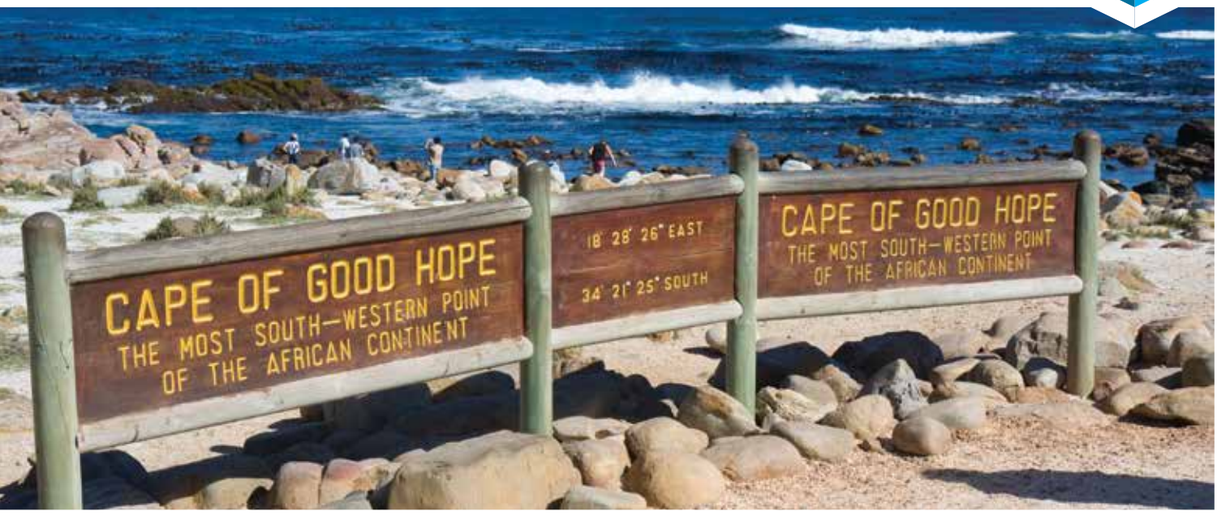
FRAGILE CONTINENT

The Intergovernmental Panel on Climate Change (IPCC) reported in early 2014 that Africa was one of the continents most vulnerable to climate change, not just because of the reality of rising temperatures and erratic weather patterns, but because of its poor state of economic development and low adaptive capacity. Understanding, confronting and managing the dynamics and impact of these challenges is a core research focus at UCT, where researchers are collaborating across all seven faculties on issues of adaptation and mitigation and working to push the boundaries of science to help build a stable future for the continent.

SCIENCE WITHOUT BOUNDARIES
AN AFRICAN RESPONSE TO CLIMATE CHANGE



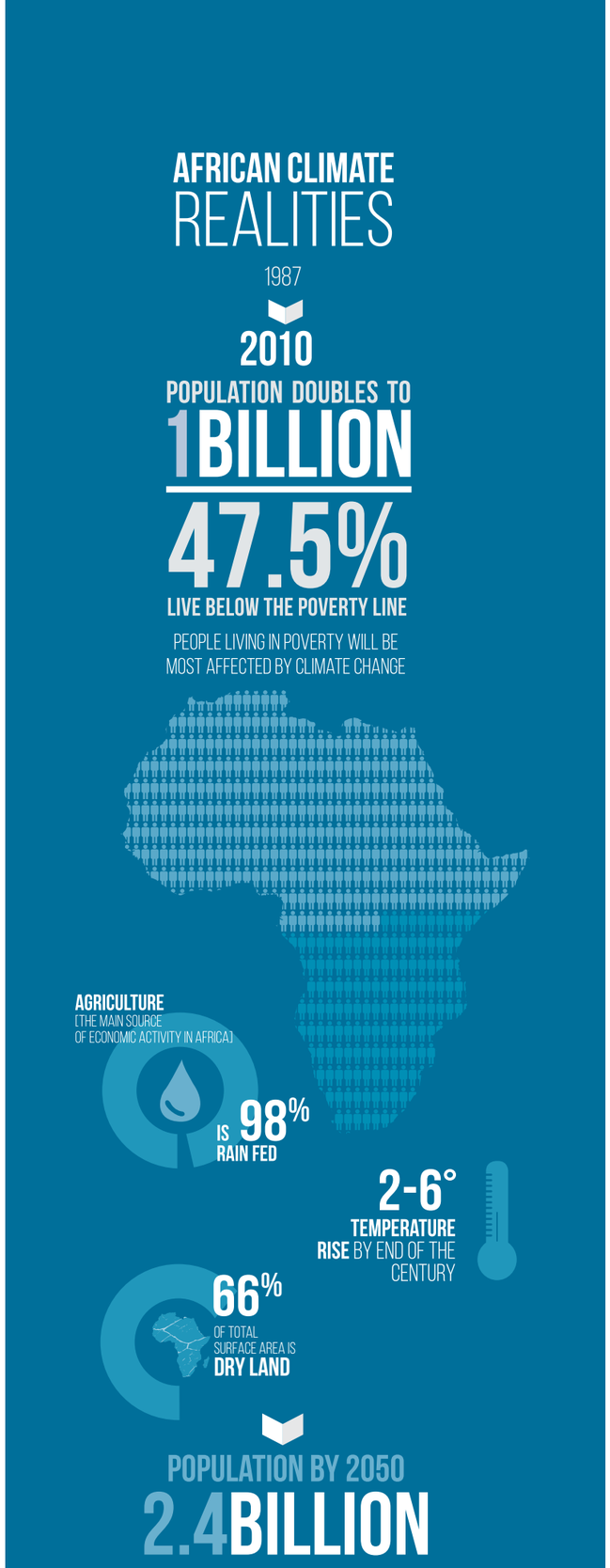
"The greater Agulhas Current is one of the most energetic current systems in the global ocean. It plays a fundamental role in determining the mean state and variability of the regional marine environment, affecting its resources and ecosystem, Southern African weather, and the global climate on a broad range of temporal and spatial scales," writes Dr Björn Backeberg, a postdoctoral fellow at the Nansen-Tutu Centre for Marine Environmental Research at UCT, and his colleagues in a recent paper.

Students of oceanography and related disciplines naturally gravitate to UCT, at the tip of Africa, which juts out into the Atlantic Ocean just north of a point where the wild Southern Ocean meets the Atlantic and the Indian oceans. The Agulhas Current moves along the eastern side of the continent to a place roughly south of Cape Town, where it turns (retroflects) and heads back into the Indian Ocean once more. These features play a profound role in the planet's climate, in the oceans, on land and in the atmosphere.

The combination of UCT's situation in this interesting geographical nexus, together with its reputation as one of Africa's top research institutions, has proved irresistible, and the university has attracted a vast pool of talent in climate change science and research over the years.

"At UCT, we arguably have the biggest critical mass of expertise in the climate change domain in Africa," says Professor Mark New, who heads up the African Climate and Development Initiative (ACDI) – one of the university's six Signature Themes. "We are the recognised centre of excellence in Africa and one of a very few developing countries that really can compete at an international level in climate change science."

It is important that Africa takes a lead in this regard because the continent is one of the most vulnerable to the effects of climate change. According to the *Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report,* released in 2014, the reality of rising temperatures and erratic weather patterns, coupled with high levels of poverty and low adaptive capacity, makes it likely that people on the continent will bear the brunt of the negative effects of climate change: from worsening food security to increased health risks. The report states that annual temperatures in Africa are likely to rise faster than the global average, exceeding two degrees by the end of the century (relative to the late 20th century), and could reach as much as three to six degrees under some scenarios. Given that two-thirds of the continent is already classified as dry land and that 98% of agriculture in sub-Saharan Africa, which is the mainstay of economic activity in terms of employment, is rain fed, the need for



adaptation is paramount. Africa is the second most populated continent in the world after Asia, with one billion people as of 2010, and this is expected to rise to 2.4 billion by 2050. Forty-seven-and-a-half percent of people still live below the poverty line, a significant proportion of which are chronically poor.

UCT scientists, working in collaboration with global and African peers, are playing a key role in understanding and mitigating these threats. The ACDI, which was established in 2011, is at the heart of much of this work, co-ordinating research within and across disciplines at UCT, and facilitating interdisciplinary work focused on two main areas: the impact of and adaptation to climate change, and mitigation.

"The ACDI is a network, a broker and a matchmaker, working with departments and research groups across all seven faculties at UCT, from atmospheric physics through to the business school and law faculty," says Professor New. "Complex problems such as climate change demand a co-ordinated, interdisciplinary response. We are working on developing research strategically in specific areas, as well as creating new research areas that are relevant to the Signature Theme."

To do this, ACDI builds on the work of a number of established research groups within or allied to various departments, such as the Energy, Environment and Climate Change Group at the Energy Research Centre, the Percy FitzPatrick Institute of African Ornithology and the Climate Systems Analysis Group (CSAG), all of which have drawn in exceptional scientists and students with a strong focus on climate change issues. Many of these nodes of excellence are internationally recognised in their own right.

ADAPTATION BEYOND BORDERS

A flagship ACDI project is the new five-year research project, Adaptation at Scale in Semi-Arid Regions (ASSAR), which is focused on understanding climate change in semi-arid areas across Africa and Asia and determining what kind of adaptation strategies are necessary. ACDI is taking the lead in ASSAR and will drive the Southern African component of the research.

The project is funded by Canada's International Development Research Centre (IDRC) and the United Kingdom's Department for International Development (DfID), and falls under the umbrella of the Collaborative Adaptation Research Initiative in Africa and Asia (CARIAA), a seven-year, C$70-million

research initiative in Africa and Asia. "Our aim is to understand what the critical vulnerabilities to climate change are, with a special focus on the poorest and most vulnerable in semi-arid areas," says Professor New. "The consortium will seek to understand potential adaptation options to reduce poverty and improve livelihoods, and perhaps even more critically, to understand what the barriers to and enablers of effective response are."

COMPLEX PROBLEMS SUCH AS CLIMATE CHANGE DEMAND A CO-ORDINATED, INTERDISCIPLINARY RESPONSE.

"The scope of ASSAR's research is huge," says Professor New. "And it is a flagship of the ACDI because of its regional breadth and its emphasis on interdisciplinarity."

GREATER THAN THE SUM OF THE PARTS

If ASSAR is an exemplar of ACDI's interdisciplinary approach on a regional and global scale, the Bergrivier Climate Knowledge Network (CKN) is doing the same thing on a local scale. Led by a team of UCT action researchers from across the university, in partnership with the Western Cape Government and funded through a number of sources, including the Carnegie Corporation, Cape Higher Education Consortium (CHEC), the British High Commission and, more recently, National Treasury, via the Flanders International Co-operation Agency, it is a collection of projects initially focused on exploring climate change, environmental and development issues within the Bergrivier Local Municipality, situated in the greater West Coast district of the Western Cape.

"The Bergrivier Climate Knowledge Network brings together a network of academic practitioners and civil society members working within the ambit of the Bergrivier Municipality to facilitate knowledge-sharing, relationship-building and applied interdisciplinary research. We wanted to push the boundaries of what is possible at a local level by taking an interdisciplinary approach to a local challenge, and this region presents an ideal test site," says Professor New.

One area of focus of the project is the Berg River. Recognised as a system under extreme environmental and resource stress that is critical to the economy of the Western Cape, the Berg River flows from its primary source in the Drakenstein mountains to the sea north of Saldanha Bay, passing through some of the Western Cape's most important agricultural areas along its 294-kilometre length. About half of its length forms the southern boundary of the Bergrivier Municipality, which stretches from the Atlantic Ocean to the Groot Winterhoek Mountains inland.

"Professor New approached us and said he would like to offer scientists and students a chance to do applied research," says Penny Price, Control Officer (Climate Change Adaptation) in the Western Cape Government. Since the provincial government wanted to mainstream climate change, incorporating the concept into all its programmes, it took up the offer with alacrity. The province is well aware of the climate change pressures being brought to bear on the region, and the urgency for action. "We were hoping to get support from experts in the development of adaptation plans at a local level," says Price.

Lack of water and sanitation facilities impact on downstream water quality in the Berg River.

HEALING IN THE WILDERNESS

Honours student Nicola Kuhn is assessing the vegetation in the Groot Winterhoek Wilderness Area (GWWA) as part of the Bergrivier Climate Knowledge Network (CKN). "This is one of the main catchment areas, so it is of interest to get a sense of its environmental history and see if it is functioning as it should since it became a wilderness area in 1973," says Professor Timm Hoffman, head of the Plant Conservation Unit.

Protea laurifolia.

Kuhn used four indicators to assess the health of the GWWA: changes in the intensity of gulley erosion and the extent of soil deposition areas; changes in composition and extent of cover of the vegetation; changes in two specific Protea species; and changes in thickets around rocky areas.

After 40 years of protected area management, she found that gulley erosion had stabilised and that most deposition areas had become vegetated. Total basal cover was approximately eight times greater than it was in 1973. The *Protea nitida* population was more than five-and-a-half times greater and had a large number of juvenile individuals. The *Protea laurifolia* population was approximately four times greater, with the dominant class shifting from adults in 1973 to seedlings in 2013. An extensive fire in 2009 took its toll on thicket cover at some, but not all, rocky outcrop locations. "While evidence suggests an improvement of most ecosystem health indicators and therefore an effective management regime, the GWWA is still at risk of being affected by climate change with an increased aridity and occurrence of wildfires predicted for the area," concludes Kuhn.

It's taken time to get off the ground, says Professor Timm Hoffman, who heads up the Plant Conservation Unit, based in the Department of Botany, and is an ACDI associate and part of the Bergrivier CKN, but that's because it has required the development of trust and real relationships between people coming from very different worlds. However, Price feels it has now reached a point where a genuine network has been created; one that has its own momentum. "Municipal managers feel they can pick up the phone and talk to a scientist about research they'd like to do. It has been incredibly useful," adds Price. "It's a model we'd like to replicate."

The Bergrivier CKN has delivered real benefits to the municipality. For example, a piece of research done by UCT scientists in collaboration with the Council for Scientific and Industrial Research (CSIR) has given the municipality very valuable information for planning, says Price. "They looked at statistically significant trends in rainfall, and found, contrary to expectations, that rainfall is not decreasing in the area. The number of rainfall days has decreased, but the rain has intensified."

This strong signal for the future has important implications for smaller towns in the Bergrivier Municipality, in terms of infrastructure planning: storm-water pipes will probably need to be larger to cope with the increased flow. And in the agricultural sector, intensified rainfall demands a greater focus on erosion control and protection of the soil.

Another sub-project of the CKN is aiming to cast light on how the nexus concept – the intersection of water, food, biodiversity, energy and land – applies at the catchment scale. Researchers are working to describe and quantify the natural resource base of the Berg River region in order to inform decision-making and project development that is consistent with sustainable resource use and development within the municipality and the Berg River catchment area.

The cross-fertilisation between these various projects is significant. Professor New says that what they are discovering, as the CKN unfolds, is

that an interdisciplinary approach has tremendous benefits even for those projects that have a more monodisciplinary focus. "Because they are taking place within an interdisciplinary environment, this allows for better framing of the problem and the research is informed from multiple viewpoints. And of course, the results feed into other projects and interest groups," he says.

A WIDER CONVERSATION

One of the benefits of an interdisciplinary approach is that it enables everyone in the network to interact with a much broader set of expertise. In the same way, the ACDI strives to add value to existing areas of research excellence within the university, such as the CSAG, by linking them into a broader framework and into a wider conversation.

Director of the CSAG, Professor Bruce Hewitson, has been with UCT since 1992 and has seen this group of multidisciplinary scientists expand its vision in that time, moving from relatively narrow-focus science to a body that looks at climate change through a multitude of lenses, from agriculture to economics and ethics, thanks in part to the additional linkages ACDI brings.

CSAG's role has also expanded, not just beyond the boundaries of the university, but also beyond the boundaries of South Africa. "We want to export capacity, through capacity-building, across Africa," says Professor Hewitson. "We are working with a number of regional partners – and with young, emerging scientists – in West, East and Southern Africa."

As part of its capacity-building work, the CSAG hosts a Winter School, a two-week intensive course targeting mid-career professionals engaged in decision-making and policy development that involves issues related to climate change and adaptation. The most recent example was a course for city managers from Addis Ababa, Dar es Salaam, Maputo, Kampala and Luanda.

The CSAG has also invested in a Climate Information Platform, which offers free use of a massive database, integrated with guidance documents that will help the user to make the most of the information in the system.

Professor Hewitson also chairs CORDEX, the Co-ordinated Regional Downscaling Experiment, funded by the World Climate Research Programme. CORDEX arose out of a recognition that there was a need for high-resolution regional information regarding future climate – in other words, very detailed models at local level. Due to the dearth of African regional information, Africa is a priority of CORDEX.

Scientists can no longer think in silos; there is an ethical dimension to their work, and they have a responsibility to society to provide information that will lead to relevant and appropriate decision-making. In a paper published in *Climatic Change* in November 2013, Professor Hewitson and his co-authors stress the importance of providing information that satisfies the criteria of being plausible, defensible and actionable: "Climate scientists cannot absolve themselves of their ethical responsibility when informing adaptation and must, therefore, be diligent in ensuring that any information they provide adequately addresses these three criteria."

THE CANARY IN THE MINE

When it comes to data on the local level, birds can act as an indicator of approaching problems – just like the canary in the mine – and this is one way that research carried out by the Percy FitzPatrick Institute of African Ornithology contributes to the growing understanding of climate change.

The southern fiscal (*Lanius collaris*, also known as the fiscal shrike or common fiscal), a sit-and-wait predator that perches on exposed branches and drops down on small creatures such as lizards, has been studied by Drs Susan Cunningham and Rowan Martin (postdoctoral fellows in the FitzPatrick Institute), together with Carryn Hojem (field assistant) and the late Professor Phil Hockey (previously director of the institute).

The researchers were interested in the impact of higher temperatures on the breeding success of the birds, so they looked at birds close to the edge of their range where temperatures are highest.

In a recent paper published in the *Public Library of Science (PLOS)*, the scientists reported that, at higher temperatures, the parent birds reduced the rate at which they brought food to the nest, resulting in growth stunting in their offspring. The nestlings left the nest smaller and later, which could both help them (smaller birds may cope better in hotter temperatures) and harm them (staying in the nest longer exposes them to a greater risk of predation).

This study was undertaken in the context of a larger programme of research, called "Hot Birds", where researchers seek a greater understanding of precisely how climate change is likely to affect our birds through investigation of the mechanistic links between climate, physiology, behaviour and, ultimately, population processes.

THE FUTURE OF THE OKAVANGO BASIN

The great Okavango Delta is fed by seasonal rains that fall in southern Angola, sending waters on a 1 200-kilometre journey to the basin that holds the Okavango. But with predictions of rising temperatures in the west of Southern Africa, will the waters still come? And will they be as massive and awe-inspiring, filling the basin with enough water to protect and maintain the Okavango ecosystem? Or are we likely to see floods even bigger than the ones that occurred from 2009 to 2011?

Dr Piotr Wolski, senior research officer in the Department of Environment and Geographical Science, together with Professor Bruce Hewitson, director of the Climate System Analysis Group (CSAG) at UCT, and colleagues in the USA, have laboured over models of the delta's future, and have concluded that more severe flooding is unlikely, despite the general prediction that anthropogenic climate change leads to an increase in frequency and magnitude of extreme weather events such as floods.

According to their paper, published in the *Journal of Hydrology* in January 2014, greenhouse gas emissions have in fact substantially reduced the chance of the floods. "The air is warmer in the climate we are experiencing and the river takes a long time to flow down to the delta," explains Dr Wolski, "so you get more evaporation occurring before the river even reaches the delta, and thus fewer high floods." However, natural variability in the system means that above-average flooding will continue to occur.

"If not for climate change," says Dr Wolski, "the Okavango system would have experienced even larger flooding from 2009 to 2011 than it actually did." However, he said that in the long term, the delta was likely to shrink somewhat in size.

FISHER WOMAN

A postdoctoral student at the UCT Marine Research Institute (Ma-Re) was recently joint winner of a prestigious United Nations award, one of the 2013 SEED (Supporting Entrepreneurs for Sustainable Development) awards. Dr Hilkka Ndjaula's Dried Fish Company (DFC) and its partner, the Women's Enterprise Development Initiative (WEDI), aim to help Namibians attain food security and reduce the economic gender gap in that country by boosting women-led enterprises.

For someone hailing from a country where the fishing industry is a pillar of the economy, it's hardly surprising that Ndjaula's postdoctoral studies in marine biology revolve around the population dynamics of small pelagic fish like sardines and anchovies. Her doctorate and master's in marine biology were completed in Norway. DFC uses solar energy to dry frozen horse mackerel, which is then distributed to outlets run by WEDI, a women's co-operative that has exclusive distribution rights focused on rural areas.

Pictured right: Dr Hilkka Ndjaula.

THE FUTURE OF FOOD

Another living system vulnerable to the effects of climate change and one that has enormous significance for humans – especially in Africa – is the already fragile food system. According to a 2009 World Bank report on climate resilience in Africa, rain-fed agriculture contributes some 30% to African GDP, employs about 70% of the population and is the main safety net of the rural poor. And yet many regions in Africa can already not claim to be food secure; as temperatures rise and rainfall fluctuates, the picture could become much worse. Scientists across the ACDI network are involved in several research projects aimed at understanding and adapting to the impact of climate change on agriculture.

"Adaptive Intervention in Agriculture to Reduce Vulnerability of Different Farming Systems to Climate Change in South Africa" is a project led by Dr Peter Johnston in the CSAG and funded by the Water Research Commission, which will investigate the impact of projected climate change on agriculture; assess the vulnerability of crops, rangelands and farming households and enterprises; and identify and suggest appropriate adaptive techniques and practices in selected catchments and farming areas. The report will provide an assessment of the vulnerability of different farming systems to climate change. It will evaluate alternative adaptation practices and techniques (both indigenous and science-based knowledge) and, if necessary, develop and test innovative, appropriate and sustainable interventions, including internal management measures and external policy measures.

The CSAG's Dr Olivier Crespo has been working with colleagues across South Africa and in Swaziland on a related project involving an expert team of climate, crop, economic and IT research scientists evaluating the impact of climate change on the production and prices of important crops. At the same time, the project seeks to build human and institutional capacity in this field.

The project is testing models that estimate what the production of staple crops in the region during the period 2070 to 2099 will be. These models will yield an accurate picture of productivity and projected prices in important staple crops – maize, sorghum, sugar cane, wheat and sweet potatoes – and will then be used to test the economic outcomes of different farming systems, providing options for the future.

According to a paper published in *Global and Planetary Change* in December 2013 by Nkulumo Zinyengere (a PhD fellow in the CSAG), Dr Crespo and Dr Sepo Hachigonta, harvests in Africa are likely to decline steadily over the next 90 years. The researchers reviewed 19 recent studies of the impact of climate change on crops in the 21st century, and found that maize yields are projected to decline on average by 18%.

MARINE PROTECTED AREA IMPROVES YIELD WITHOUT DISADVANTAGING FISHERS

Do Marine Protected Areas (MPAs) disadvantage fishermen? In a paper published in *Nature Communications* in August 2013, Dr Sven Kerwath (a research associate at UCT and scientist at the Department of Agriculture, Forestry and Fisheries), postdoctoral fellow Dr Henning Winker, Dr Albrecht Götz of the Southern African Environmental Observation Network and Professor Colin Attwood of Ma-Re, set out to answer this question.

Their research focused on the roman (which most people know as the red roman, *Chrysoblephus laticeps*), a sea bream endemic to South Africa's coast. Examining 15 years of data, they found that the establishment of the Goukamma MPA did not result in a drop in total catch, nor did the fleet have to travel greater distances to get the catch.

The suggestion is that roman left the MPA as fish densities built up, spilling out into areas where catching them was legal. In addition, a boost in roman egg production in the protected area would benefit unprotected areas too, as eggs drift with the currents.

THE SEA, THE SEA

Agriculture – and thus food security – across Africa is profoundly affected by changes that scientists are recording in the seas around us. Features ranging from huge currents to massive eddies in the Atlantic, Indian and Southern Oceans are crucial factors in the global climate picture, directly affecting agricultural land use through rainfall patterns and temperature shifts – and indirectly impacting on the rest of the planet, too. These seas are relatively easily accessible to the more than 40 researchers who work at UCT Marine Research Institute (Ma-Re) and those in the Department of Oceanography. Ship cruises, field trips and remote sensing by satellite are used to gather samples and data for analysis by the multidisciplinary team.

On one such research expedition, an all-women team of scientists from UCT, led by senior lecturer Dr Isabelle Ansorge of the Department of Oceanography, sailed on the polar research vessel *SA Agulhas II* to the subantarctic Prince Edward Islands in April 2014. A key purpose of the trip was to study warm eddies in the ocean. These southward-moving eddies bring warm, salty water to the polar frontal band of ice circling the Antarctic. The focus was on two ocean eddies: a recently formed eddy in the subantarctic (at 49°S, 30°E), and one that has relocated southwards into the Antarctic zone (to approximately 58°S).

Eddies, Dr Ansorge explains, are areas of intense biological and physical activity and are "one of the main mechanisms in which water characteristics such as heat, salt, carbon dioxide, nutrients and biota are exchanged around the oceans."

Heat, salt and carbon dioxide: these are all features affected by climate change, and eddies are a mechanism to balance the world's ocean climate. That makes them an important subject that needs to be understood. Master's student Kirrin Reid had studied

them via satellite images, but this voyage gave her a chance to get up close and personal with the eddies she had only seen from afar. Reid was supported by four other postgraduate students attached to UCT's Department of Oceanography: Katherine Hutchinson, Moagabo Ragoasha, Lisa Holton from the UK, and Alice Lebehot from France. Katherine Hutchinson graduated in December 2013, having earned a rare co-badged master's degree from UCT and l'Université de Bretagne Occidentale, France. Co-badged qualifications reflect the changing academic environment, which is trending towards greater collaboration between academic institutions, especially between those in the Global North and the Global South, as well as towards a greater fluidity in postgraduate study – much more research happens in a multidisciplinary environment today.

TOWARDS GREATER ACCURACY

Several aspects of science are involved in creating a rich, detailed and accurate understanding of the dynamics of climate change. The kind of on-site measurement Dr Ansorge's team has been doing feeds information and data into the science of prediction, which must be as reliable and accurate as possible. This is the area that Dr Backeberg of the Nansen-Tutu Centre (NTC) is currently working on.

The NTC is a joint venture between the Norwegian Nansen Environmental Centre and South African partners that aims at improving the capacity to observe, understand and predict the seas, to support research as well as fisheries, coastal management, maritime security, recreation and tourism.

"Two years ago, I had a paper published in *Nature* in which I used satellite measurements to show that all around South Africa, ocean features like eddies (mesoscale structures between 100 and 400 kilometres in diameter) are intensifying," says Dr Backeberg.

Now he is working on a new paper aimed at laying the foundation for the development of a regional prediction system for the greater Agulhas Current system. "We are trying to develop a system that will give more accurate and better results," he says. This is crucial to predicting extreme weather events, as well as understanding features like the sardine run, which is dependent on movements of the Agulhas Current.

INVESTING IN CAPACITY

Dr Backenberg's work illustrates how science can contribute to addressing complex problems that affect life on Earth and makes a good case for why investing in this capacity is important. The potential, and the need, for this kind of research is infinite. Fortunately, this node of climate change capacity at UCT is attracting significant funds to the university that is enabling a growth of capacity.

At the beginning of 2014, three new research chairs and one senior research fellow were seconded to the ACDI for a three-year tenure. These positions have a strategic role: each of them will offer leadership and boost research production through activities focused on the themes they lead.

Professor Ralph Hamann at the UCT Graduate School of Business, one of the three new research chairs, will look at complex social and environmental problems, including climate change, food security and mining-company–community relations. Associate Professor Martine Visser, who takes up the second research chair, focused on behavioural economic applications to climate change, natural resource use, health and poverty alleviation, is studying how social norms and preferences such as trust, co-operation and risk aversion impact on decision-making. The third research chair will be held by Associate Professor Res Altwegg, who will be looking at understanding the impact of climate change on biodiversity and ecosystem services (using birds as indicators) and quantifying weather changes in Southern Africa and their attribution to climate change, with detailed analysis of weather trends.

Dr Britta Rennkamp, who joins ACDI as a senior research fellow, will be addressing trade-offs between climate change mitigation and poverty alleviation – how can governments reduce emissions over the long term without jeopardising their countries' achievements in socio-economic development?

These four senior scientists add to the formidable range of experience, skill and knowledge in the ACDI and Ma-Re networks. Together, these two Signature Themes form the bedrock of the university's climate change response.

In February 2014, the Intergovernmental Panel on Climate Change (IPCC) reported that scientists are now 90% certain that human activities are causing climate change. Observational evidence indicates that natural systems in all continents and most oceans are being affected by climate changes, particularly temperature increases. It is now certain that these impacts will have an effect on the day-to-day lives of people and ecosystems.

How we deal with this is up to us, and the research under way at UCT, by sea and land, across a range of disciplines, is helping to make sure that the African continent is as prepared as it can be to understand and manage the dynamics and impact of this crisis.

'SCARE LINES' SLASH ALBATROSS DEATHS BY 99%

A seven-year research project, recently published in the international scientific journal *Animal Conservation*, has shown that using "scare lines" to keep birds away from trawl cables during trawl fishing can dramatically reduce seabird deaths.

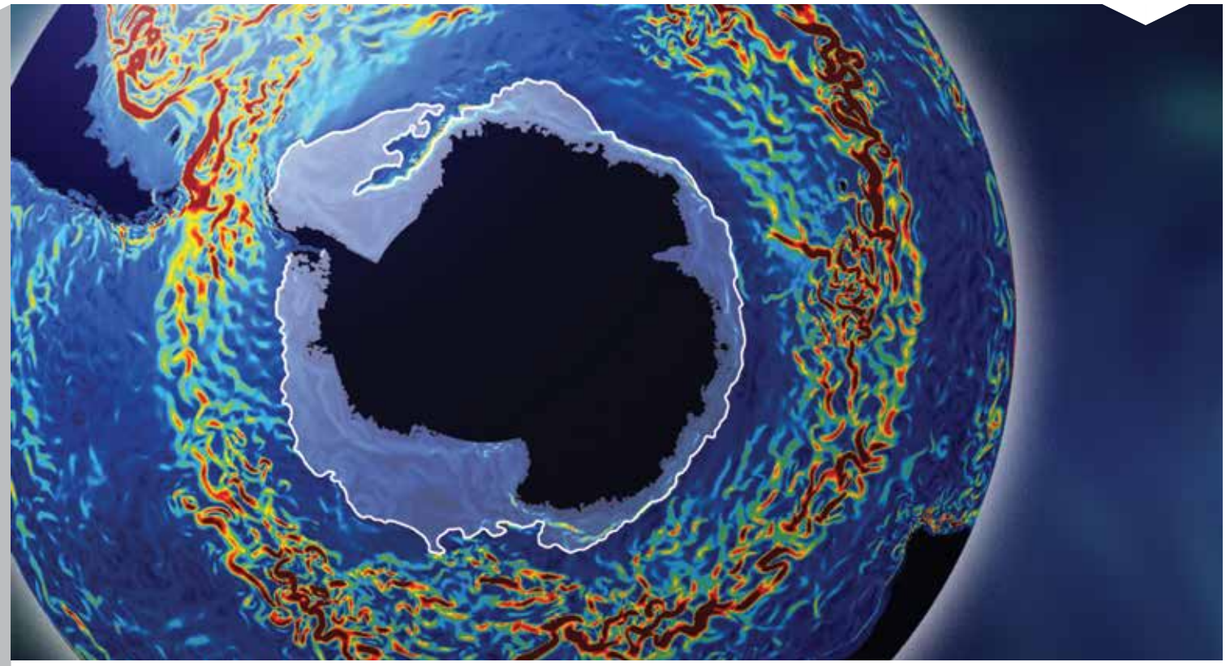
The research, which monitored trawl fishers off the coast of South Africa from 2006, showed that the use of the lines resulted in a reduction of 90% in seabird deaths and 99% in albatross deaths.

Flurry for food: Seabirds attracted to the fish offal as a result of onboard processing. Many become tangled in the trawl cables and drown.

Seabirds, especially albatrosses and petrels, are drawn in their thousands by the offal discarded from onboard processing factories. While they're scavenging, they become tangled in the trawl cables and drown.

Trawlers (mainly the hake fishery) use large nets, held in the water by thick cables, to trawl the seafloor. The scare lines – a simple 30m length of strong rope with five to 10 paired lines of visible streamers attached – work by distracting and confusing the birds, keeping them away from the trawl cables.

Accidental seabird deaths during fishing pose the single biggest threat to seabird populations around the world, says co-author of the paper Dr Ross Wanless, a UCT research associate and seabird division manager and the Africa co-ordinator of the BirdLife International Marine Programme.



This image of the Antarctic Circumpolar Current indicates current speed: blue shows slow-moving water and dark red indicates speeds of above 1.5km per hour. The pale blue halo around Antarctica indicates sea ice. Image courtesy of the National Science Foundation.