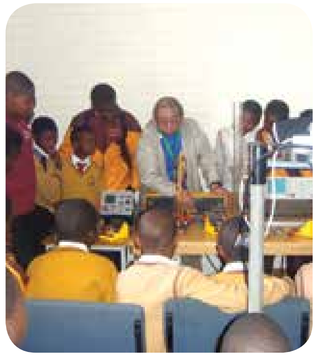
Osizweni Education and Development Centre: The centre is attached to Sasol in Secunda and has already hosted two volunteers. The volunteers provide support to learners in nearby communities through mathematics, science and technology education. They have played an active role in introducing interactive, practical remedial classes aligned with the prescribed school syllabus for grades ten to twelve. The intention is to enhance the learners' skills in the fields specified above. The volunteers are also instrumental in providing support and advice to educators, establishing mentoring programmes for educators in the field and transferring their skills, expertise and knowledge accumulated from their teaching experiences in Japan.

FOSST Discovery Centre: The centre, which is linked to the University of Fort Hare, has hosted three volunteers. The presence of these volunteers further affirms the mandate of such collaboration through the community outreach programme whereby volunteers build networks and foster relationships between the two countries through Science. Various outreach programmes such as the PC training workshops on basic Windows OS, Microsoft Word, Excel and Internet Explorer have contributed to the development of computer literacy skills for high school learners in neighbouring districts as well as professionals.

Unizul Science Centre: Attached to the University of Zululand, Unizul Science Centre has hosted three volunteers, whose work and support to the centre is notable. The work included training for science centre staff and interns, provision and introduction of new equipment, interaction with learners, cultural exchange activities and computer assistance.

Yuki Ishida demonstrates the exciting world of Lego robotics to high school learners.

Yuki Ishida engages with learners after an interactive science education demonstration.



Senior volunteer Jinitsu Niinuma demonstrates electromagnetism using a coil and magnets.

Japanese science teachers conduct a workshop on making a Benham's spinning top with paper during their tenure as short-term volunteers for the 2014 National Science Week.

High school learners look at a mosaic polarised through 3D glasses at the Richards Bay Science Centre.

A science centre intern teaches Mon-Kiri, a form of Japanese paper craft.

Science Africa seminars

Similarly, science exhibit initiatives during Science Africa seminars has contributed to advancing knowledge on science by educating communities on basic scientific principles and increasing access to much-needed science education for disadvantaged learners.

Theme-specific projects such as the Recycle Venture (where soaps and candles are produced from recycled oil) are projects tailored for learners. They are aimed at exposing learners to the practical application of science theory. These initiatives act in parallel to the DST's objective of capacitating science centres to inspire young individuals to follow careers in science, engineering and technology and sensitise the community to the benefits of science in their daily lives.

South Africa - Japan research cooperation by schemes

Science and Technology Research Partnership for Sustainable Development (SATREPS)
Japan Science and Technology Agency (JST) and Japan International Cooperation Agency (JICA)
August 2013 Embassy of Japan opens in South Africa

2010-2013	Prediction of climate variations and its application in the southern African region	Japan Agency for Marine-Earth Science and Technology (JAMSTEC), University of Tokyo	Applied Centre for Climate and Earth Systems Science (ACCESS)
2010-2015	Observational studies in South African mines to mitigate seismic risks	Ritsumeikan University, Tohoku University, University of Tokyo, National Institute of Advanced Industrial Science and Technology (AIST)	CSIR, Council for Geoscience (CGS)
2013-2018	Establishment of early-warning system for infectious diseases in southern Africa, incorporating climate predictions	Nagashaki University, JAMSTEC	ACCESS, Medical Research Council (MRC), University of Cape Town (UCT)

Life Sciences: Japan Science and Technology Agency (JST) and National Research Foundation (NRF)
Strategic International Research Cooperation Programme (SICP) I MoU signed in 2008

2009-2012	The toll signaling pathway in Enterobacter intermedius	Tohoku University	Univ. of the Witwatersrand (Wits)
2009-2012	Integration of metabolomics and molecular genetics of indigenous South African plants for the discovery of anti-malaria and anti-HIV activity	Osaka University	University of Pretoria (UP)
2009 -2012	Characterisation of the Pfj2, a heat shock protein 40 chaperone predicted to localise to endoplasmic reticulum of the malaria parasite (Plasmodium falciparum)	Kyoto Sangyo University	Rhodes University (Rhodes)
2009 -2012	Probiotic lactic acid bacteria and antimicrobial peptides novel ways to fight pathogens	University of Tokyo	Stellenbosch University (SU)
2011-2014	Biodiversity and evolution of algae in the Indo-Pacific: A Japan/ South Africa comparison	Hokkaido University	UCT
2011-2014	Genomic analysis of pathogenesis of Amebiasis toward development of new diagnostics and intervention	Tsukuba University	University of Venda (Univen)
2013-2016	Protective and subversive mechanism of macrophage genes in Mycrobacterium Tuberculosis infection	Centre for Life Science Technologies at RIKEN	UCT
2013-2016	The effects of HIV Infection on pre-eclampsia	Fukui University	University of KwaZulu-Natal (UKZN)
2013-2016	Genetic and pathogenic diversity of Pantoea Ananatis strains	Shizuoka University	UP

JST-NRF | Bilateral cooperation

2005-2008	Add value to indigenous plants in South Africa to aid in combatting infectious diseases	RIKEN	UP

JST | Strategic funds for the promotion of science and technology and for the promotion of international joint research

2011-2013	Transcriptomics to identify drug/vaccine candidates against Tuberculosis and Leishmania	RIKEN	UCT

JSPS – NRF | Bilateral Programme | MoU signed in 2005

2006-2008	Molecular epidemiology and molecular biology of hepatis viruses in Africa	Nagoya City University	Wits
2006-2008	Characterisation of novel antibiotic resistance mechanisms in Nocardia and related bacteria	Chiba University	Wits
2006-2008	Biochemical studies on ostrich meat as a healthy, natural food resource	Tohoku University	Nelson Mandela Metropolitan University
2006-2008	Joint sevelopment of South African speech synthesis	Advanced Telecommunications Research Institute International	SU
2007-2009	Development of phthalocyanines with catalytic properties	Tohoku University	Rhodes
2007-2009	The evolution of galaxies in superclusters and the stellar formation in the Milky Way	Nagoya University	UCT
2008-2010	Development of diagnostics tests for tick borne diseases of animals in South Africa and Japan	Obihiro University of Agriculture and Veterinary Medicine	Onderstepoort Veterinary Institute
2008-2010	Multi-enzyme complex producing Bacillus strains and utilisation of their cellulolytic and hemicellulolytic enzymes for rapid degradation of biomass for the biofuel industry	Mie University	Rhodes
2009-2011	Search for anti-multi drug resistant Mycobacterium tuberculosis agents from marine organisms	Osaka University	UKZN
2009-2011	A study of stellar formation and galaxy evolution	Nagoya University	UCT
2009-2011	Molecular epidemiology and functional characterisation of hepatitis B virus isolates from Africa	Nagoya City University	Wits
2009-2011	An integrated drought early warning system for dry grassland in South Africa	Tottori University	University of the Free State (UFS)
2009-2011	Development of molecular imaging and its application to immune reconstitution syndrome in AIDS	Tohoku University	Walter Sisulu University
2010-2012	Quantum information and computation	Okayama University of Science	UKZN
2010-2011	Development of unsymmetrical phthalocyanines for medical and sensor applications	Tohoku University	Rhodes
2011-2013	The impact of HIV on factors associated with the prediction of pre-eclampsia	Fukui University	UKZN
2011-2013	Investigation of health related benefits of South Africa's native plants such as rooibos and honeybush	Tokyo University of Agriculture and Technology (TUAT)	Agricultural Research Council (ARC)
2012-2013	Blood brain barrier evaluations of potential anti TB Meningitis compounds	Nagasaki University	UKZN

JSPS – NRF I Bilateral Programme I MoU signed in 2005

2012-2014	Engineering improved yeasts for biofuel production	Kobe University	SU
2013-2015	Elucidation of the mechanisms for health promoting effects of rooibos and honeybush	TUAT	ARC
2013-2015	Investigation of the effects of the ingestion of herbal teas, rich in anti-oxidants, on urine chemistry, in the context of kidney stone formation	Nagoya City University	UCT

JSPS I Asia-Africa Science Platform Programme

2005-2008	Network formation for studies on infections caused by arthropod-borne protozoan parasites in Asia and Africa	Obihiro University of Agriculture and Veterinary Medicine	UFS
2005-2008	Preserving the cultural heritage of Africa: From memories to histories	National Museum of Ethnology	Wits
2011-2014	Towards the development of an'oasis of peace' through the institutionalisation of a research network in southern Africa	Osaka University	UFS

JSPS I Core-to-Core Program, B. Asia-Africa Science Platforms

2012-2015	Establishment of international toxicology consortium with eight African countries	Hokkaido University	University of Johannesburg (UJ)

Other research cooperation between South Africa and Japan

2007-2009	Rare earth materials	AIST, JOGMEC	CGS
2007-2009	Bioleaching technology	JOGMEC	MINTEK
2007-2009	High performance computing	JAMSTEC	CSIR, Meraka Institute, Centre for High Performance Computing
2007-2009	Study of the antimicrobial activities of local medicine plants against HIV and opportunistic bacterial as well as parasitic pathogens incriminated in HIV/AIDS cases	Tohoku University	Univen
2007-2009	Implementation Agreement for International Cooperative Research and Capacity Building between Meraka Institute of the CSIR, Republic of South Africa (MI) and Earth Simulator Centre (ESC), Japan Agency for Marine-Earth Science and Technology	JAMSTEC, ESC	CSIR, Meraka Institute
2006	Anti-microbial activities of medicinal herbs in South Africa	Tohoku University School of Medicine	Univen
2007-2008	Anti-HIV and immunomodulatory activities of medicinal herbs in South Africa	Tohoku University School of Medicine	Univen, UKZN
2006	Synthesis of nanomaterials	NIMS	iThemba LABS
2004	Heat-resistant Pt-Al coating	NIMS High Temperature Materials Centre	CSIR
2004	Development of PGM base supralloy	NIMS High Temperature Materials Centre	MINTEK
2006-2010	Research cooperation for cyclotron mutagenesis on African crops	RIKEN	PlantBio Trust, National Innovation Centre for Plant Biotechnology
2010-2013	Transcriptomics to identify drug/vaccine candidates against Tuberculosis (Fantom5 Project)	RIKEN	UCT

Future prospects for scientific and technological cooperation between South Africa and Japan

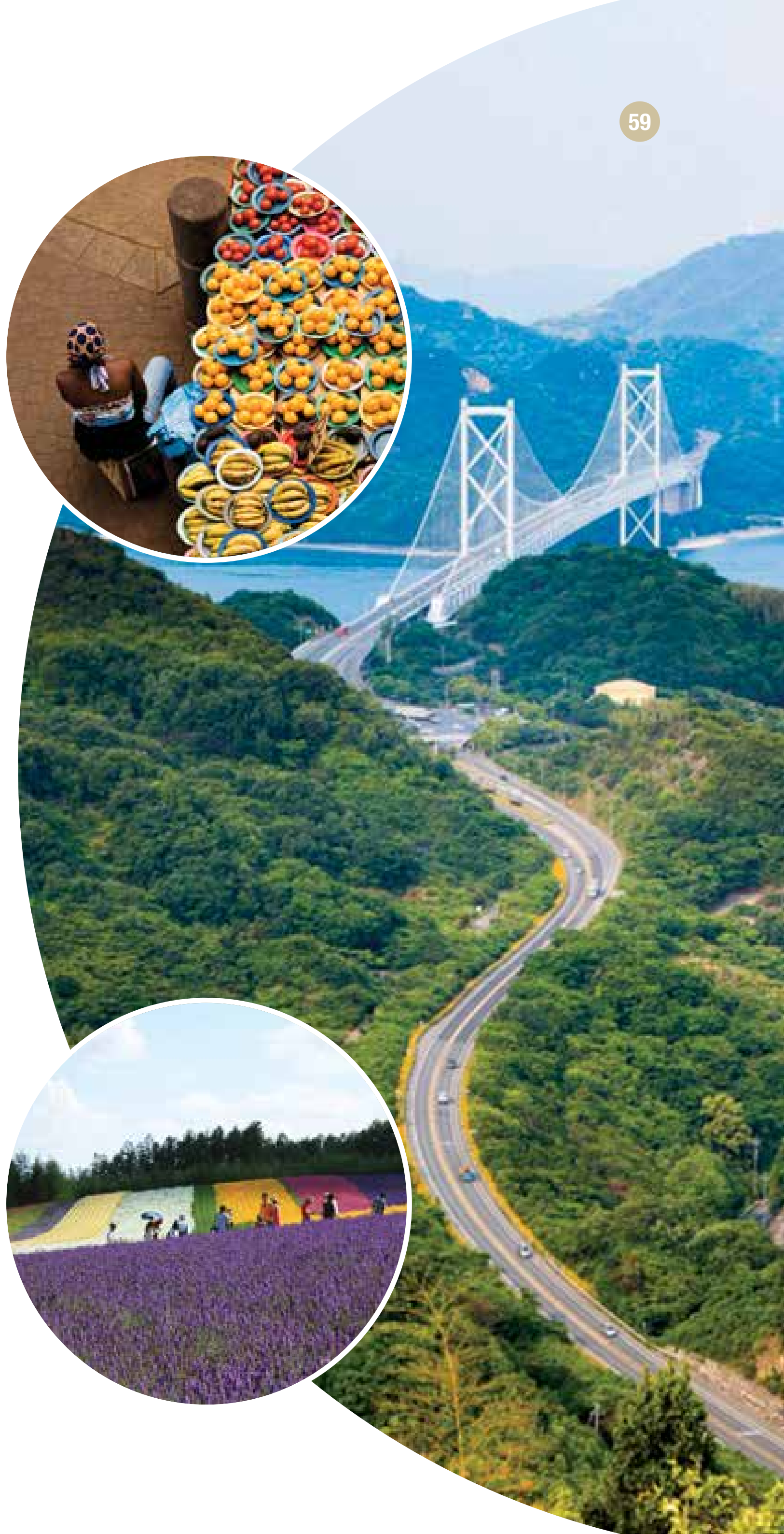
Both South Africa and Japan are committed to continue with their efforts to grow and strengthen S&T cooperation. In this respect both countries will explore new avenues to ensure that both parties promote the advancement of scientific and technological cooperation. The future holds a number of possibilities such as:

- **Revival of the South Africa-Japan University (SAJU) Forum:** The SAJU Forum is an initiative that was established in 2007. The main objective of the Forum was to provide a structured framework for collaboration between the higher education sectors of the two countries. Although the priority focus within SAJU is on higher education, its revival could be extended to offer opportunities to deepen collaboration between higher education, business and government in both countries and across other African countries. In spite of marked differences in size, economic development and challenges faced, Japan and South Africa share several areas of complementarities, which could provide a strategic foundation for the SAJU partnership.
- **Expansion of the NRF-JST Programme:** While this programme has yielded a number of positive outcomes through research carried out under "Life Sciences" as a focus research theme, it envisaged that it could be expanded in future to include other research themes. Possible research themes to be considered for this purpose include material sciences (focusing on minerals and energy) and astronomy.
- **Cooperation in space science and technology:** Since the signing of the agreement there has not been any active collaboration in the area of space science and technology between South Africa and Japan. However, efforts are being made to grow cooperation activities in this area. To initiate discussions for possible cooperation in this area, the DST jointly hosted a first seminar on space science and technology with the Government of Japan, represented by the Japanese Embassy in South Africa. The seminar took place in October 2011 as part of the International Astronautical Congress in Cape Town, South Africa. Following the seminar, several discussions took place between DST and JICA, which resulted in the two institutions signing an agreement to implement a bilateral technical cooperation project titled 'Earth Observation Advisor', aimed at strengthening the human capacity of SANSA officials and other related public institutions. There is room to grow this cooperation in future.

There are further opportunities for collaboration in space science and technology between SANSA and Japanese institutions (following the visit to Japan by SANSA in October 2012), such as the Space Weather and Information Centre of the National Institute of Information and Communication Technology (NICT), the Remote Sensing Technology Centre (RESTEC), the University of Tokyo, the Nippon Electric Company (NEC); and the Japan Space Systems (JSS). Possible projects with these institutions will mainly cover areas such as remote sensing and space weather; micro-satellite development and telemetry and control services for Earth observation dataset.

- **Infectious Diseases Early Warning System (iDEWS) project:** With ongoing efforts by both South Africa and Japan in climate change and infectious diseases, an MoU on the iDEWS project was signed between DST and JICA-SA in May 2014. This five-year project aims to develop a climate-based early-warning system for improved management of infectious diseases in the Limpopo area. In the next five years, it is envisaged that research carried out under this project would lead to the development of a good practice model for climate-based early detection of infectious diseases such as malaria, pneumonia and diarrhoea. Even though the project focuses on malaria, pneumonia and diarrhoea only, the envisaged model to be developed would be able to detect other outbreaks, of note Ebola. Although the project targets the lowveld area of Limpopo as pilot, given the high prevalence of these diseases in the province, project outcomes could be applied to other parts of the country if proven successful.
- **JSPS and NRF to co-host the Global Research Alliance Council Annual Conference:** The JSPS and the NRF are members of the Global Research Council (GRC) established in May 2012 at the meeting called "Global Summit on Merit Review", hosted by the National Science Foundation (NSF) of the United States (US). The main objective of the GRC is to find mutual paths for international research collaboration among countries of the world. The NRF and the JSPS are scheduled to co-host the next GRC Annual Conference to be held in May 2015 in Tokyo, Japan.

Having taken stock of the achievements of the ten years of cooperation in science and technology, both South Africa and Japan look forward to many more years of fruitful and mutually beneficial partnership.



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MediaClubSouthAfrica.com
Limpopo province: Elephants in the Kruger National Park.
Photo: MediaClubSouthAfrica.com

Mpumalanga province: The Kwena Dam and surrounding fields, near Lydenburg. Photo: Graeme Williams, MediaClubSouthAfrica.com

Cape Town Stadium: Artist's impression. Photo: Local Organising Committee

Cape Town, Western Cape province: Oil rigs and drilling ships in the the harbour. Photo: Rodger Bosch, MediaClubSouthAfrica.com

Beaufort West, Western Cape province: Electricity pylons.
Photo: Chris Kirchhoff, MediaClubSouthAfrica.com

Limpopo province: Baobab trees stand out against the bushy landscape near Musina. Photo: Graeme Williams, MediaClubSouthAfrica.com

Durban, KwaZulu-Natal province: The aquarium at the uShaka Marine World theme park. Photo: Graeme Williams, MediaClubSouthAfrica.com

Johannesburg, Gauteng province: A view of the city centre skyline at sunset from the rooftop of the Oribi Hotel in Troyeville.
Photo: Chris Kirchhoff, MediaClubSouthAfrica.com

Johannesburg, Gauteng province: A fruit trader on Noord Street in the city centre. Photo: Chris Kirchhoff, Media Club South Africa

Acronyms and Abbreviations

ACCESS	Applied Centre for Climate and Earth Systems Science
AE	acoustic emission
AOTS	Association for Overseas Technical Scholarship
ARC	Agricultural Research Council
BFG	National Bioinformatics Functional Genomics
CAGE	Cap Analysis of Gene Expression
CGS	Council for Geoscience
CSIR	Council for Scientific and Industrial Research
CSTI	Council for Science, Technology and Innovation
DHET	Department of Higher Education and Training
DST	Department of Science and Technology
GDP	gross domestic product
GEAR	Growth, Employment and Redistribution (strategy)
GEO	Group on Earth Observations
GEOSS	Global Earth Observation System of Systems
GRC	Global Research Council
HCD	human capital development
ICGEB	International Centre for Genetic Engineering and Biotechnology
iDEWS	Infectious Diseases Early Warning System for Southern Africa
JAMSTEC	Japan Agency for Marine-Earth Science and Technology
JAXA	Japan Aerospace Exploration Agency
JICA	Japan International Cooperation Agency
JOCV	Japan Overseas Cooperation Volunteers
JSPS	Japan Society for the Promotion of Science
JSS	Japan Space Systems
JST	Japan Science and Technology Agency
MEXT	Ministry of Education, Culture, Sports and Science and Technology – Japan
MOFA	Ministry of Foreign Affairs of Japan
MoU	memorandum of understanding
MRC	Medical Research Council
Mtb	Mycobacterium tuberculosis
NICT	National Institute of Information and Communication Technology
NRF	National Research Foundation
NSF	National Science Foundation
NUT	Nagaoka University of Technology
NWU	North-West University
ODA	official development assistance
POPs	persistent organic pollutants
R&D	research and development
RESTEC	Remote Sensing Technology Centre
RNA	Ribonucleic acid
S&T	science and technology
SADC	Southern African Development Community
SALT	Southern African Large Telescope
SANSA	South African National Space Agency
SANSN	South African National Seismograph Network
SATREPS	Science and Technology Research Partnership for Sustainable Development
SICP	Strategic International Research Cooperation Programme
SKA	Square Kilometre Array
STS	Science and Technology in Society
TB	tuberculosis
TICADV	Tokyo International Conference on African Development
TUAT	Tokyo University of Agriculture and Technology
TUT	Tshwane University of Technology
UCT	University of Cape Town
UJ	University of Johannesburg
UKZN	University of KwaZulu-Natal
UNESCO	United Nations Educational, Scientific and Cultural Organization
WHO	World Health Organization

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