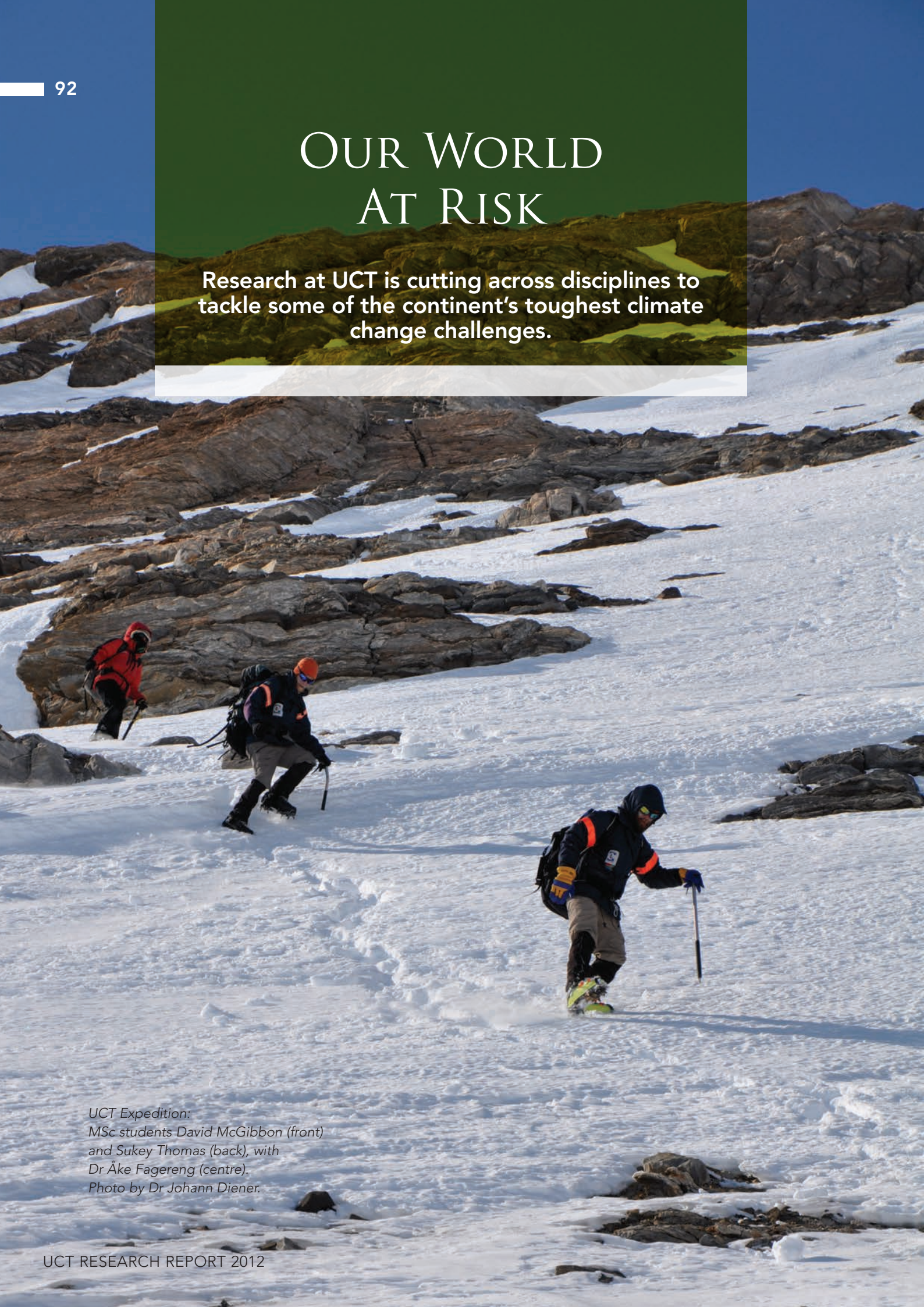
Our World At Risk

Research at UCT is cutting across disciplines to tackle some of the continent's toughest climate change challenges.



UCT Expedition: MSc students David McGibbon (front) and Sukey Thomas (back), with Dr Åke Fagereng (centre). Photo by Dr Johann Diener.

There is growing urgency across the globe to address the effects of climate change. Academic research at the University of Cape Town is rising to the challenge by spearheading cutting-edge and proactive programmes and projects on regional and local issues where climate change is of concern.

Climate change has become a critical global concern affecting all countries and continents. Developing nations are particularly at risk as rising temperatures, floods and droughts have more devastating effects in areas afflicted by poor infrastructure, inadequate housing, poverty and a lack of resources. Because of the complexity of the problem, the University of Cape Town has been working to stimulate cross-disciplinary research and teaching to address a range of dilemmas raised by climate change.

Principal amongst these initiatives is the university's flagship African Climate and Development Initiative (ACDI), launched in 2011 with the aim of advancing inter-disciplinary research and graduate training on climate change from an African development perspective. ACDI harnesses the research being undertaken across the university under a unified umbrella and takes a holistic approach towards all research projects.

A ground breaking new postgraduate course at UCT offers an integrated approach to climate change topics.

The past year represents the first full year of ACDI being in operation, after the appointment of Professor Mark New, in mid-2011 as Pro-Vice-Chancellor and director of the initiative. The aims of ACDI in 2011/2012 were to establish the ACDI master's programme, to enhance activities and exchanges within the university's many departments, to pilot deeper research enquiries, and to develop research partnerships with external stakeholders.

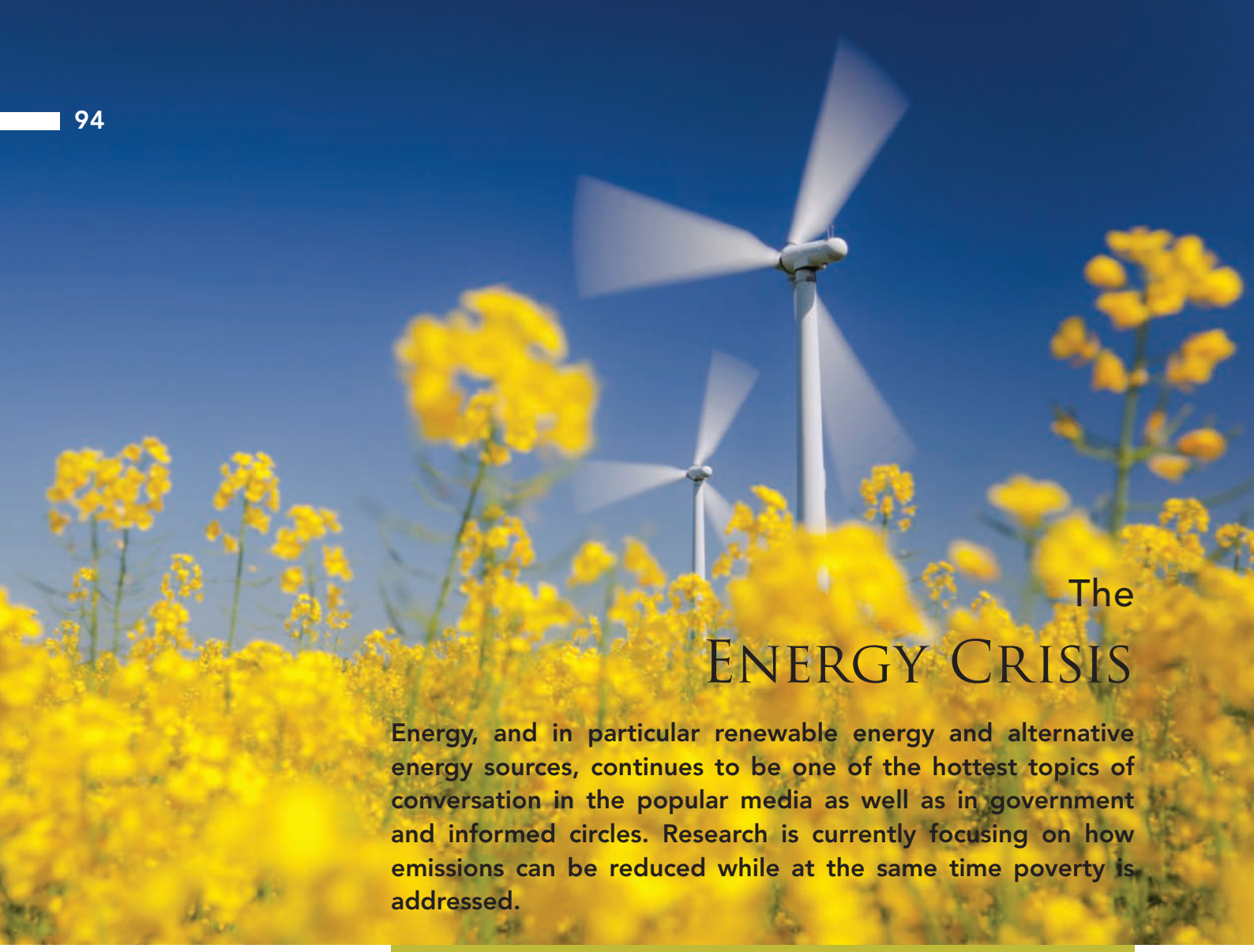
ACDI accepted its first cohort of nine students on the master's in Climate Change and Sustainable Development; all of whom will graduate in June 2013. This MSc programme breaks new ground at UCT, offering an integrated approach to climate-change topics, with contributions to core and elective courses from a number of departments representing all UCT faculties.

An ACDI highlight in 2012 was the initiation of research exploring climate and development issues in the Berg River area of the Western Cape, supported by the Carnegie Corporation. This project is unique in bringing together UCT researchers from seven departments and a range of actors in the Berg River municipal area – from regional and local government, commercial agriculture and industry, to nature conservation. In addition, serving as a laboratory to explore the success, challenges and opportunities that inter- and transdisciplinary research presents to the university, the project has facilitated the "bottom-up" development of several collaborative research projects, where the research questions and methods are co-produced collectively between researchers and practitioners.

Undoubtedly, climate change is both a global and a very personal phenomenon. It affects just about every area of our lives. This interconnectedness is what is driving UCT's inter-disciplinary approach to climate-change studies. From the economics of poverty and inequality to energy security, palaeosciences and marine and bird research, there is a wide range of research at UCT that, impacts upon and feeds into the work of ACDI.

ACDI research projects undertaken by students

- Climate risks and constraints to adaptation for sustainable livelihoods of the rural poor
- The co-benefits of environmental job-creation projects in Cape Town
- The University of Cape Town's food system and its relation to the institutional carbon footprint
- Socio-economic implications of the implementation of coastal development setback lines
- Urban agriculture in Cape Town and the City of Cape Town Urban Agriculture Policy 2007
- Measuring, reporting and verifying mitigation actions at the municipal level: City of Cape Town
- Energy efficiency and environmental performance of the South African cement industry since 1980
- Mechanisms encouraging transport modal shifts from private to public transport to reduce transport emissions in the City of Cape Town
- Public perception of climate change in Lavender Hill, Cape Town



The Energy Crisis

Energy, and in particular renewable energy and alternative energy sources, continues to be one of the hottest topics of conversation in the popular media as well as in government and informed circles. Research is currently focusing on how emissions can be reduced while at the same time poverty is addressed.

The accumulation of greenhouse gases (GHGs) in the atmosphere is a long-term problem, but immediate action needs to be taken. The impacts caused by climate change potentially threaten any development and especially affect poorer members of society. Climate change may be an environmental issue but it deeply affects our society and economy – in particular the energy sector.

Changing how we use energy and finding new technologies and systems to produce low- and zero-carbon energy require rigorous evidence, based on research.

In South Africa and globally, most emissions come from the use and supply of energy, in particular the burning of fossil fuels. Changing how we use energy and finding new technologies and systems to produce low- and zero-carbon energy require rigorous evidence, based on research. This involves quantitative analysis, including modelling, policy analysis, stock-taking through inventories and carbon accounting, analysis of climate-friendly technologies, and understanding how to change behaviour – with a view to living well while using less energy. UCT's Energy Research Centre (ERC) has worked on climate-change mitigation – reducing GHG emissions – since the 1990s. The ERC's Energy, Environment and Climate Group, working with others at UCT and beyond, is engaged in a number of projects that focus on energy modelling, poverty, efficiency and renewables.

Mitigation Action Plans and Scenarios

UCT is actively involved in climate-change mitigation research, which focuses on concrete actions aimed at reducing or limiting damage caused by climate change. Mitigation action plans and scenarios (MAPS) is a collaborative research project between developing countries like Colombia, Chile, Brazil, Peru, Argentina and, more recently, India. Particular research streams include poverty, economy-wide and sectoral modelling, and possible mitigation actions in the energy, transport and agriculture sectors. The MAPS programme is being undertaken by the ERC and the organisation SouthSouthNorth.

The collaboration aims to link climate-compatible economies with similar economic-development and poverty-alleviation programmes. MAPS builds on the experience of South Africa's long-term mitigation scenarios, and will crucially include a participative process with stakeholders from all sectors. In this sense, MAPS is not simply another research study – the information will be produced in partnership with the best indigenous and international research. Through strategic collaboration, MAPS offers an opportunity to establish synergies and share lessons with participating developing countries as well as the broader climate-change and development community.

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The ERC's Professor Harald Winkler is one of the directors of MAPS, with Professor Marta Torres (Oregon State University, USA) co-ordinating research, and MAPS includes a long list of researchers involved in a wide range of research activities and products.

In addition to continuing engagement with in-country researchers and facilitators in Peru, Chile, Colombia and Brazil in 2012, a number of research papers were completed and a knowledge platform was established.

Reducing Poverty and Emissions

This project investigates how developing countries can reduce emissions and poverty at the same time. ERC researchers Dr Britta Rennkamp, Anya Boyd, Holle Wlokas and Tara Caetano and doctoral student Loveline Che are approaching this big question in two research projects. In the first, funded through the Climate Change Capacity Development Network, the ERC developed a South African Mitigation Action Impact Matrix in 2012, based on the country's low-carbon development goals.

The matrix helped to establish how the different electricity-generating technology options such as wind, solar and nuclear power impact on the country's development goals as stated in its recent development and energy plans: emissions reductions, poverty and inequality reduction, GDP growth, job creation and increasing renewable energy in the overall energy mix. The innovative research design combined a quantitative modelling exercise with qualitative case studies and a participative rating with experts. Results showed that solar and wind energy technologies contribute better to the development goals than nuclear technologies.

At the same time, large parts of the population live below the national poverty lines.

The ERC's research on poverty and climate-change mitigation is ongoing. In a new project funded through the Volkswagen Foundation, the question asked is how low-carbon development interventions such as carbon taxes, renewable energy programmes and green housing programmes impact on poverty and income distribution in three developing countries: South Africa, Mexico and Thailand.

Each of the three countries has a semi-industrialised economy and a substantial portion of their emissions derives from industrial processes, coal burning and oil refining. At the same time, large parts of the population live below the national poverty lines. In this multi-disciplinary research project, the UCT team collaborates with five research institutions and structures the research in a comparative design with Mexico and Thailand.

Looking towards
Our Oceans

Marine ecosystems are extremely vulnerable and sensitive to climate change. UCT's Marine Research Institute is conducting various programmes and research projects across the African continent that focus on the effects of human activity on marine ecosystems, fish populations and health as well as other related topics.

The University of Cape Town has gained an international reputation for its cutting-edge marine research. The location of the Marine Research Institute (Ma-Re) at the tip of the African continent and its proximity to three major oceans has contributed to its importance.

There are two South African Research Chairs with close ties to Ma-Re: Marine Ecology and Fisheries, headed by Associate Professor Astrid Jarre, and the Chair in Ocean Climate Modelling, which is hosted by the Oceanography Department and is currently vacant.

Under the leadership of Honorary Professor Larry Hutchings and Associate Professor Astrid Jarre and in collaboration with the Department of Environmental Affairs, St Helena Bay has been the focus of research into ocean change. St Helena Bay is a very productive ocean region and a nursery ground for many juvenile fish. The results from this research have highlighted variability and changes in the Benguela region, and the importance of human activity on observed ecosystem changes. This project is funded by the SARChI Chair in Marine Ecology and Fisheries, the Department of Environmental Affairs, and NansClim.

One of the outcomes of UCT's long-standing association with the Council for Scientific and Industrial Research (CSIR) was the awarding of the ACCESS Centre of Excellence in 2010. This is hosted by the CSIR but is a joint initiative with UCT and several other partner institutions. In 2012 UCT received R4.65 million from ACCESS across seven themes, of which R3 million was earmarked for bursaries. Many of the ACCESS students funded by ACCESS are affiliated with Ma-Re.

St Helena Bay is a very productive ocean region and a nursery ground for many juvenile fish.

Also working in this area is the Nansen-Tutu Centre for Marine Environmental Research, which was established in 2010 with the founding partners including Ma-Re and the Department of Oceanography, ACCESS, the Nansen Environmental and Remote Sensing Centre (NERSC), the Institute of Marine Research Centre for Development Co-operation in Fisheries, the University of Bergen (Norway), and Princeton University.

The centre's aim is to contribute to developing and implementing operational oceanography and data-assimilation methods around Southern Africa, including the South Atlantic and Indian Oceans, and the Southern Ocean. Its main focus areas are ocean state, marine environmental and ecosystem modelling (including climate and global teleconnections), research and capacity building.

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In 2012 the Nansen Tutu Centre funded two African MSc Students (Joseph Amollo and Francisco Francisco) and two postdoctoral research fellows (Drs Bjorn Backeberg and Issufo Halo). The Nansen Tutu Centre also contributed to the MESOBIO project, which is a multinational collaboration on marine research in the Mozambique Channel.

The centre contributes to various successful programmes and projects, such as the African Coelacanth Ecosystem Programme, and personnel also teach in the Applied Marine Science and Ocean Climate Dynamics master's degrees and the Oceanography Honours course.

Exploring Deep Waters

Ma-Re BASICS is the focal research activity of Ma-Re. The four-year initiative began in mid-2010 and is funded from a number of sources, the main one being the Vice-Chancellor's strategic initiative fund for the project *Marine multi-scale data and models: the key to predicting climate variability in Africa and its biological and social consequences.* It is structured as a network of research across multiple disciplines, departments and faculties at UCT. BASICS provides the umbrella framework to link diverse projects on marine social and ecological systems. Some of these are listed in this section to give an indication of the breadth of research under way.

The initial aim of Ma-Re BASICS was to provide students and researchers with a common identity, a common goal and a supportive, stimulating and informative research environment. During 2011 and 2012 a number of events were organised to stimulate and encourage communication, awareness and collaboration among staff and students undertaking diverse individual projects. Ma-Re held a series of focused discussions, such as the "themed lunch" on a marine law theme, led by Professors Jan Glazewski and Loretta Feris of the Institute of Marine and Environmental Law. The discussions during this first themed lunch resulted in further discussion and a collated response to the recent Green Paper on the *National Environmental Management of the Ocean.*

The Air We Breathe

One of BASICS's projects looked at bromoform – a chemical compound found in the air above the sea surface produced by marine plants. Most bromoform is produced naturally and readily crosses the sea-air boundary into the marine-boundary layer. Once in the atmosphere, bromoform is broken down by light energy into bromine radicals, which destroy ozone in the lower and upper troposphere.

Brett Kuyper and the Applied Marine Science master's students at the South African Weather Services.

Brett Kuyper and colleagues developed a simple, cost-effective method to detect and quantify bromoform in environmental air samples. They then measured bromoform concentrations at the Cape Point Global Atmospheric Watch station. These concentrations were found to be 5–7 times greater than in most other studies, although they fell within the range reported for similar marine environments.

The high concentrations are probably caused by the extensive kelp beds that occur in close proximity to the measuring station, although a possible anthropogenic influence from the nearby urban areas of Cape Town could not be excluded. This project is funded by ICEMASA and Ma-Re.

Postdoctoral research fellow Dr Laura Blamey.

Monitoring Marine Species

Over the past two decades, several marine species have changed their distributions in waters off the South African coast. One of the species that has moved its population centres is the commercially important rock lobster (*Jasus lalandii*), which has decreased in abundance on the West Coast and increased on the South Coast, east of Cape Hangklip. The reasons for the shift are not fully understood, but are probably linked to changes in environmental conditions.

Postdoctoral research fellow Dr Laura Blamey and colleagues applied three different statistical methods to environmental and biological data sets to try and identify what factors might have contributed to the shifts. They found that rock lobsters grew much more slowly from the mid-1980s and progressively moved eastward during the early to mid-1990s, at a time when summer winds strengthened and coastal upwelling was very variable.

From the mid to late 1990s there were fewer Bank Cormorants (which eat rock lobsters) on the West Coast and more on the South-West coast, probably in response to the movement of their prey. Rock lobsters eat sea urchins, so increased numbers of rock lobsters on the South Coast have also caused sea urchins to virtually disappear. In turn, sea urchins provided shelter from predators for juvenile abalone, and when the sea urchins disappeared many more juvenile abalone were eaten, impacting the adult populations at a time when they were being affected by uncontrolled illegal fishing. The results of this research are part of the effort under Ma-Re BASICS to develop environmental indicators to act as early warning signals for long-term ecosystem-scale changes. This project is funded through the SARChI Research Chair in Marine Ecology and Fisheries, and BASICS.

Many Fish in the Sea

Postdoctoral Research Fellow Dr Hilkka Ndjaula used long-term historical records of lengths and weights of fish to develop an index that can be used to assess changes in the health of fish populations. An average fish of any species will weigh a standard amount for a given length, but will weigh less when it is in poor condition and more when it is in good condition.

Fish will typically be in good condition when food is plentiful, as might occur when fish population sizes are small or when food sources have increased. Dr Ndjaula used enormous historical data sets to identify periods of good and bad fish condition for three species of fish: sardine (*Sardinops sagax*), anchovy (*Engraulis encrasicolus*) and redeye round herring (*Etruneus whiteheadi*). She adopted a new statistical method to analyse the historical length and weight data, in collaboration with Dr Ken Gerow from the University of Wyoming, USA, and found a consistent decrease in the index for all three species over the past decade.

These results indicate common environmental conditions experienced by the fish on a system-wide basis. The index is being used in a knowledge-based system developed by a current PhD student, an example of cross-pollination across projects within BASICS. This project is funded by SARChI Research Chair in Marine Ecology and Fisheries, and BASICS.

Marine Collaboration

A joint initiative between several laboratories in South Africa and France, that emerged from collaboration between UCT, Marine and Coastal Management and the French Institut de Recherche pour le Développement (IRD), has resulted in the International Centre for Education, Marine and Atmospheric Sciences over Africa (ICEMASA) collaboration.

ICEMASA focuses on Marine Sciences (marine ecosystems, resources management, physical oceanography, ocean-atmosphere exchanges, and biogeochemistry) over the Southern African coasts and the Southern Ocean. Its approach is richly multidisciplinary and is designed to attract collaborators from the Department of Environmental Affairs (Oceans and Coasts), the Department of Agriculture, Forestry and Fisheries (Fisheries Branch), UCT (Ma-Re and the Departments of Oceanography and Biological Sciences), Laboratoire de Physique des Océans, Centre de Recherche Halieutique Méditerranéenne et Tropicale – Ecosystèmes Marins Exploités, Laboratoire des sciences de l'environnement marin, the IRD, the Institut National des Sciences de l'Univers, and Université de Bretagne Occidentale (UBO, France).

ICEMASA works closely with the African Centre for Climate and Earth Systems Science (ACCESS), a DST/NRF Centre of Excellence that is hosted at the Council for Scientific and Industrial Research. ACCESS offers various educational programmes that include workshops and advanced seminars, research projects and computer modelling.

Under ICEMASA, the IRD provides funding for postdoctoral research fellows and postgraduate students as well as for foreign students. Linked to the ICEMASA initiative, Ma-Re and the IRD received funding from the PEERS programme for the joint execution of a research and training project entitled *South-African/French Co-Masters in Marine Sciences* (SAFCOMS). The purpose of this project is to provide bursary funds to students in marine science master's programmes at UCT and UBO for 2012/13.

Under the banner of ICEMASA and hosted by Ma-Re, five scientists from the IRD presented a postgraduate course on end-to-end marine ecosystem modelling at UCT. The course was attended by 25 participants from all over the world, including Seychelles, France, Kenya, Senegal, Peru and Holland, as well as South Africa.

How are Birds Affected?

The impact of climate change on bird populations in South Africa is a key research field for UCT researchers. Birds are particularly sensitive to changes in their habitat, with a rise in temperature of only a few degrees contributing to the extinction of some species.

Although the conservation of rare species is to some degree reactive, studies of the conservation issues related to global change, especially climate change, are more proactive in nature. We know that the world's climate is changing: we also know that many species, birds included, are already responding to these changes. The key challenge is predicting how these nascent biological changes will manifest themselves in the future in terms of changing biological communities, and what the larger ramifications of these changes might be.

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To date, much climate-change research has remained the domain of modellers, and there has also been significant documentation of biological changes, especially for specific species. However, what is lacking is a good understanding of the mechanisms that lead to such changes. The FitzPatrick Institute is contributing to filling this niche and building the bridge between modelling and empiricism.

Climate Change and Fynbos Birds

South Africa's most dramatic global biodiversity hotspot is the Cape Floral Kingdom or fynbos biome. Its remarkable biodiversity is one of its strategic advantages for tourism, rural economic development and human well-being. Fortunately much of the mountain fynbos is protected for water catchment, and the threat posed by invasive plants is well understood. However, it is crucial to assess the vulnerability of the biome and its avifauna to climate change.

The project to assess the vulnerability and adaptation of fynbos endemic birds to climate change explores how the six passerine species endemic to mountain fynbos are impacted by climate change and changing fire regimes. Fynbos birds are increasingly threatened by the unravelling of plant-pollinator mutualisms, invasion by woody plants and too-frequent fires.

The key questions pertain to the vulnerability of fynbos-endemic birds to climate and land use change, how the endemic birds disperse across ecosystems and how conservation planning and management can help birds adapt to global change. The research team includes ornithologists, pollination ecologists, population and stress ecologists, behavioural ecologists, a veterinarian, a small network of volunteer observers and amateur bird-ringers.

Catching 3000 Birds

Postdoctoral research fellow Dr Alan Lee initiated a biome-wide fynbos-endemic bird survey at the start of 2012. Summer and winter surveys were conducted at 900 points from the Cederberg to the eastern Baviaanskloof. This data has been used to calculate density estimates for the endemic birds, allowing the first robust estimates of their global populations. Cape Sugarbirds (*Promerops cafer*), Orange-breasted Sunbirds (*Anthobaphes violacea*) and Victorin's Warblers (*Cryptillas victorini*) appear to be vulnerable to changes in vegetation structure expected to occur if predictions of a warmer, drier and more fire-prone environment come about.

A ringed Cape Sugarbird

In addition to a broad overview of the biophysical limits on the ranges of endemic birds in the biome, the project has various study sites. Given the potential importance of habitat fragmentation, birds were mist-netted and ringed during 2012 at sites of varying distances apart in the Kouga, Outeniqua and Kammanassie mountains. More than 3000 birds have been captured with no evidence of movement between sites. At a fine scale, researchers are assessing the extent to which urbanisation creates opportunities and poses novel threats for fynbos birds. For example, birds might be able to seek refuge in urban gardens during fires, hot dry winds or rainstorms, but at the same time be exposed to commensal predators and pathogens. The research will increasingly cast light on conservation planning, policy and land management. As attention is paid to the security of biodiversity in the fynbos, this project will help guide landowners to make more robust conservation-planning decisions based on fine-scale understanding of the implications of climate-driven change in this very special biodiversity hotspot.

Hot Birds

The "hot birds" project, initiated in 2009, seeks to predict how climate change will affect birds living in hot, arid environments such as the Kalahari Desert. During 2012, a team of researchers led by Professor Phil Hockey and Professor Andrew McKechnie (University of Pretoria) examined the role of body size in determining susceptibility to heat stress, the links between physiology and behaviour, and how temperature affects the fitness of breeding birds. The team also expanded the project to investigate the heat tolerance and evaporative cooling capacity of Kalahari birds.

A White-browed Sparrow-weaver panting to dissipate heat

Using data for 35 Kalahari species, PhD student Ben Smit showed that activity levels and body mass played a major role in heat dissipation and found data providing exciting insights into how species cope with very high temperatures, shedding new light on how populations inhabiting climatically distinct regions may vary in their biology. In related research, Postdoctoral Research Fellow Rowan Martin used heat-transfer models to predict how birds of different sizes use thermal landscapes in the Kalahari.

And as part of the project's Southern Hemisphere scope, Grace Russell, a BSc Honours student at the University of Western Australia, examined behaviour among bird species in the Upper Gascoyne region of Western Australia to establish whether the same relationships between heat-dissipation behaviour, body mass and ecological variables occur in Australian species.

Postdoctoral Research Fellow Susie Cunningham completed her study of the links between temperature and breeding success in Common Fiscals (*Lanius collaris*) at Tswalu Kalahari Reserve. As temperatures increase, breeding adults spend more time in shaded sites, reducing their foraging efficiency and thus their provisioning rates to nestlings. High maximum daily temperatures also compromise nestling mass gain.

During 2012, PhD student Tanja van de Ven initiated a study of how temperature affects fitness, and the threshold temperatures above which fitness costs begin to increase in the Southern Yellow-billed Hornbill (*Tockus leucomelas*). Hornbills are vulnerable to high maximum daily temperatures because the female seals herself into the nest cavity as a protective mechanism against predators. She spends most of the chick-rearing period inside the cavity, and this places high demands on the male as he is solely responsible for food provisioning.

In 2012, researchers collaborated with the South African Weather Service to assess how patterns of hot weather events have changed over the last five decades in the north-western regions of South Africa. Results showed temperatures increasing, with more heat waves as well, paving the way for the use of the technique as a conservation planning tool.

And, lastly, MSc student Maxine Whitfield investigated evaporative cooling and body- temperature regulation in a variety of species. While resting and inactive, all species appear able to avoid hyperthermia even at air temperatures higher than those that currently occur in the Kalahari.

Karoo Birds on a Line

The open, arid Karoo is home to six bustard species and South Africa's national bird, the Blue Crane (*Anthropoides paradiseus*). Unfortunately, bustards and cranes are relatively cumbersome in flight, and are unable to react rapidly when they encounter unexpected aerial obstructions. Historically, they have had the freedom of open skies, but the proliferation of power lines and the future installation of wind turbines pose a real threat to these birds. FitzPatrick Institute students have been investigating the implications of power-line collisions in the Karoo, particularly for the endemic Ludwig's Bustards (*Neotis ludwigii*).

Jess Shaw recently graduated with a PhD for her research into the impact of power-line collisions on large Karoo birds. By regularly surveying hundreds of kilometres of high-voltage power lines in her Mazda Wildlife Fund vehicle, she was able to count bird carcases, and noted that many were not found because they were overlooked, or were removed by scavengers. Shaw also regularly looked for dead birds along low-voltage power lines, finding that these are nearly as lethal for Ludwig's Bustards as the larger power lines. Considering that the low-voltage line network is nearly four times the size of the high-voltage grid, this is of great concern. She estimates that power lines kill tens of thousands of Ludwig's Bustards annually.

The proliferation of power lines and the future installation of wind turbines pose a real threat to these birds.

But, surprisingly, she also found little population decrease compared with 20 years ago, suggesting that Ludwig's Bustards may be more productive breeders than previously thought.

Marking power lines with devices to make them more visible is the standard international mitigation for collisions, but evidence that it works for the Ludwig's Bustards and Blue Cranes is lacking. In the autumn of 2011, together with staff from the Endangered Wildlife Trust and Eskom, the researchers put up a large-scale line-marking experiment over 70 km of high-voltage power lines from a helicopter in the eastern Karoo.

This will test whether the marking devices reduce bird-collision mortality, particularly for Ludwig's Bustards and Blue Cranes.

Avian Malaria in the Western Cape

We are familiar with malaria as a human disease that is almost unavoidable in sub-Saharan Africa, and indeed across several other regions of the globe. But human malaria has many counterparts in the animal kingdom, one of which is avian malaria. Unlike the human form, which is caused by parasites of the genus *Plasmodium*, avian malaria is caused by three genera: *Plasmodium*, *Haemoproteus* and *Leucocytozoon*.

Avian malaria is capable of devastating impacts on its hosts, with the best-known case study of what can occur when an alien infectious disease is introduced into a region having taken place in Hawaii. Following the introduction of a mosquito vector, several forms of avian malaria contributed to the extinction of several honeycreepers, and had serious consequences for many other endemic Hawaiian birds. There is evidence that rising temperatures in Africa and elsewhere may facilitate the expansion of the range for avian malaria.

Avian malaria prevalence varies among bird species, with weavers, wagtails and canaries having higher infection rates than other bird families.

The Western Cape is blessed that it remains free of human malaria. However, the same cannot be said for avian malaria, which causes isolated fatalities in chickens, penguins and ostriches, with resultant socio-economic impacts. Many wild African birds can act as natural carriers of the disease without succumbing to its effects. In spite of this, not much is known about the ecology of avian malaria, especially in an African context. Former PhD student Sharon Okanga and her colleagues investigated the incidence of avian malaria in Western Cape passerine birds. She assessed which bird species were more susceptible to infection and looked for signs of preference in the malaria parasites. Blood samples were taken from 1 000 birds at 26 wetlands in the Western Cape. Avian malaria prevalence varies among bird species, with weavers, wagtails and canaries having higher infection rates than other bird families. Research continues into various areas of avian malaria.

The Threat to Penguins

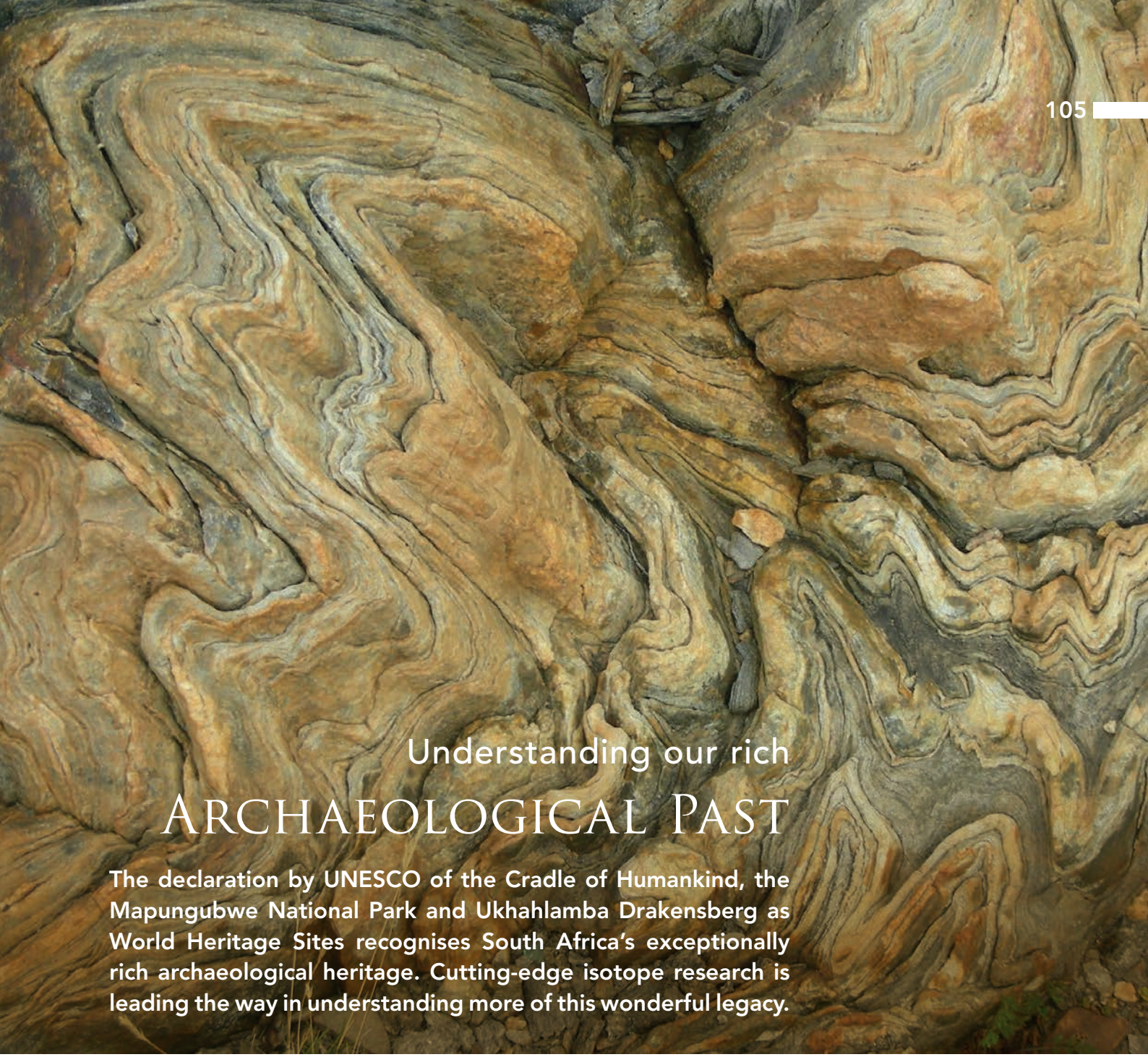
Research by the FitzPatrick Institute, in collaboration with the Department of Environmental Affairs, SANParks and the Centre National de la Recherche Scientifique, revealed that relatively small no-fishing zones can be of great benefit to breeding African Penguins (*Spheniscus demersus*), which rely on highly mobile pelagic fish prey.

Postdoctoral Research Fellow Dr Lorien Pichegru replacing a penguin chick in its nest on St Croix Island

African Penguins were upgraded to *Endangered* in February 2010, following a 60% decrease of their global population between 2001 and 2009, leaving only 26000 pairs in the wild. The dramatic drop in their numbers is attributed mainly to a lack of food, after the distribution of anchovies and sardines shifted 500km eastwards. Purse-seine fisheries exploiting the remaining pelagic fish stocks off the West Coast increase this food shortage.

During 2009, Marine and Coastal Management, the South African government agency responsible for fisheries management, closed an area of 20 km in radius to purse-seine fishing around the world's largest African Penguin colony at St Croix Island in Algoa Bay, Eastern Cape.

After the fishing ban, penguins on St Croix spent less time foraging for food and needed to spend less energy each day looking for food. This showed the immediate benefits of no-fishing zones for breeding penguins, which seem to respond extremely rapidly to concomitant changes in pelagic fish distribution. Appropriately designed Marine Protected Areas therefore benefit threatened top predators, even those relying on mobile prey over a small area.



Understanding our rich
ARCHAEOLOGICAL PAST

The declaration by UNESCO of the Cradle of Humankind, the Mapungubwe National Park and Ukhahlamba Drakensberg as World Heritage Sites recognises South Africa's exceptionally rich archaeological heritage. Cutting-edge isotope research is leading the way in understanding more of this wonderful legacy.

South African researchers are fortunate in having easy access to a treasure trove of fossil and archaeological collections and the natural environments from which they came, providing local researchers with a special advantage. UCT researchers in particular have been able to use the South African environment as a natural laboratory in which to explore questions about isotope systematics – how stable isotopes are distributed through ecosystems. This type of approach is not possible in more polluted or ecologically degraded parts of the world.

Palaeontological research aims to understand how and why humans evolved as they did as well as why certain climatic events occurred in some parts of the world and not in others.

The *Ten-Year Plan for Science and Technology* of the Department of Science and Technology (DST) identifies palaeontology (together with earth systems and environmental sciences) as being among South Africa's Science Missions, in which it advocates the

exploitation of "South Africa's 'living laboratories'" of local resources and geographic advantage.

The South African Strategy for Palaeosciences, approved in 2012, furthermore recognises the importance of and the need for archaeological and palaeontological research. The appointment in 2012 of the DST/NRF South African Research Chair in Stable Isotopes in Archaeology and Palaeoenvironmental Studies was UCT's response to this national imperative to prioritise and revitalise research in the palaeosciences.

Stable light isotopes reflect primarily the types of foods consumed in life, while heavy isotopes can be used to track movement across geological zones.

Stable isotopes are a key tool in the earth and life sciences. They are also essential in the palaeosciences that underlie and enhance our understanding of our human past, especially palaeoecology (including palaeodiets), palaeoenvironments and palaeoclimates. These fields form the foundations for the interpretation of the hominid fossil record and associated archaeology from the earliest stages of human evolution up until the last few hundred years.

Collaborations in palaeoscience research are nurtured with several research units and departments at UCT, as well as other institutions around the country. The Department of Archaeology at UCT pioneered aspects of stable isotope research and its applications to human palaeosciences.

Climate changes during our current geological era are well documented in some parts of the world (mainly in the northern hemisphere) but poorly known in the south, including South Africa.

In other related research, palaeobiologist Professor Anusuya Chinsamy-Turan from the Zoology Department (now Biological Sciences) is an internationally recognised expert on the microscopic structure of the bones of extinct and extant vertebrates. Among recent highlights in her work has been the discovery of information recorded in the bones of duck-billed dinosaurs that lived in the Arctic about 70 million years ago, providing fascinating insights into the lives of these ancient creatures. This project was carried out with collaborators from Temple University (USA) and the Museum of Nature and Science (USA).

Stable Isotopes in Archaeology and Palaeoenvironmental Research

Understanding our past a little bit better is the focus of the South African Research Chair in Stable Isotopes in Archaeology and Palaeoenvironmental research. In these studies, stable-isotope techniques are the primary tool. Stable isotopes of light elements are a key tool in many areas of the earth and life sciences and are naturally occurring, non-radioactive atoms that allow for the study of detailed chemical reactions in certain processes – specifically the metabolisms of people and animals.

Isotopic analyses of archaeological and other remains can help us understand how and why humans evolved as they did, as well as why certain climatic events occurred in some parts of the world and not in others. Climate changes during our current geological era are well documented in some parts of the world (mainly in the northern hemisphere) but poorly known in the south, including South Africa. This work will link with other programmes at UCT on climate and environment, notably the African Climate and Development Initiative.

Isotopes also provide a powerful means of studying human behaviour. Stable light isotopes reflect primarily the types of foods consumed in life, while heavy isotopes can be used to track movement across different geological zones. A major focus of the research programme for this Chair is to study pre-colonial times which lack documentary records. Southern Africa is one of the areas of the globe that has been continuously inhabited for the longest time. For the majority of that time, it was occupied entirely by hunter-gatherers. Research in this area will expand on ways in which humans were able to live as hunter-gatherers.

The focus of the Chair is therefore strongly inter-disciplinary, with connections to both the humanities and the sciences. The intention is to build collaborative links across disciplines and departments at UCT and beyond.

Cold Dinosaurs

Dinosaurs are well known from all parts of the world, and from many different latitudes. However, the discovery of dinosaurs from areas that were well within the Arctic and Antarctic during the Mesozoic is fascinating. These so-called polar dinosaurs pose a biological enigma: how did they cope with the hostile polar winters? Did they migrate? Did they overwinter? And if they did stay, how did they survive? These questions have long plagued paleobiologists, and various theories have been put forward to explain these findings.

A recent study by a team of dinosaur palaeontologists from UCT, Temple University (USA), and the Museum of Nature and Science (USA) has uncovered information recorded in the bones of duck-billed dinosaurs that lived in the Arctic about 70 million years ago which suggests that they did not migrate, but rather endured the long, dark, polar night.

How did they cope with the hostile polar winters? Did they migrate? Did they overwinter? And if they did stay, how did they survive?

One of the collaborators in this study, Dr Anthony Fiorillo, and UCT palaeobiologist Professor Anusuya Chinsamy-Turan reasoned that perhaps clues pertaining to how these dinosaurs lived at such high latitudes might be recorded in the microscopic structure of their bones. This collaboration grew to include UCT postdoctoral researcher Dr Daniel Thomas and Temple University's Allison Tumarkin-Deratzian.

These researchers found that the bones of the polar dinosaurs had an unusual texture, similar to tree rings – the bones showed periodic changes in texture which suggest a fast and slower rate of bone deposition, which probably correspond to a summer and winter bone pattern and are likely to be related to the availability of food.

The research is particularly exciting because the data from the bone histology independently corroborates what researchers are seeing in the field. The results highlight the importance of both biological and geological evidence for interpreting the life habits of extinct organisms.

Studying Dwarf Elephants

Matthew Scarborough of the Palaeobiology Research Group in UCT's Department of Biological Sciences is a PhD student investigating the rather unusual evolution of fossil dwarf elephants and mammoths on Mediterranean islands (particularly Sicily, Malta and Sardinia) over the last one million years. Scarborough's research is aimed at gaining a better understanding of how elephants and mammoths adapted to different kinds of island environments.

1m high dwarf elephants (Palaeoloxodon 'falconeri') from Spinagallo Cave, Sicily. With kind permission of the Museo di Palaeontologia, Roma, Italy.

The research enables collaboration at an international level; he has spent time in Rome, Palermo and Basel studying the anatomy of the feet and limbs of Sicilian dwarf elephants. For the most part, his recent research has focused on explaining several unusual anatomical features in the feet of dwarf elephants, using a comparative approach to investigate to what extent dwarf elephant locomotion was adapted to the very hilly environment of Sicily. During the course of conducting fieldwork, he visited caves and a quarry in north-western Sicily where these dwarf elephants were found. Scarborough is attempting to date the age of the fossils from Alcamo Quarry using a radiometric dating technique (Uranium-Thorium dating), and is also planning to investigate the palaeogeography of Sicily.

A rather unexpected recent finding has been the documentation of dwarf elephant bones which fall outside the size ranges currently accepted for the two dwarf elephant species which inhabited Sicily. Research on the possible existence of a third species of dwarf elephant on Sicily and Malta is still ongoing.

Centres of Exellence
associated with this theme

DST/NRF Centre of Excellence at the Percy FitzPatrick Institute of African Ornithology, "Birds as Keys to Biodiversity Conservation"

The Centre of Excellence (CoE) at the Percy FitzPatrick Institute undertakes scientific studies involving birds that contribute to the theory and practice affecting the maintenance of biological diversity and the sustained use of biological resources. The centre continued to achieve its targeted number and quality of scientific publications, with 87 papers published in peer-reviewed journals in 2012, including 28 in journals with ISI science impact factor ratings of 3.5 or higher. Seven contributions to semi-technical books and 40 semi-popular articles were also published.

During 2012, the centre supported 13 postdoctoral fellows, 19 PhD and 40 MSc students, and one BSc Honours student, of whom 18% were black and 50% were women. Sixteen postgraduate students graduated during 2012 (three PhD, one MSc thesis and 12 MSc in Conservation Biology).

The CoE co-hosted and funded a local conference, *Frontiers in South African Ornithology*, with BirdLife SA and an *International Blue Swallow Action Plan Review Workshop* with the Endangered Wildlife Trust during 2012.

CoE members also presented seminars and illustrated talks at numerous universities, bird clubs, and membership-based societies. A broad range of close collaborative working relationships with scientific peers and a variety of conservation NGOs and governmental organisations exists both nationally and internationally. The CoE continues to build much-needed African capacity in the broad arena of biodiversity conservation. It also continues to be active in advising conservation organisations, government departments and industry on a variety of research projects. During 2012, CoE members served on 18 journal editorial boards, reviewed at least 158 papers for 64 peer-reviewed journals, and participated on 47 advisory boards.

CoE research projects have recently generated 29 full-time jobs and 93 part-time jobs, mostly filled by women. These include 19 full-time and 49 part-time jobs in previously disadvantaged communities in South Africa, 10 full-time and 40 part-time jobs in Zambia, and four part-time jobs in Angola.

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Remembering Professor Phil Hockey

Professor Philip Hockey, the Director of the Percy FitzPatrick Institute of African Ornithology, passed away in January 2013 after a long battle with cancer. Professor Hockey was instrumental in elevating the centre to one of the top three in the world and he was recognised as an expert in his field. During his career, he graduated 18 PhD and 33 MSc students, supervised eight Postdoctoral Research Fellows and some 30 honours projects. In addition to more than 120 scientific papers, Phil published over 150 semi-popular articles and 12 books and book chapters. He co-authored the best-selling regional field guide *Sasol Birds of Southern Africa*, and was editor-in-chief, along with Richard Dean and Peter Ryan, of the seventh edition of *Roberts Birds of Southern Africa*.

Marine Research Institute

The Marine Research (Ma-Re) Institute, one of UCT's signature themes, serves as an umbrella body to stimulate and co-ordinate marine research across all faculties and departments involved in research into the salty waters around Southern Africa. It also serves as a window between the outside world and UCT for marine research and marine contracts. It hosts the Marine Remote Sensing Unit and the Research Dive Unit.

The Ma-Re Institute has two SARChI Chairs associated with it, the Chair in Marine Ecology & Fisheries, and the Chair in Modelling of the Coupled Ocean-Land-Atmosphere (phenomena related to climate). It has been instrumental in getting the Applied Centre for Climate and Earth System Science (ACCESS) and the Nansen-Tutu Centre for Marine Environmental Research off the ground. Both the Marine Ecology & Fisheries Chair and the Ma-Re flagship research project BASICS (Benguela and Agulhas Systems supporting Interdisciplinary Climate-change Science) are inter-disciplinary programmes that aim to tackle aspects of climate-change research and an ecosystem approach to fisheries.

Photo of a sea snail taken by Ma-Re student Grea Wessels while diving.

Ma-Re co-ordinates and convenes a taught master's degree in Applied Marine Science (by coursework and dissertation), runs a weekly seminar series, and has initiated bilateral research and teaching exchange agreements with Norwegian, French, British, and other European Union institutions, as well as American ones. It has also played an important role in promoting marine research in the South African Global Change Grand Challenge and in the marine component of the India-Brazil-South Africa (IBSA-Ocean) trilateral agreement on science and technology.

Ma-Re is active in outreach to the public through interactive sessions at schools, the Two Oceans Aquarium and Science Centres. Ma-Re also participates in the national Science Festival (Scifest), and in developing curriculum-relevant educational resources concerning the role of the oceans in climate change.

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African Climate and Development Initiative

The African Climate and Development Initiative (ACDI) co-ordinates exciting inter-disciplinary research and training on the twin issues of climate change and sustainable development. ACDI brings together natural scientists, engineers, social scientists, lawyers, economists, and urban planners, among others, from UCT and beyond, to provide an African perspective, grounded in strong science, addressing issues relating to climate variability and global change affecting the African continent. It actively creates opportunities for African researchers and young scholars to contribute their own perspectives to these issues.

Through the establishment of strong partnerships throughout Africa, ACDI contributes towards developing African leaders of the future who have an intimate understanding of the physical and human needs of Africa, and who will contribute to address this all-important issue facing mankind.

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Research Groupings
associated with this theme

Energy Research Centre

The Energy Research Centre (ERC) conducts high-quality, targeted and relevant research, as well as offering postgraduate opportunities at master's and doctoral levels. The four main research areas are energy efficiency, energy, environment and climate change, energy poverty and development, and energy systems analysis and planning. ERC staff members have qualifications in engineering, natural and environmental sciences, urban and regional planning, economics, law, politics, sociology, and anthropology.

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Environmental Evaluation Unit

The Environmental Evaluation Unit (EEU) is an independent, self-funded research, consulting and training unit based at UCT. Founded in 1985, the EEU has established itself as a leader in the fields of integrated environmental and coastal management and sustainable development, responding to local, regional and global environmental challenges using an inter-disciplinary and participatory approach. During this time, the EEU has undertaken work throughout South Africa and Southern Africa, has participated in global research and policy initiatives, and has provided expertise to leading private and public corporations, research institutions, planning and development organisations, state departments, local authorities, and communities. The EEU has implemented a wide diversity of projects that have contributed to academic debates and informed policy while having practical impacts on the ground. The EEU works in five main thematic areas: integrated environmental planning, management and assessment; integrated coastal and small-scale fisheries management; biodiversity use, trade, livelihoods and social justice; sustainable business and cross-sector collaboration; and public participation.

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Nansen-Tutu Centre for Marine Environmental Research

The Nansen-Tutu Centre for Marine Environmental Research, under the patronage of Nobel Laureate Archbishop Emeritus Desmond Tutu, was set up in 2010 to assist in the worldwide need to develop the capacity to understand, model and predict the state of the ocean and its ecosystems, just as the meteorological services do for weather and climate. The founding partners of the Nansen-Tutu Centre in Norway and South Africa have the necessary complementary expertise and knowledge to address these challenges in the three oceans around Southern Africa. A central theme for the centre is to undertake research into the science underpinning operational oceanography, particularly in numerical ocean modelling, as well as continuing to develop skilled African postgraduate marine scientists. The centre actively contributes to the OceanSAfrica initiative, with partners from the Department of Environmental Affairs' Ocean and Coasts Branch, the South African Weather Service, the Council for Scientific and Industrial Research, and the South African Earth Observing Network.

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Plant Conservation Unit

The Plant Conservation Unit (PCU), established in 1993 and located in the Science Faculty, undertakes research and teaching directed at improving the conservation status of the vegetation of Southern Africa, with a particular focus on the winter rainfall region. Staff and students within the PCU investigate palaeoecological, historical, and current impacts on the vegetation of the region and work closely with land users to conserve and prevent further transformation of the region's biodiversity.

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Animal Demography Unit

The mission of the Animal Demography Unit (ADU) is to contribute to the understanding of bird populations, especially bird-population dynamics, and thus contribute to the conservation of avian biodiversity. The ADU achieves these goals through a variety of projects in which para-ornithologists throughout Southern Africa can participate. These projects range from identifying bird species, through undertaking census surveys, to making detailed observations on breeding productivity.

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Professor Bruce Hewitson

Climate Change

Professor Bruce Hewitson heads the Climate Systems Analysis Group focusing on climate modelling, variability, change, and regional projections. He is extensively engaged with capacity-building in Africa and with the communication of regional climate information supporting responses to climate change. He plays numerous roles internationally, including that of co-ordinating lead author in the Intergovernmental Panel on Climate Change (IPCC), and currently co-chairs both the IPCC Task Group on Scenarios for Climate and Impact Assessment and the World Climate Research Programme (WCRP) working group on regional climates. He is a lead co-ordinator in the WCRP global Coordinated Regional Climate Downscaling Experiment programme to develop regional climate projections.

Professor David Jacobs

Animal Evolution and Systematics

Professor David Jacobs holds a PhD in Zoology from the University of Hawaii, where he completed a thesis titled "Character release in the endangered Hawaiian hoary bat, Lasiurus cinereus semotus". He has been at the University of Cape Town since 1994, where his main research interests are focused on all aspects of evolutionary biology. He has conducted research all around the world, including Australia, Costa Rica, Belize, Israel, Canada, Namibia, and Zambia. He has supervised more than 20 postgraduate degrees and many of his students have won prestigious awards such as the Purcell Memorial Award for the best PhD thesis and the SA Association for the Advancement of Science – S2A3 Bronze Medal for the best master's degree thesis.

Professor Judith Sealy

Stable Isotopes, Archaeology and Palaeoenvironmental Science

Judith Sealy is Professor of Archaeology and the former head of the Department of Archaeology at UCT. She also heads UCT's Stable Light Isotope Laboratory, a major facility housing analytical equipment. Professor Sealy obtained her PhD from UCT in 1989 for her thesis entitled "Reconstruction of Later Stone Age diets in the south-western Cape, South Africa: evaluation and application of five isotopic and trace element techniques". Her main research interests include the development and application of stable-isotope techniques for dietary reconstruction, hunter-gatherer archaeology across the period from the emergence of modern humans to the recent past, and the beginnings of food production in Africa. She has published more than 75 peer-reviewed journal articles and book chapters, including articles in *Nature* and *Science*.

Ocean Climate Modelling

The focus of this SARChI Chair (previously held by Professor George Philander) is multi-disciplinary and it is well poised to build research capacity in ocean-atmosphere studies, particularly with regard to satellite remote sensing of the oceans, numerical modelling, data assimilation, and forecasting of the coupled ocean-atmosphere ecosystem. The Chair will enable us to better understand and model the properties of the oceans around Southern Africa and its impact on climate change not only regionally but globally as well.