Grassroots

Newsletter of the Grassland Society of Southern Africa
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7 reasons we're facing a global water crisis

Meet the new GSSA president

The bad and really bad of invasive species

Genetic engineering: a tool for conservation?

Advancing Rangeland Ecology and Pasture Management in Southern Africa

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FROM THE EDITOR

It gives me great pleasure to welcome you to the fourth and final issue of Grassroots for 2017.

This issue is jam packed with multi-disciplinary news articles, GSSA52 congress feedback articles, book reviews, feature articles and snippets of the new council members.

Firstly, I would like to introduce you to our new president of the Grassland Society of Southern Africa, Mrs Sigrun Ammann. Inside you will find a brief background summary of our new president.

Furthermore in this issue, we take a look at how to restore our soils; why we are facing a global water crisis; SA's invasive species list; the effect of climate change on the birds, bees and the aardvark; the shocking truth about electric fences; camera traps and genetic engineering as tools for conservation and the history of the natural rangelands in the Eastern Cape.

This issue also contains three feature articles. Two of the feature articles focus on the Komga and Coastal Thornveld of the Eastern Cape, assessing veld condition and evaluating the impact of browsing and fire on species composition, respectively. The third feature article emphasises the influence of soil fertility on pasture growth.

Lastly, this issue includes a summary of the GSSA52 congress as well as reports on the mid-congress tours which was held at the WITS Rural Facility near Hoedspruit on the border of Mpumalanga and Limpopo from 23rd to 28th July of 2017. Also, meet our new council members inside.

I would like to invite you to submit your news snippets, opinions, dates of important events and feature articles to Grassroots – we would love to hear from you all. It will also be good to keep track of our members and hear of anyone who has lately moved jobs.

We would also enjoy hearing from anyone who has recently received a post graduate achievement. Let's make Grassroots a hub of knowledge and excellence.

You will notice that the layout has changed a bit owing to our new Layout team. Please feel free to forward any recommendations with regards to layout and content of Grassroots to me.

Thank you to those who contributed to this issue – keep those articles coming.

Enjoy this one!

Josef van Wyngaard
EDITOR

5 things to look forward to in this issue:

- Meet Mrs Sigrun Ammann, the new GSSA president
- Why we are facing a global water crisis
- GSSA52 congress feedback and mid-congress reports
- Feature articles on the impact of browsing and fire on species composition; and the influence of soil fertility on pasture growth
- We welcome four new council members

Introducing our new GSSA president 2017/2018

Sigrun Ammann

By Derryn Nash

Sigrun Ammann *nee* Kassier – better known to her friends as Sigi – is KwaZulu-Natal born, bred and educated. She grew up a farm girl and went to school in Hermannsburg. Her tertiary education was completed at the then University of Natal where after she joined the Agricultural Research Council (ARC) grasslands team (pasture breeding) based at Cedara. Sigi's MSc revolved around breeding a number of new *Eragrostis tef* varieties and the agronomics of teff, which now serve the farming community well.

Sigi worked for the ARC on a number of breeding projects and evaluation trials and eventually led the team on Cedara. She is passionate, methodical and uncompromising in her research and her general knowledge is extensive. During her time at the ARC she married Thomas Ammann. She also served on the GSSA council first as additional member and then as secretary for a number of years.

In 2012 Sigi crossed the road on Cedara to fill a long vacant grassland science post for the Department of Agriculture and Rural Development. Her move was a great and irreplaceable loss to the ARC. In no time at all new trials were registered and planted at Cedara for the KZN DARD. Sigi has always had an excellent relationship with seed companies, farmer's study groups and fellow researchers and was the mouthpiece at most presentations.

She is passionate, methodical and uncompromising in her research and her general knowledge is extensive

Unfortunately for KwaZulu-Natal, Thomas received a work offer in the George area that he could not refuse. Fortunately, the Western Cape Department of Agriculture had a post come vacant and after much heartache Sigi was transferred to Outeniqua Research Farm and joined Thomas in George. She settled down quickly and has already made a positive contribution to research and dairy farming in the area.

Sigi's decision to stand as vice president in 2016 and president in 2017 was taken despite the fact that it would likely impact negatively on her ability to complete her PhD studies. This is an indication of her commitment to her craft and the GSSA, the society is in safe hands.

Figure1: Sigrun Ammann managing cultivar trials at Cedara

To restore our soils, feed the microbes

Matthew Wallenstein

Current Address: Colorado State University, United States
E-mail Address: matthew.wallenstein@colostate.edu

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Our soils are in trouble. Over the past century, we've abused them with plowing, tilling and too much fertilizer.

What many think of as "just dirt" is actually an incredibly complex mixture of rock-derived minerals, plant-derived organic matter, dissolved nutrients, gases and a rich food web of interacting organisms.

By plowing and overtilling, we have increased erosion on agricultural fields by 10 to 100 times natural rates. Over just the last several decades, we may have lost about half of the topsoil that natural processes produced over thousands of years in the U.S. corn belt.

Topsoil is rich in soil organic matter – dark spongy material formed from decomposed plant and animal tissue. Soil organic matter is critically important: It helps soils hold onto water and nutrients and supports soil microbes that recycle nutrients. Loss of soil organic matter has made many farms increasingly reliant on fertilizers, pesticides and herbicides.

Much recent research has focused on adding organic material back to soils to restore them. This is an important strategy, but I believe we also should aim to enhance the microbes that are responsible for soil formation. I was part of a research team that demonstrated in a 2015 study that adding efficient microbes to soils can enhance the percentage of plant carbon that is transformed into soil. New research suggests that by fostering an efficient and active soil microbiome, we can accelerate soil regeneration far beyond typical rates seen in nature.

It takes a village to make healthy soil

Natural soils are thriving with life. They contain an incredible diversity of microscopic bacteria, fungi, viruses and other organisms. A single handful of soil can contain tens of thousands of different species.

These microbes interact closely with each other, forming complex networks. They communicate with chemical signals. They work together to break down complex organic materials, including dead plants and animals. They often work in teams to complete biochemical processes, such as transforming nitrogen from an inert gas to plant-usable forms, and recycling it from dead plant materials back into dissolved forms.

In healthy soils, organic matter is protected from decomposition inside clumps of soil called aggregates. But tilling crushes aggregates, unlocking their carbon and allowing microbes and soil fauna to attack it.

This creates a temporary feast for soil microbes, but eventually they deplete their food supply and die off. Without a healthy microbial community, nutrients are no longer recycled, opportunistic pests can invade and farmers rely increasingly on chemicals to replace biological soil functions.

Reviving agricultural soils

Soil degradation is a critical problem because it threatens our ability to produce enough healthy food for a growing human population and contributes to climate change. In response, large companies, nonprofits, scientists and government agencies are working together to restore soil health.

For example, General Mills is working with the Nature Conservancy and the Soil Health Institute to encourage farm-

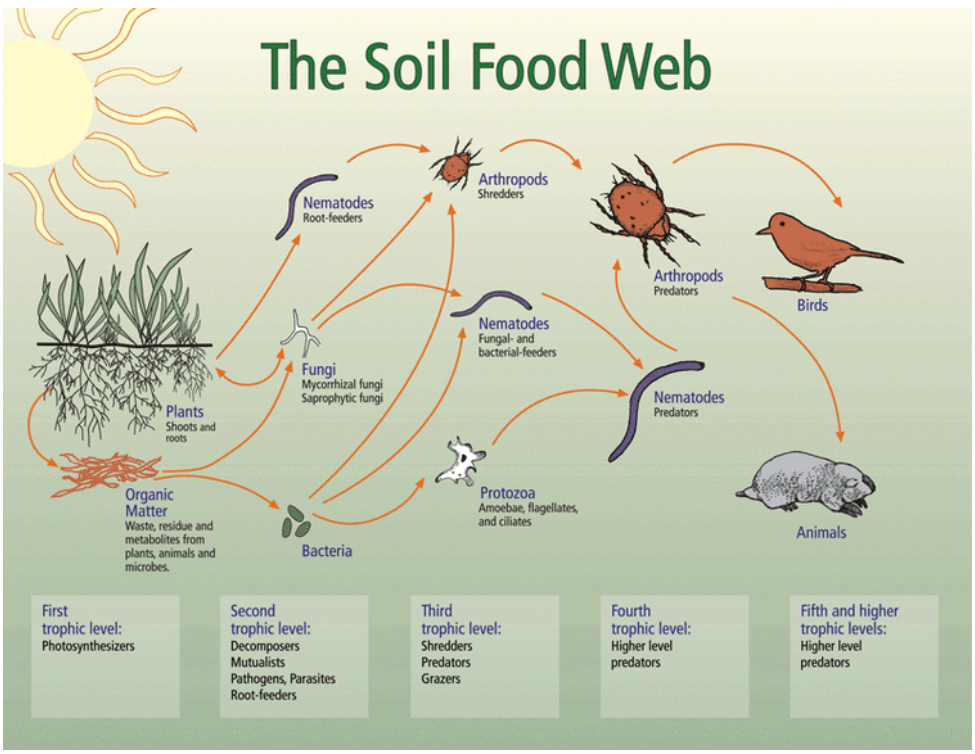

Figure 1: Microbes perform critical functions in soil food webs, such as decomposing organic materials, cycling nutrients and improving soil structure. Credit: USDA NRCS

ing practices that begin to rebuild soils.

The first step to improving soil health is to stop the bleeding. Instead of leaving fields barren in between crops, which leads to erosion, farmers are increasingly planting cover crops such as rye grass, oats and alfalfa. They also are replacing intensive tilling with no-till practices to prevent the breakdown of soil structure.

Soil organic matter contains over 50 percent carbon. Globally, soils contain more carbon than plants and the atmosphere combined. Losing carbon-rich organic matter from soils releases carbon dioxide, a greenhouse gas, which can accelerate climate warming. But by regenerating our soils, we can sequester more carbon underground and slow climate warming.

In addition to protecting soil, cover crops take carbon out of the atmosphere as they grow and funnel it into the soil. Unlike cash crops that are harvested and removed from the soil, cover crops are left to decompose and contribute to soil formation.

Increasing the supply of plant carbon in this way is an important first step in rebuilding soil carbon. But new research suggests that it may be insufficient.

A new paradigm of soil formation

We used to think that soil organic matter was formed from leftover bits of plants that were difficult to degrade. Over time, we thought that these plant particles became chemically transformed into what was called humus – dark, long-lasting material left over when dead plants and animals decay. This view suggested that the key to building soils was getting a lot of dead plant material into the ground.

Recently, however, technological advances have transformed our understanding of soil formation. There is now strong evidence that the most persistent forms of soil carbon are formed primarily from dead microbial bodies rather than from leftover plant parts. The vast majority of old soil carbon appears to have undergone microbial decomposition. While plants are the original source of carbon for soils, microbes control its fate by using it as food, thus ensuring that at least some of it will remain in the soil.

Technological advances have transformed our understanding of soil formation

Feeding the soil by feeding microbes

Microbes can take a simple compound like sugar and transform it into the thousands of complex molecules found in soils. When microbes break plant matter down, they use some of the material they consume for building new biomass – that is, to fuel their own growth – and exhale the rest as carbon dioxide. The efficiency with which they create new biomass varies widely. Some microbes are like weeds: They grow quickly in food-rich environments, but are sloppy eaters and waste much of what they consume. Others are slow-growing but hardy, waste little and are able to survive times of starvation or stress.

To maximize the proportion of plant carbon that is transformed into soil organic matter, we should aim to support and enhance soil microbiomes that quickly and efficiently transform dead plant materials into soil organic matter. Healthy soils should also contain microbiomes that help prevent disease, cycle nutrients and help reduce plant stress.

My research group is now bioprospecting for groups of microbes that are especially efficient at forming new soil and recycling nutrients. We are also researching which crop traits support microbiomes that help enhance soil health. Making soils more healthy will make it possible to grow more food with fewer inputs, which will make farming more profitable and protect our air and water.

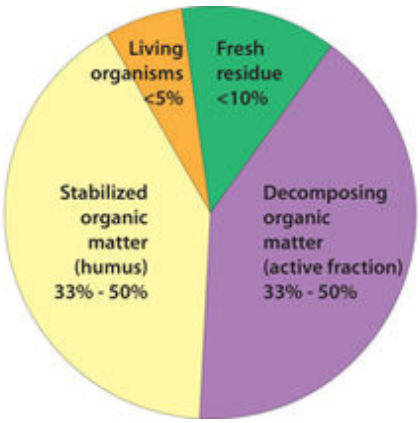

Figure 2: Components of soil organic matter. Credit: USDA NRCS

Figure 3: Credit: https://www.slideshare.net/Reinbottt/weed-control-and-soil-health-during-transitioning-to-organic

Figure 4: Credit: http://notillveggies.org/cover-crops-for-no-till/

Seven reasons we're facing a global water crisis

Every day brings more news of water-related troubles from around the world. Here are seven things you need to know about our escalating water crisis, and what we can do about it.

Leah Schleifer

Current Address: World Resources Institute, United States
E-mail Address: leah.schleifer@wri.org

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Droughts in Somalia. Water rationing in Rome. Flooding in Jakarta. It doesn't take a hydrologist to realise that there is a growing global water crisis. Each August, water experts, industry innovators, and researchers gather in Stockholm for World Water Week to tackle the planet's most pressing water issues.

What are they up against this year? Here's a quick rundown on the growing global water crisis.

We're changing the climate, making dry areas drier and precipitation more variable and extreme

Climate change is warming the planet, making the world's hottest geographies even more scorching. At the same time, clouds are moving away from the equator toward the poles, due to a climate-change driven phenomenon called Hadley Cell expansion. This deprives equatorial regions like sub-Saharan Africa, the Middle East and Central America of life-giving rainwater.

Paradoxically, climate change is also increasing precipitation in other areas, and people who live near rivers and streams have the most to lose. Currently, at least 21 million people worldwide are at risk of river flooding each year. That number could increase to 54 million by 2030. All countries with the greatest exposure to river floods are least developed or developing countries – which makes them even more vulnerable to climate change and natural disasters. This summer, extreme flooding submerged over a third of Bangladesh, claiming over 115 lives and affecting 5.7 million citizens.

When the price of receiving clean water is closer to its actual service cost, efficient water use will be incentivised. And on the flip side, the poor often end up paying disproportionately high prices for water, stunting development.

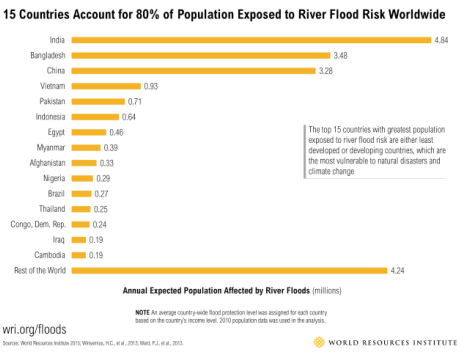


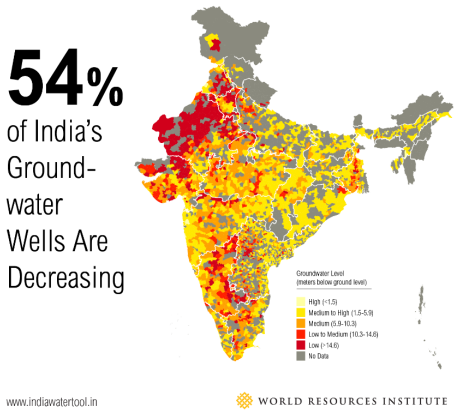
Figure 1: The world is facing a water crisis - how can we solve it? Credit: Asian Development Bank, CC BY-NC-ND 2.0

More people + more money = More water demand

It's a simple equation: As populations increase and incomes grow, so does water demand. The world's population, now at 7.5 billion, is projected to add 2.3 billion more people by 2050. How can the planet satisfy their thirst? Growing incomes also exacerbate the water problem, because of the water-intensive products-like meat and energy from fossil fuels-that richer populations demand.

Groundwater is being depleted

About 30 per cent of Earth's fresh water lies deep underground in aquifers. And it's extracted daily for farming, drinking and industrial processes – often at dangerously unsustainable rates. Nowhere is this more evident than India, which guzzles more groundwater than any other country. 54 per cent of India's groundwater wells are decreasing, meaning that water is used faster than it's replenished. Unless patterns shift, in 20 years, 60 per cent of India's aquifers will be in critical condition.



Unlike an incoming hurricane or a drained lake, the naked eye cannot see when groundwater reserves in aquifers are declining. Global water supplies are susceptible to this hidden and growing threat.

Water infrastructure is in a dismal state of disrepair

Having enough water to go around is only the beginning. That water also needs to be transported, treated, and discharged. Around the world, water infrastructure-treatment plants, pipes, and sewer systems-is in a state of disrepair. In the United States, 6 billion gallons of treated water are lost per day from leaky pipes alone. Built infrastructure is notoriously expensive to install and repair, meaning that many localities ignore growing infrastructure issues until disaster strikes, as it did in California earlier this year.

And natural infrastructure is being ignored

Healthy ecosystems are "natural infrastructure" and vital to clean, plentiful water. They filter pollutants, buffer against floods and storms, and regulate water supply. Plants and trees are essential for replenishing groundwater; without them, rainfall will slide across dry land, instead of seeping into the soil. Loss of vegetation from deforestation, overgrazing and urbanisation is limiting our natural infrastructure and the benefits that it provides. Forested watersheds around the world are under threat: watersheds have lost up to 22 per cent of their forests in the past 14 years.

Water is wasted

Although it's true that water is a renewable resource, it's often wasted. Inefficient practices like flood irrigation and water-intensive wet cooling at thermal power plants use more water than necessary. What's more, as we pollute our available water at an alarming rate, we also fail to treat it. About 80 per cent of the world's wastewater is discharged back into nature without further treatment or reuse. In many countries, it's cheaper to receive clean drinking water than to treat and dispose of wastewater, which encourages water waste.

This brings us to the next issue:

The price is wrong

Globally, water is seriously undervalued. Its price does not reflect the true, total cost of service, from its transport via infrastructure to its treatment and disposal. This has led to misallocation of water, and a lack of investments in infrastructure and new water technologies that use water more efficiently. After all, why would a company or government invest in expensive water-saving technologies, when water is cheaper than the technology in question? When the price of receiving clean water is closer to its actual service cost, efficient water use will be incentivised. And on the flip side, the poor often end up paying disproportionately high prices for water, stunting development.

It's not too late

Amidst these seven deadly water sins, there is good news: governments, businesses, universities and citizens around the world are waking up to water challenges, and beginning to take action. Each year brings more solutions – like using wastewater for energy, using restoration to bring water back to dry topographies, and monitoring groundwater levels more closely. However, even the best solutions will not implement themselves. Along with fresh water, political will and public pressure are critical resources in ensuring a sustainable future for all.

Figure 4: Heavy machinery removing trees in Ecuador. Credit: Flickr/CIFOR

Why the future of Africa's forests and savannas is under threat

Julie C. Aleman

Current Address: Yale University, United States
Web Address: http://www.juliealeman.com/

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Tropical Africa has two distinct features – rain forests which are dominated by trees and savannas which are dominated by grasses. Both depend on rainfall quantity and seasonality. Seasonality measures how constant the distribution of rainfall over the course of a year is – in other words how long the dry season is.

Forests located close to the Equator receive lots of rainfall constantly over the year, while savannas receive less rainfall and only during the wet season.

Forests and savannas are expected to be strongly affected in the coming decades by changing rainfall patterns, including increased dry periods and decreasing annual rainfall. These changes are already being felt. In some areas of Burkina Faso desertification is increasing, while in Chad rainfall is increasing. These changes are being linked to climate change across the world.

Forests and savannas are expected to be affected greatly by these changes because they depend heavily on rainfall quantity and seasonality.

Figure 1: Tropical forests in the Congo for example have exceptionally high animal and plant species. Credit: Shutterstock

Forests and savannas are important ecosystems

Savannas and forests function very differently but they are important ecologically and economically. They sustain a lot of plant and wildlife. Tropical forests have exceptionally high animal and plant species. They also play a crucial role in regulating the global climate, for example by storing lots of carbon. And people make a living off forests.

Most of sub-Saharan Africa's agriculture takes place in savanna areas which support most of the continent's cropland and pasture areas. Importantly, savannas such as the Serengeti National Park in Tanzania are also home to the largest animal populations on Earth.

But future changes in the climate could have an impact on these symbolic landscapes. For example, decreasing rainfall in forest areas, and increasing number of droughts, may cause trees to die. In savanna areas, more rain may increase tree growth and cover.

The way people are using the land can also have a big impact on forests and savannas. For example changing agricultural practices toward intensification and conversion of very large areas to cropland has been shown to have a major impact. Thus, conservation efforts need to start taking into account the effects of climate change as well as the potential impact of agricultural conversion to target forests and savannas that are at greatest risk.

The ecological importance of fire

The Congo Basin is Africa's main tropical forest block covering more than 178 million hectares – a third of the size of the Amazon. Tropical forests are also present in East and West Africa but in smaller areas. Trees in these tropical forests are very sensitive to disturbances such as fires which are exacerbated by droughts. Indeed, increasing drought can enable fires to spread from savannas into the adjacent forests. This is what happened during the massive wildfire in the Congo Basin in January 2016.

For their part, savannas need disturbances like fire, but recurring fires limit the number of trees, and thus the tree cover, and promotes biodiversity.

Responding to climate change and land use

The prediction is that rainfall will in-

crease in some savanna areas of Central African Republic. This will lead to an increase in tree cover within savannas. If not compensated by fire landscape opening, this tree cover increase could be an issue because it would limit the quantity of grasses accessible for livestock and wild herbivores.

The predictions for the drier regions are more variable. In some areas of the Sahelian region, like Chad, it's predicted that rainfall will increase, similarly leading to an increase in tree cover. But this is likely to have a positive effect because it will mean more productivity for grasses and trees. In other areas, like in Burkina Faso, the length of the dry season may increase which could drive desertification.

In the case of the Congo Basin, an increase in seasonality could lead to a decrease in tree cover because it's likely to limit tree growth and increase tree mortality.

But climate change is not the only threat that forests and savannas are facing. The way people are using these two ecosystems is also having an impact. For example, new development policies suggest that more savanna areas should be targeted for biofuel production.

Future simulations suggest that increasing cropland and pastureland by 2070 will modify tree cover in both forests and savannas more than climate change. Environmental policies are crucial because they have the power to influence where large conversions to agriculture take place. This is particularly important for areas of low population densities and where agricultural practices are still traditional, as in the Central African Republic.

Figure 2: Savannas need disturbances like fire. Credit: Shutterstock

Using history to understand how natural rangelands in the Eastern Cape have changed

Gina Arena

Current Address: SAEON Arid Lands Node / University of Cape Town, South Africa
E-mail Address: arenag14@gmail.com

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South African scientists have a lot to be thankful for when considering the pioneering work of the country's 20th century botanists and agriculturalists.

Not only have the detailed botanical studies of these botanists and agriculturalists formed the foundation of the comprehensive species inventories and vegetation maps of which so much of the research relies heavily upon today, but so do their historical photographs and vegetation data sets continue to provide insightful snapshots of past vegetation condition.

These historical records create opportunities for researchers to return to the same sites to resurvey vegetation and take repeat photographs to assess the extent, rate and nature of change over time.

Pioneering vegetation surveys

Dr Piet Roux, an agriculturalist and avid botanist, spent the better part of his career traversing the Stormberg Plateau region in the Eastern Cape between the 1940s and 1970s. He spent years conducting vegetation surveys to track the distribution of a grass species, *Tetrachne dregei*; work which he eventually published in a PhD thesis in Botany.

Oom Piet (a term of endearment used by many) was also very interested in understanding the physiological intricacies of this grass, which is an indicator of veld degradation under various climatic and grazing scenarios. Of particular interest from these data are the measures of species composition and cover on approximately 70 different farms spaced across a rainfall gradient where the Nama-Karoo and the Grasslands biomes meet.

Oom Piet's survey data and historical landscape photographs were collated and archived at the Grootfontein Agricultural Development Institute (GADI) in Middelburg in the Eastern Cape, and at the Plant Conservation Unit (PCU) in Cape Town, respectively. Eight of these sites were revisited and resurveyed by Timm Hoffman in 1989 and then again by past PCU student, Mmoto Masubelele, in 2009, but a large proportion of these sites are yet to be resurveyed.

Figure 1: Gina Arena spent an afternoon meeting with Dr Piet Roux at his home in Middelburg, Eastern Cape. Credit: Timm Hoffman

Revisiting the sites

Following in the footsteps of Oom Piet, SAEON PDP PhD student Gina Arena will be revisiting as many as 68 sites to assess how these environments have changed over a 60-year period. Over 19 to 23 June 2017, Gina visited Middelburg in the Eastern Cape with her supervisors Timm Hoffman (University of Cape Town), Tim O'Connor (SAEON) and Helga van der Merwe (SAEON), to scout out a few of the sites she will be resurveying for her PhD.

The four held discussions around Gina's main research questions on assessing long-term changes in rangeland vegetation in the Eastern Upper Karoo, which has been influenced by past and current climate and land-use patterns. A visit with Oom Piet himself inspired Gina as he delivered meticulous accounts of his research in the Karoo veld.

Reconnaissance

The reconnaissance involved visiting the Afrikaner and Boesmanskop camps at GADI, where Oom Piet took a number of historical photographs in the 1960s. Timm Hoffman guided Gina through the process of taking a repeat photograph of an original photo taken at the Boesmanskop site.

Gina also worked through her first vegetation resurvey at Boesmanskop, where Oom Piet used a wheel point to survey the vegetation 60 years ago.

Already, differences in the vegetation could be seen between the 1960 and 2017 photographs, such as a change in grass species composition and species abundance, and the instalment of a grazing exclosure experiment. Data collected from the vegetation surveys will provide the quantitative analysis of any species shifts and/or increases in grass cover between these time steps.

Social component

Gina's research will also take on a social component through her interactions and interviews with farmers and landowners who are likely to possess valuable knowledge and/or records on historical land-use practices, climate and fire history on the farms to be surveyed.

Without input from landowners, any changes in vegetation over this period may not be understood in the full land-use context.

Gina will also take this opportunity to provide feedback to landowners from her research at their farms to broaden the impact of her findings.

Visit these websites to find out more about research at the Plant Conservation Unit at UCT and rePhotoSA, their repeat photography citizen project.

Figure 2: Left: Compiling a general species list of plants at the original site surveyed by Dr Roux at Boesmanskop, Grootfontein in 1960. **Right:** Working through the descending point method transect at Boesmanskop where Dr Roux surveyed vegetation in 1960. Gina was assisted by Helga van der Merwe (far left), Lisa Hebbelmann (second, left) and Justin du Toit (far right). Credit: Timm Hoffman

Figure 3: Left: A photograph taken by Dr Roux in 1960 at Boesmanskop on the Grootfontein farm in Middelburg. **Right:** The repeat photo taken by Timm Hoffman in 2017. In the historical photo, grass cover was dominated by the grasses *Digitaria argyrograpta* in the foreground, *Themeda triandra* in the middle and *Eragrostis bicolour* in the background, with *Tetrachne dregei* sparsely scattered in this cover, and with *Pteronia tricephala* (dark shrubs) and *Pentzia globosa* (grey shrubs). In the repeat photo, grass cover is denser and taller, with a shift in dominance of the grass species *Digitaria eriantha* and *Sporobolus fimbriatus*, and shrub *Lycium cinereum*.

Climate change is disrupting the birds and the bees

We all know that climate change will cause more extreme weather and rising seas. But it is also having an unexpected effect on sex.

Claire Asher

Current Address: United Kingdom
Blog Address: http://www.curiousmeerkat.co.uk/

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Our changing climate seems set to disrupt just about everything. From rising sea levels to ocean acidification, the list of negative consequences from climate change is endless. But one area that often goes unmentioned in the climate change discussion is sex.

Over the last two decades, scientists have found that warmer temperatures are quietly spoiling the mood, making it harder for plants and animals to reproduce.

Here are five ways that climate change is ruining sex lives.

It's a numbers game

While humans and many other animals determine sex genetically, many reptiles and some fish use the incubation temperature of the eggs to set the gender of their offspring.

This means that changing global temperatures could alter the ratio of sexes produced, making it harder for these animals to find mates.

Eastern three-lined skink females can partially compensate for temperature increases by digging deeper nests and laying earlier in the season.

Nevertheless, according to a study published in 2009, their nests still warmed by 1.5°C over 10 years. This shifted the sex ratio towards females.

Not every species is as badly affected. Australian water dragon females have been shown to buffer temperature differences of 4°C by nesting in sunnier or shadier locations. When it comes to climate change, behavioural flexibility is often a big advantage.

Figure 1: As temperatures rise, green turtle populations may be heavily skewed in favour of females. Credit: Alamy

Warmer temperatures are quietly spoiling the mood, making it harder for plants and animals to reproduce

In the plant world, temperature can influence sex ratios in more subtle ways. For example, the tobacco root plant, which lives in alpine meadows in North America, has been producing ever more male plants over the last 40 years. This may be due to reduced water availability, since females require more water to develop. So far, the extra males have actually boosted seed production, but if the trend continues, the lack of females could eventually leave male tobacco roots feeling a little lonely.

Meanwhile, the majority of the world's sea turtles use temperature to set the sex of their offspring. "Embryos are laid with no gender," says Graeme Hays of Deakin University in Australia. "They can develop into males or females."

Warmer eggs develop into females, cooler eggs into males. "Temperature during the middle third of incubation controls the sex," says Hays, by switching on and off the genes that trigger development into either a male or a female.

The difference between male and female is just a couple of degrees. That means even slight changes in the climate could skew the sex ratio, making males harder to find. Incubation temperatures above 29°C are predicted

to produce increasingly female-biased clutches.

There is evidence that this shift is already underway. Over the last century, the sex ratios of green turtles, hawksbill turtles and leatherback turtles have become increasingly sex-biased. By 2030, the percentage of male green turtles produced has been predicted to drop to just 2.4%. "All else being equal, a warming climate will produce more female sea turtle hatchlings," says Hays.

The difference between male and female is just a couple of degrees

But his research suggests that all things are not equal. High temperatures also increase mortality in sea turtle embryos, so female embryos are less likely to survive. Combine this with the fact that male sea turtles can mate more frequently, and with many females each season, and the impact on reproduction may not be as severe as first predicted.

Still, Hays warns that this is only true up to a point. Temperatures above 35°C would produce such skewed sea turtle clutches and low hatching success that populations would struggle to survive. "There are many places where a 3°C temperature rise would lead to extinction of sea turtle populations," says Hays.

One solution for sea turtles and other reptiles with temperature-based sex determination is to breed at different times of year. This is called a "phenological shift". "Earlier nesting may mean that sea turtles avoid incubation conditions that are too hot," says Hays.

Timing is everything

Phenological shifts are common, because many animals use environmental cues like temperature and rainfall to time key events like migration, flowering and breeding. Climate change is changing the timing and strength of the seasons, and as these cues change, the annual ebb and flow of the natural world is being disrupted.

In fact, one of the first pieces of evidence for the effect of climate change on living things was the discovery that plants are flowering earlier and earlier each year. In 2002, a landmark study showed that 385 British plant species were flowering on average 4.5 days earlier than in the 1990s. The same story is playing out across the globe: a 2008 meta-analysis looked at 650 temperate plant species in Europe, Asia and North America, and found that spring flowering had advanced by 1.9 days per decade on average.

The biggest concern is that plants and their pollinators might respond differently to climate change, leading to a mismatch that could significantly affect plant reproduction. For instance, in Japan the flowering of the plant *Corydalis ambigua* has advanced faster than the emergence of its bumblebee pollinators, resulting in a mismatch that reduces seed production in years with an early spring. Such mismatches could have a major impact on certain crop plants.

Happily, a 2011 study found that most plants and pollinators are responding to climate change in a similar way, maintaining their synchrony despite large changes in temperature.

Autumnal events, such as fruiting and leaf dropping, have also been delayed. This means that plants are now flowering and growing for longer. That sounds like a good thing, and climate change is predicted to increase yield for some crops in some regions.

But overall, the expectation is that climate change will make our crop plants less productive, by speeding the ageing process and reducing fertility.

It isn't just plants that need to time reproduction carefully. Birds are also changing their annual calendars. Many are now breeding and laying eggs earlier in the year. For some species this may be a good thing, because hatching earlier means the chicks have longer to develop. For pied flycatchers, warmer springs mean larger clutches and more chicks surviving to fledge.

For others, climate change may shorten the already narrow window of opportunity to breed.

Brunnich's guillemots live in the Arctic Ocean, off the coast of Canada. They time their breeding based on summer ice cover, but ice cover is strongly affected by winter and spring temperatures, and has been retreating since the 1970s. Guillemots in the south of their range now breed earlier, but their chicks grow more slowly and are less likely to survive. In the longer term, warmer temperatures and reduced sea ice may extend the breeding season for birds in the north, but more southerly birds could see their breeding window close early.

Changing environmental cues might also influence how animals court members of the opposite sex

More serious problems may be in store for birds that cannot keep up with the changing climate. The relative timing of hatching in relation to the abundance of food is key to successfully raising young. In the Netherlands, peak caterpillar abundance occurred nine days earlier in 1995 than in 1973, but great tits did not lay their eggs any earlier. This could mean that the chicks get less food than they otherwise could, worsening their chances of survival.

Even birds of prey are being affected

Figure 2: Some predatory birds are hatching after their prey, meaning they have less to eat. Credit: Alamy

by mismatches. Eurasian sparrowhawks have found that prey species like common blackbirds and house sparrows are breeding earlier, and the sparrowhawks have only partially kept pace. In the 1970s, the sparrowhawks' prey were most common when chicks were around two weeks old, but by 1997 it was happening when they were just six days old. At this age, the chicks are too young to make use of this abundance, and may suffer from food shortages later in development.

Bending the rules of attraction

Changing environmental cues might also influence how animals court members of the opposite sex.

The decorations, displays, dances and songs that animals use to attract a mate are all heavily dependent on the environmental conditions the animal lives in. That is why they became attractive in the first place, says Carlos Botero of Washington University in Saint Louis.

"For example, female birds often find bright colours attractive, and the building blocks that males use to produce these colours are often obtained from their diet," says Botero. "When a female sees a brightly-coloured male, she is indirectly seeing a potential mate that is clearly capable of finding enough food to not just maintain himself but to have extra to spare on looks."

Across the animal kingdom, lavish looks and elaborate displays act as honest signals of the quality of a mate, helping females to choose the right parent to give their offspring the best genetic start in life.

But environmental changes can break the link between appearance and quality. A study published in January 2017 found that warming spring temperatures had changed the course of evolution for collared flycatchers. Previously, males with the largest white head patches attracted more females, but during the 34-year study a 1.5°C rise in average spring temperatures completely reversed this pattern.

Males with large head patches, which previously had the highest survival rates, had the lowest survival rates at warmer temperatures. Their head patch no longer meant anything in terms of quality. As a result, males with smaller patches now enjoy their pick of the ladies.

Warmer climates seem to have a tendency to make animals less faithful

Climate change seems to be levelling the playing field among grey seals. Between 1996 and 2004, lower rainfall forced females to venture out of their normal foraging areas, giving subordinate males the opportunity to mate. The proportion of breeding males in the colony increased by 61% in wetter years. This in turn has increased the population's genetic diversity, which could help the seals cope with climate change.

For other species, changes in the timing of events have left room for exaggerated sexual appearance. Male barn swallows have grown ever longer tail feathers since the 1970s, as a result of arriving early at their breeding grounds. Females have not changed the timing of their migration, so males now have extra time to look their best before the females arrive.

This seems like good news for the males, but it may make it harder for females to distinguish between mates of different quality, again altering the course of evolution.

These studies offer tantalising glimpses into how climate change is putting the sexual lives of animals into disarray. However, the long-term consequences of these shifts are difficult to predict and are likely to be highly species-specific.

A mate for life?

Warmer climates seem to have a tendency to make animals less faithful. In a 2012 study, Botero studied monogamy in 122 species of bird. He found that "in places where environments change

Figure 3: Many birds, like flycatchers, are hatching earlier to make the most of abundant food. Credit: Alamy

more frequently and unexpectedly, apparently monogamous females tend to hedge their bets by mating with more than one partner on the side".

These "extra-pair relationships" become increasingly frequent as annual climatic cycles become more variable. Female birds "are also more likely to terminate bonds with partners that are no longer yielding the benefits they expected", says Botero. He argues that these "divorces" and "affairs" may become more common as the climate becomes less predictable.

Increasing infidelity may also be on the cards for mammals like alpine marmots. A 2016 study led by Aurélie Cohas of Claude Bernard University Lyon found that, between 1992 and 2013, the frequency of extra-pair litters increased as spring arrived earlier and winter snowfall increased.

This effect was largely due to improved survival as alpine temperatures rose. "The number of pups, as well as their survival, is highly linked to the climatic conditions they endure during hibernation," says Cohas.

Pups that survive the winter will tend to stick around and help the family raise the next litter. In turn, "females are more likely to produce extra-pair litters when there are more subordinates in their family" to help, says Cohas.

"We could likely expect species living in alpine, snowy and cold habitats to be more unfaithful in the future."

Climate change may shorten migration distances, and could actually lead to an increase in monogamy and bi-parental care in some migratory birds

Why does this happen? "Climate influences mating systems in mammals by constraining the resources available, constraining movement, and changing the costs involved for animals to meet sexual partners," says Cohas. "Any change in climate that will relax these constraints will likely influence their mating system."

In migratory shorebirds, there is a link between the distance of migration and whether both parents help care for the young. This "bi-parental care" is usually restricted to short-distance migrants, because birds that migrate long distances cannot rely on both parents to make the long journey, so females tend to raise the offspring alone. Climate change may shorten migration distances, and could actually lead to an increase in monogamy and bi-parental care in some migratory birds.

Similarly, among shorebirds called plovers, males have been shown to invest more effort in helping to raise young chicks as the climate warms and becomes more unpredictable. This flexible behaviour may help these birds buffer some of the harsher effects of climate change on chick survival.

The heat-wave slump

Finally, climate change might even impact on our own sex lives.

A 2015 working paper by the National Bureau of Economic Research found a correlation between hot temperatures and low birth rates in the USA. A single hot day when temperatures went over 26°C reduced birth rates nine months later by 0.4%, equating to over 1,100 births. It isn't clear whether this was due to a reduction in the frequency of sex – after all, sometimes it is too hot to do anything – or due to reduced fertility at high temperatures.

The authors offer a possible solution to this problem: air conditioning. But air conditioning needs power to run, and if that power comes from burning fossil fuels we would end up warming the climate even more.

A 2016 study in Japan found a correlation between extreme temperatures, whether hot or cold, and increasingly sex-biased miscarriages, producing a female-biased sex ratio in new-borns.

Since climate change is predicted to increase the frequency of extreme weather events, in theory it could affect human fertility too.

Figure 4: Rising temperatures may make alpine species like marmots more prone to infidelity. Credit: Alamy

South Africa should sort out the bad from the really bad on its invasive species list

Tsungai Zengeya

Current Address: South African National Biodiversity Institute, Cape Town, South Africa
E-mail Address: t.zengeya@sanbi.org.za

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Alien species have been introduced to Africa for a variety of reasons. They provide food, raw materials for industry, ornamental plants, recreation in the form of sport fishing, hunting and pets. Some that are highly valued have been moved around widely. And in some areas they now form prominent components of societies and ecosystems like the domestic cat for example.

Many alien species bring considerable benefits. But some have become invasive, causing a loss of biodiversity, changes to ecosystems, economic losses and, in some cases, even affecting people's health.

The shrub *Prosopis* or mesquite is an example. It was introduced to South Africa to provide fodder, firewood and shade in arid parts of the country. But it's also a major water user. And two trout species (*S. trutta* and *O. mykiss*) are used for recreational angling and commercial aquaculture. But they've also been implicated in having a negative effect on the environment.

Managing invasive species is therefore critical. In South Africa the movement and use of 552 listed invasive species are managed under the Biodiversity Act and regulations attached to it. But not all the species on the list are equally harmful. Several may in fact be relatively harmless.

All the listed species under these regulations require management. Given that the capacity is limited, regulations should arguably focus on priority species because not all are necessarily harmful to the extent that would justify spending large amounts of time and effort on keeping them under control.

The question then is: are there some species that could be removed from the list? In our recent study we set out to answer this question by classifying species as inconsequential, beneficial, destructive or conflict generating species. This was done by assessing the relative degree of benefit they brought and their negative effects.

Beneficial and harmful species

The classification was done by using a simple scoring system. It had two categories for the negatives (ecological and socio-economic) and two for the benefits (economic and intrinsic).

1. Inconsequential species: these make up 55% of the species listed under the act and in the regulations. They were associated with relatively low costs and low benefits to society. Species in this group had limited distribution or no known impact and were largely introduced as ornamentals or pets. Some examples include the eastern grey squirrel (*Sciurus carolinensis*), European perch (*Perca fluviatilis*), and the Père David's Deer (*Elaphurus*

Figure 1: Managing trout is a contentious issue with conflicting views about whether they pose a risk, or are beneficial. Credit: Shutterstock

davidianus).

2. Destructive species: these make up 29% of the list. They don't bring substantial benefits to society or the environment, but they have a highly negative impact. Many were introduced accidentally and are regarded largely as pests and weeds. Examples include invasive rodents like the black rat (*Rattus rattus*) which causes damage to infrastructure and transmission of zoonotic diseases and pitch canker (*Fusarium circinatum*) a growing threat to pine plantations and forests worldwide.

1. Beneficial species: they make up 10% of the list and have clear social or environmental benefits. For example the Jacaranda (*Jacaranda mimosifolia*) is an iconic tree species in the city of Pretoria where the species is regarded as part of the identity and "sense of place" of the city. Active management is not necessary or should only be done in particular cases.

2. Conflict-generating organisms: these can be either beneficial or destructive, depending on one's perspective or what value is placed on them. They make up only 6% of the list. There's huge disagreement about whether these species should be controlled, or how they should be controlled. Examples include woody plants introduced for forestry, erosion control, sand dune stabilisation, agriculture and as ornamentals. Acacias and pines are examples. Animal examples include species like the Himalayan tahr which was introduced to the Table Mountain National Park. The goat has been the focus of eradication attempts, despite strong opposition. It also includes species introduced for aquaculture like maroon and brown trout. Managing trout has been highly contentious with conflicting views about whether they pose a risk, or deliver a benefit. This has led to them being listed and delisted. The trout fraternity refuse to acknowledge that trout are invasive species and highlight the lack of scientific evidence of the risks they pose.

Finding common ground

We need to keep sight of the fact that there is general agreement on 94% of listed species. By identifying the small number that are generating the greatest tension, it's more likely discussions can be held to reach common ground on regulation.

Most countries in Africa don't have invasive species regulations. But there's growing recognition that they're needed. South Africa offers useful lessons on how this could be done.

The control of species listed under the country's biodiversity act is compulsory. This means that plans to manage them have to be drawn up and implemented. But this doesn't seem sensible given that not all are equally harmful and resources are limited. Our study suggests that some of the species currently regulated could be removed from the list.

Countries wanting to set up a system of managing invasive species could start by classifying a prospective list of candidates. Policymakers could then quickly bring out legislation against the most damaging and destructive ones. At the same time, discussions could be had on the ones that generate conflict with the aim of reaching consensus.

This would allow managers and regulators to focus on the most destructive species – as well as those that are at the centre of fierce disagreement.

Figure 2: The jacaranda is an iconic tree species in the city of Pretoria where it's regarded as part of the identity. Credit: Shutterstock

Scientists come up with innovative ways to save endangered plant

Mariska Botha

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E-mail Address: not available
Reprinted From: http://www.sabc.co.za/news/a/7121e70041fa59e7bfebbfdc4bf1bc75/Scientists-come-up-with-innovative-ways-to-save-critically-endangered-plant-2017230

Scientists from the University of Stellenbosch are using technology to save a critically endangered plant from extinction.

The Paintbrush Lily, found in a fynbos section known as Renosterveld, is one of the smallest of the lily group. Urbanisation is diminishing its habitat, a similar fate to an increasing number of plant species.

Human development has been the cause of major destruction in nature. Ironically, it's this very development that could also be its saving grace.

Where they once thrived here in Stellenbosch, among others, it's estimated that less than 200 plants still exist in nature.

A group of scientists has embarked on a mission to save the species.

Dr Gary Stafford, US Institute for Plant Biotechnology says: "Using science and technology, we can reverse the process of what's happened already and hopefully introduce more plants back into this environment and other environments, where it occurred before.

Saving even the smallest paintbrush lily could be the saving grace of the great balance of all life on earth.

For example, there's a brick factory not too far away from here, which historically had a population of these plants and we would like to return some plants to that. There's a development around one of the schools nearby, that we would like to introduce the plants into a wetland rehabilitation programme so ideally we would like to save this population, get it to be self-sustaining."

Figure 1: The Paintbrush Lily, found in a fynbos section known as Renosterveld, is one of the smallest of the lily group. Credit: SABC

Taking nature into the concrete jungle structures of the university, they are using existing basic techniques to develop a new method of plant multiplication.

The process is similar to cloning.

Dr Paul Hills, US Institute for Plant Biotechnology says: "Because it's so endangered, we don't want to destroy any of them so we're hoping we can just use the leaves and then from each little piece of the leaf we're hoping we can make one maybe two little bulblets by treating with the right hormones, the right conditions and from that we can take those plants and divide those again and make more so micro propagation has the potential to create millions of plants from just one small sample."

And the next generation of scientists are already on board.

Dominique West, an Honors Degree BSc Student says: "I think a lot of people go into medicine, that's the normal route, but BSc has a lot to offer, so it depends. Genetics has always been an interesting one for me, actually determining what's going on in our bodies on a molecular level."

If successful, specimens will be sent to botanical gardens around the world for safekeeping.

Saving even the smallest paintbrush lily could one day prove to be the saving grace of the great balance of all life on earth.

Conservation versus profit: South Africa's 'unique' game offer a sobering lesson

Adam Hart

Current Address: University of Gloucestershire, United Kingdom
E-mail Address: ahart@glos.ac.uk

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South Africa's wildlife is thriving. One of the reasons for this is that landowners can profit from animals living on their land. Wildlife can be hunted for meat and trophies as well as being used non-consumptively for ecotourism. Thousands of former cattle ranches are now profitable game farms, hunting reserves and ecotourism lodges making South Africa a conservation success story.

But mixing profit and conservation is not simple. For example, a wildlife ranch generating profit from hunters must have animals that clients wish to hunt while a tourist lodge needs to stock species that are attractive and visible to those enjoying recreational game drives. Successful conservation requires a balanced, long-term approach but sometimes the goals of pursuing profit and long term conservation don't always coincide.

One example of this is the market for "colour variants" - unusually coloured forms of particular species caused by rare mutations. Naturally occurring mutations causing colour variations happen in many animals. Rare colour variants of hunted African species have been known for a long time. They include black and white varieties of impala, golden wildebeest and pure white varieties of springbok. Trophy hunters seeking novelty might pay more to hunt these unusually coloured individuals.

The extraordinary spike, and then spectacular collapse, in the prices that these mutant colour forms sold for in the game auctions of South Africa over the past decade or so provides a timely reminder that profit does not always sit comfortably with conservation. Using resources on colour variant animals will divert from the conservation of other wildlife and can be detrimental.

The history

Over the past decade or so, colour variants of a number of species including wildebeest, impala, zebra, blesbok, gemsbok and springbok began to be intensively bred by some game farmers, ultimately for the trophy hunting market.

In 2012, these rare varieties were estimated to represent only 1% of game in the country. Scarcity and the thought that hunters would pay handsomely for novel trophies led to a confidence that there would be considerable future payoffs. As a result, prices escalated. Normal impala could be bought for R1400, whereas black impala fetched R600 000. These colour variants were not yet being hunted – owners were focused on breeding lines and increasing numbers.

But over the next 2 years things changed. By 2014 rare game accounted for 16% of turnover at game auctions with the average price for white impala rams reaching R8.2 million.

As prices continued to rise, critics continued to point out problems. Many believed it was putting profit before conservation.

They pointed out:

- the dangers inherent in intensively breeding animals from limited genetic stock, leading to the problems associated with inbreeding, including reduced viability and fertility;
- of offering captive bred animals to hunters, which many believe to be unethical and not "fair chase";
- of diverting resources from other conservation as game farms focus on colour variant animals to the detriment of other wildlife.

Despite naysayers, breeders bred and sold animals that commanded high prices throughout 2015. But talk of a bubble – when the price of an asset is based on past performance rather than actual value – was rife. Once potential buyers realise the asset is overvalued no one wants to buy it and prices collapse.

This is exactly what happened. At the beginning of 2016 prices started to fall and the devaluation continued spectacularly. Black impala rams now fetch perhaps less than R10,000 (1.7% of 2012 price) and white impala have dropped to R48,000 (0.5% of their 2014 peak value).

The problem seems to have been that demand didn't exist on the scale imagined. Hunters were simply not enthused about adding these new colour variants to their trophy rooms. As a result, breeders were only selling to other breeders and to game farmers, many of whom went on to become breeders themselves, exacerbating the problem.

The problem with the profit motive

As one bubble bursts another seems to be inflating rapidly.

Advertisements for unusual colour variant game can still be seen in game ranching publications. But more apparent in the last two years have been captive-bred buffalo, sable and roan. They are normally coloured, but many have massive horns, a trait that is being bred for, and made even larger, by specialised game breeders. These animals are now regarded as the "fashionable" high-value game species and, as with colour variants, their prices are soaring. A buffalo bull went under the hammer for R168 million in 2016.

Inflated prices and controversy over hunting – especially following the killing of Cecil the Lion in Zimbabwe – make "greedy" wildlife ranchers obvious targets for those who oppose the use of wildlife for hunting.

But the profit-conservation balance isn't necessarily any better in non-consumptive models. For example, baiting popular dive sites for sharks, crowding waterholes with cars or pushing boats closer to bird colonies are but a few of the sharp ecotourism practices driven mainly by greed.

The system works, for now

For all the faults of ecotourism and wildlife ranching in South Africa, the truth is that allowing wildlife to pay its way does appear, at the moment, to be working for conservation.

Conservation necessarily involves money and finding ways for humans and wildlife to live together. In many places, making money from wildlife through hunting and tourism satisfies both needs.

But it seems inevitable that some practitioners of "it pays it stays" will attempt to make wildlife pay more than its rent.

The colour variant bubble is perhaps a timely lesson that models to conserve nature must also account for the greed in human nature.

Figure 1: The price of rare coloured animals like the Golden Wildebeest have fluctuated wildly. Credit: Shutterstock

Study suggests climate change may kill off the aardvark in some areas

Bob Yirka

Current Address: Bloomfield, Indiana, United States
E-mail Address: not available
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A team of researchers with the University of the Witwatersrand in South Africa has found evidence that suggests the aardvark may face a large decrease in population as the planet heats up due to global warming. In their paper published in the journal Biology Letters, the group describes how they fastened monitors to a group of aardvarks who by happenstance were forced to endure a severe drought—and how the animals fared.

Aardvarks are interesting mammals, to say the least; they have floppy ears, a tubular snout and a body reminiscent of an armadillo. They survive by hiding from sub-Saharan African heat inside burrows they dig and eating ants and termites at night. As the researchers note, aardvarks are considered to be a keystone species because others animals use the burrows they build as nests, sleeping quarters or simply as a place to escape from predators and the intense desert heat. But their very existence might be in jeopardy, the researchers with this new effort have found, as the planet heats up and conditions in parts of Africa become more inhospitable.

As part of an ongoing study of the creatures, the researchers affixed sensors to the bodies of several specimens and then released them back into the wild. The sensors tracked both body temperature and activity. As it turned out, the period of study happened to occur during a particularly hot and dry spell in the area, offering an opportunity to see how the aardvarks might fare as sub-Saharan Africa grows hotter and drier.

As it turned out, the aardvarks did not fare well at all—five out of six of the monitored creatures died from apparent unnatural causes. Study of data from the sensors showed that the animals had swapped their usual routines, venturing out during the day to eat, rather than at night. They also showed that the body temperature of the animals had declined—an indication of malnourishment. This was backed up by measurements of extremely low body weight. The researchers suggest the reason the aardvarks had trouble finding food was because ants and termites need a certain amount of water in the soil to survive. The aardvarks that died had starved to death, the researchers concluded, as had several other aardvarks they observed in areas around the test site. This, the team suggests, indicates that aardvark populations are likely going to plummet as their habitats grow hotter and drier.

More information

Benjamin Rey et al. Drought-induced starvation of aardvarks in the Kalahari: an indirect effect of climate change, Biology Letters (2017). DOI: 10.1098/rsbl.2017.0301

Abstract

Aardvarks (*Orycteropus afer*) are elusive burrowing mammals, predominantly nocturnal and distributed widely throughout Africa except for arid deserts. Their survival may be threatened by climate change via direct and indirect effects of increasing heat and aridity. To measure their current physiological plasticity, we implanted biologgers into six adult aardvarks resident in the semi-arid Kalahari. Following a particularly dry and hot summer, five of the study aardvarks and 11 other aardvarks at the study site died. Body temperature records revealed homeothermy (35.4–37.2°C) initially, but heterothermy increased progressively through the summer, with declining troughs in the nychthemeral rhythm of body temperature reaching as low as 25°C before death, likely due to starvation. Activity patterns shifted from the normal nocturnal to a diurnal mode. Our results do not bode well for the future of aardvarks facing climate change. Extirpation of aardvarks, which play a key role as ecosystem engineers, may disrupt stability of African ecosystems.

Figure 1: Aardvark mother and young. Credit: Wikipedia/CC BY-SA 2.0

The shocking truth about electric fences

Alan Lee and Matt Macray

Current Address: University of Cape Town, South Africa
E-mail Addresses: alan.tk.lee@googlemail.com and mmacray@gmail.com
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In South Africa, we have a fence loving culture: no-one has grown up without fencing of some kind. Fence types depend on land-use types, but recently there has been a rapid growth in the use of electric fencing to control problem animals as well as manage large game species, particularly in the wildlife ranching sector. However, recent studies have found that leopard tortoises (*Stigmochelys pardalis*) are prone to dying from electrocution along electric fences, more so than any other wildlife.

The Leopard tortoise is the largest (with exceptional individuals reaching lengths of 750 mm and masses of 40 kg), most abundant and widespread tortoise across South Africa. This makes them very prone to contact with low-strand electric wires. Upon contact, the tortoise defence mechanism is engaged: this involves retracting head and limbs into the shell, often remaining in contact with the live wire. The animal is then consistently shocked, with death occurring after a prolonged period of terrible pain due to dehydration, overheating or internal organ failure.

With South Africa being home to more tortoise species than anywhere else in the world, this is a major concern. A recent study by student Matthew Macray, based at the University of Cape Town, quantified tortoise mortalities associated with electrified and non-electrified fences, comparing these to areas of veld with no fences, in the Karoo region stretching from Prince Albert to Steytlerville. Here, low-line electric fencing is commonly used to protect Angora Goats from jackal, amongst other purposes.

Matt found 403 tortoises on over 160 km of on-foot survey routes, only 40 of which were alive. Leopard tortoises were most commonly found (344 individuals, 35 alive), followed by Angulate tortoises (54 individuals, 5 alive) and tent tortoises (5, all dead). Unsurprisingly, Leopard tortoise mortalities were significantly higher along electric fences than non-electric fences. Despite forming only approximately 4% of all roadside fencing, electric fences account for 56% of leopard tortoise mortalities.

Matt also recorded Angulate tortoises (*Chersina angulata*), a smaller tortoise of up to 30 cm length and 2 kg. Mortalities did not differ between electric and non-electric fences, likely due to the lower shell height. A novel finding was that mortalities of this species were higher along diamond mesh fences than strand fences. Angulate tortoises appear to wedge themselves in mesh fences and are unable to escape. This study highlights the current threat of non-electric fencing on tortoises as no similar findings have been reported. These additional tortoise mortalities should be considered alongside other emerging threats when questioning the longevity of these tortoise populations, not only in the Karoo, but globally. For instance, Pied Crow have been recorded to feed on small and juvenile tortoises.

Implementation and practicality of mitigation strategies

Raising the electric strands has previously been suggested, but was rarely

Figure 1: Angulate tortoise trapped in mesh fence

observed, and is impractical for controlling the movement of unwanted wildlife. The implementation of rock aprons also appeared to be ineffective at reducing mortality rates, in some cases lowering the contact height between low electric strands and the ground level. However, tortoises displayed active behaviour when the temperature was above 20°C, thus thermostatic switches for electric fences could potentially reduce tortoise mortalities without compromising fence function. High temperatures are associated with later periods of the day, periods when traditional problem animals are rarely observed. Switching fences off during these periods could allow time for tortoises to escape the fences. In the Baviaanskloof area, one farmer concerned about the impact of his fences on tortoises, employed a staff member to patrol the fence every day and remove tortoises trapped on the fences. Despite having electric fences, he was still suffering stock loss due to predation by jackal, making it questionable whether the fences were proving effective: there is certainly a need for further research regarding this. Placing fences away from tall vegetation and water may also help reduce fatalities. Overall, a proactive attitude to mitigating tortoise mortalities is required.

Figure 2: Angulate tortoise trapped in mesh fence with rock apron

Figure 3: Dead leopard tortoise on a fence with a rock apron

Figure 4: Live leopard tortoise

What camera traps tell us about elephants eating crops

Josephine B Smit

Current Address: University of Stirling, United Kingdom
E-mail Address: j.b.smit1@stir.ac.uk

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An important conservation goal is to try and ensure that people and wildlife can coexist. This is especially important when it comes to elephants, whose large home ranges and long distance movements take them outside of protected areas.

One of the major challenges to coexistence is the use of food crops by elephants. This threatens the livelihoods, food security and well-being of rural communities. Elephant forays into farmland sometimes results in retaliatory and legal killings under the Problem Animal Control laws and erosion of support for elephant conservation efforts.

For people and elephants to thrive in the long-term, it's important to find ways to mitigate the impact of the animal on people's lives and livelihoods, and vice versa. To find effective solutions, we need to understand why elephants eat crops rather than fodder from the bush and how they learn about crops as a source of food.

To explore these questions our team at the Southern Tanzania Elephant Program used camera traps to capture elephant visits to farmland. The cameras were set up in an area adjacent to the Udzungwa Mountains National Park in Tanzania between 2010 and 2014.

We placed camera traps on elephant trails on the National Park boundary to photograph elephants as they travelled in and out of neighbouring farmland. We then studied the camera trap photos to identify individual elephants from key distinguishing features like ears and tusks.

High-risk, high-reward

All the elephants photographed by our camera traps were males. This is consistent with previous studies suggesting that eating crops is a high risk, high reward feeding strategy for males. Females have been documented to feed on crops, but they are generally less likely to visit farms because of the risks involved to their young.

Age also plays a role. Our study, as well as previous studies in Amboseli, Kenya and Kibale, Uganda found that eating crops appears related to specific milestones in a male elephant's life.

One of the major challenges to co-existence is the use of food crops by elephants. This threatens the livelihoods, food security and well-being of rural communities.

Two particular milestones stood out: the start of reproduction in bulls when they reach the ages of between 20-30 years, and their reproductive peak years in their 40s. When males reach these milestones, they are more willing to take risks and have increased energetic demands. Crops are an attractive source of food for males seeking to maximise their body size and reproductive success.

How do males learn about crops as a food source? In Udzungwa, we found that young bulls aged 10-14 years visited farms. This is the age when males typically leave their maternal family groups, so they may be discovering farms during the process. It's also possible that they learn about crops from older elephants.

Researchers in Amboseli found that young bulls learnt about crops from older bulls and that male social networks shaped behaviour.

How many eat crops?

Some studies have investigated how many bulls eat crops, and how their feeding habits vary. In Udzungwa we identified 48 different elephants from our camera trap photos. With so many bulls visiting the farmland in our study site, we couldn't attribute the crop damage to just a few habitual males.

We also found that the frequency of visits varied between individual bulls. Two-thirds were seen only once over the four-year study period, suggesting that these bulls visit farms infrequently. One-third of the bulls were seen multiple times and 18% more than twice over the study period. These males may be using crops more regularly. But even among these repeat offenders, males varied considerably in how often they visited farms.

In Kenya by comparison, researchers estimated that 12% of Amboseli bulls and 21% of bulls from the wider Amboseli, Kilimanjaro and Tsavo-Chyulu populations were repeat crop eaters. Combined, this evidence suggests that the majority of bulls occasionally use crops, while a small proportion may use them more frequently.

Strategies

Strategies to reduce crop losses to elephants should consider that most bulls consume crops infrequently. So, killing elephants for eating crops is unlikely to significantly reduce crop loss. Taking lethal action is also costly, for it affects those older bulls who are more likely to be eating crops. Killing these older bulls removes a crucial source of ecological knowledge as well as important breeding individuals. This is particularly damaging to elephant populations already under threat from ivory poaching.

There are much better non-lethal options for reducing crop losses to elephants. These include beehive fences and land use planning which involves carefully assessing land for the best possible use. These approaches require strong commitment, community buy-in and creativity. But, as we've found in our work in Tanzania, they offer promising avenues for improving the chances of farmers and elephants being able to coexist.

Figure 1: The Southern Tanzania Elephant Program used camera traps to capture elephant visits to farmland. Credit: STEP/ Josephine Smit

Should genetic engineering be used as a tool for conservation?

Researchers are considering ways to use synthetic biology for such conservation goals as eradicating invasive species or strengthening endangered coral. But environmentalists are worried about the ethical questions and unwanted consequences of this new gene-altering technology.

Richard Conniff

E-mail Address: richardconniff@comcast.net

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The worldwide effort to return islands to their original wildlife, by eradicating rats, pigs, and other invasive species, has been one of the great environmental success stories of our time. Rewilding has succeeded on hundreds of islands, with beleaguered species surging back from imminent extinction, and dwindling bird colonies suddenly blossoming across old nesting grounds.

But these restoration campaigns are often massively expensive and emotionally fraught, with conservationists fearful of accidentally poisoning native wildlife, and animal rights activists having at times fiercely opposed the whole idea. So what if it were possible to rid islands of invasive species without killing a single animal? And at a fraction of the cost of current methods?

That's the tantalizing – but also worrisome – promise of synthetic biology, a *Brave New World* sort of technology that applies engineering principles to species and to biological systems. It's genetic engineering, but made easier and more precise by the new gene editing technology called CRISPR, which ecologists could use to splice in a DNA sequence designed to handicap an invasive species, or to help a native species adapt to a changing climate. "Gene drive," another new tool, could then spread an introduced trait through a population far more rapidly than conventional Mendelian genetics would predict.

Synthetic biology, also called synbio, is already a multi-billion dollar market, for manufacturing processes in pharmaceuticals, chemicals, biofuels, and agriculture. But many conservationists consider the prospect of using synbio methods as a tool for protecting the natural world deeply alarming. Jane Goodall, David Suzuki, and others have signed a letter warning that use of gene drives gives "technicians the ability to intervene in evolution, to engineer the fate of an entire species, to dramatically modify ecosystems, and to unleash large-scale environmental changes, in ways never thought possible before." The signers of the letter argue that such a "powerful and potentially dangerous technology … should not be promoted as a conservation tool."

Environmentalists and synthetic biology engineers need to overcome what now amounts to mutual ignorance

On the other hand, a team of conservation biologists writing early this year in the journal *Trends in Ecology and Evolution* ran off a list of promising applications for synbio in the natural world, in addition to island rewilding:

- Transplanting genes for resistance to white nose syndrome into bats, and for chytrid fungus into frogs and other amphibians.
- Giving corals that are vulnerable to bleaching carefully selected genes from nearby corals that are more tolerant of heat and acidity.
- Using artificial microbiomes to restore soils damaged by mining or pollution.
- Eliminating populations of feral cats and dogs without euthanasia or surgical neutering, by producing generations that are genetically programmed to be sterile, or skewed to be overwhelmingly male.
- And eradicating mosquitoes without pesticides, particularly in Hawaii, where they are highly destructive newcomers.

Kent Redford, a conservation consultant and co-author of that article, argues that conservationists and synbio engineers alike need to overcome what now amounts to mutual ignorance. Conservationists tend to have limited and often outdated knowledge of genetics and molecular biology, he says. In a 2014 article in *Oryx*, he quoted one conservationist flatly declaring, "Those were the courses we flunked." Stanford University's Drew Endy, one of the founders of synbio, volunteers in turn that 18 months ago he had never heard of the IUCN—the International Union for Conservation of Nature—or its "Red List" of endangered species. "In engineering school, the ignorance gap is terrific," he adds. "But it's symmetric ignorance."

At a major synbio conference he organized last month in Singapore, Endy invited Redford and eight other conservationists to lead a session on biodiversity, with the aim, he says, of getting engineers building the bioeconomy "to think about the natural world ahead of time … My hope is that people are no longer merely naïve in terms of their industrial disposition."

Likewise, Redford and the co-authors of the article in *Trends in Ecology and Evolution*, assert that "it would be a disservice to the goal of protecting biodiversity if conservationists do not participate in applying the best science and thinkers to these issues." They argue that "it is necessary to adapt the culture of conservation biologists to a rapidly-changing reality"—including the effects of climate change and emerging diseases. "Twenty-first century conservation philosophy," the co-authors conclude, should "embrace concepts of synthetic

biology, and both seek and guide appropriate synthetic solutions to aid biodiversity."

Through "gene drive" technology, mice, rats or other invasive species can theoretically be eliminated from an island without killing anything.

The debate over "synthetic biodiversity conservation," as the *Trends in Ecology and Evolution* authors term it, had its origins in a 2003 paper by Austin Burt, an evolutionary geneticist at Imperial College London. He proposed a dramatically new tool for genetic engineering, based on certain naturally occurring "selfish genetic elements," which manage to propagate themselves in as much as 99 percent of the next generation, rather than the usual 50 percent. Burt thought that it might be possible to use these "super-Mendelian" genes as a Trojan horse, to rapidly distribute altered DNA, and thus "to genetically engineer natural populations." It was impractical at the time. But development of CRISPR technology soon brought the idea close to reality, and researchers have since demonstrated the effectiveness of "gene drive," as the technique became known, in laboratory experiments on malaria mosquitoes, fruit flies, yeast, and human embryos.

Burt proposed one particularly ominous-sounding application for this new technology: It might be possible under certain conditions, he thought, that "a genetic load sufficient to eradicate a population can be imposed in fewer than 20 generations." And this is, in fact, likely to be the first practical application of synthetic biodiversity conservation in the field. Eradicating invasive populations is of course the inevitable first step in island rewilding projects.

The proposed eradication technique is to use the gene drive to deliver DNA that determines the gender of offspring. Because the gene drive propagates itself so thoroughly through subsequent generations, it can quickly cause a population to become almost all male and soon collapse. The result, at least in theory, is the elimination of mice, rats, or other invasive species from an island without anyone having killed anything.

Research to test the practicality of the method—including moral, ethical, and legal considerations—is already under way through a research consortium of nonprofit groups, universities, and government agencies in Australia, New Zealand, and the United States.

At North Carolina State University, for instance, researchers have begun working with a laboratory population of invasive mice taken from a coastal island. They need to determine how well a wild population will accept mice that have been altered in the laboratory.

"The success of this idea depends heavily," according to gene drive researcher Megan Serr, "on the genetically modified male mice being 'studs' with the island lady mice … Will she want a hybrid male that is part wild, part lab?" Beyond that, the research program needs to figure out how many modified mice to introduce to eradicate an invasive population in a habitat of a particular size.

Other significant practical challenges will also undoubtedly arise. For instance, a study early this year in the journal *Genetics* concluded that resistance to CRISPR-modified gene drives "should evolve almost inevitably in most natural populations."

Figure 1: Credit: Illustration by Luisa Rivera / Yale E360

"We are committed to a precautionary step-wise approach, with plenty of off ramps, if it turns out to be too risky or not ethical"

Political and environmental resistance is also likely to develop. In an email, MIT evolutionary biologist Kevin Esvelt asserted that CRISPR-based gene drives are "not suited for conservation due to the very high risk of spreading" beyond the target species or environment. Even a gene drive system introduced to quickly eradicate an introduced population from an island, he added, "still is likely to have over a year to escape or be deliberately transported off-island. If it is capable of spreading elsewhere, that is a major problem."

Even "a highly contained field trial on a remote island is probably a decade or so away," said Heath Packard, of Island Conservation, a nonprofit that has been involved in numerous island rewilding projects and is now part of the research consortium. "We are committed to a precautionary step-wise approach, with plenty of off-ramps, if it turns out to be too risky or not ethical." But his group notes that 80 percent of known extinctions over the past 500 or so years have occurred on islands, which are also home to 40 percent of species now considered at risk of extinction. That makes it important at least to begin to study the potential of synthetic biodiversity conservation.

Even if conservationists ultimately balk at these new technologies, business interests are already bringing synbio into the field for commercial purposes. For instance, a Pennsylvania State University researcher recently figured out how to use CRISPR gene editing to turn off genes that cause supermarket mushrooms to turn brown. The U.S. Department of Agriculture last year ruled that these mushrooms would not be subject to regulation as a genetically modified organism because they contain no genes introduced from other species.

With those kinds of changes taking place all around them, conservationists "absolutely must engage with the synthetic biology community," says Redford, "and if we don't do so it will be at our peril." Synbio, he says, presents conservationists with "a huge range of questions that no one is paying attention to yet."

Climate change: Biodiversity rescues biodiversity in a warmer world

Source: German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig
Current Address: Leipzig, Germany
E-mail Address: idiv.info@uni-leipzig.de
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The last month was recorded as the warmest June ever in many parts of the world. Last year, 2016, was the warmest year in the modern temperature record. Our planet is constantly heating up. This poses direct threats to humans, like extreme weather events and global sea-level rise, but scientists are concerned that it may also affect our well-being indirectly via changes in biodiversity. The variety of life, from plants and animals to microorganisms, is the basis of many services ecosystems provide to us, for example clean drinking water or food. Today, ecologists are challenged by the question: what does a warmer world mean for biodiversity? More species, less species, or no change?

A team of ecologists from the German Centre for Integrative Biodiversity Research (iDiv), Leipzig University, and the University of Minnesota found that climate warming can both increase and decrease biodiversity, and that the direction of the effect depends on how much biodiversity there is in the first place. In a long-running field experiment in Cedar Creek, Minnesota, the researchers established more than 30 different meadow plots, some with only one plant species (monocultures), and others with up to 16 different plant species. Then, they warmed the meadows with heating lamps to approximately 3°C above the ambient temperature. Subsequently, the researchers recorded how this affected nematodes, little worms that live in the soil in high abundance and of which many different species exist. Nematodes play important roles for several ecosystem functions, for example they help to make the soil fertile which is crucial for plant production.

When the researchers warmed the monoculture plots, the diversity of nematodes substantially declined. However, when they warmed the plots with a high number of different plant species, the number of nematode species increased. Dr Madhav P. Thakur, the lead author of the study and a postdoctoral researcher at the iDiv research centre and the Leipzig University, says: "The story is simple; you need biodiversity to conserve biodiversity in a warmer world."

Figure 1: The meadow plots were part of the Long-Term Ecological Research Station in Cedar Creek, Minnesota, USA. The heating lamps placed above the meadows heated the meadow to approx. 3 degrees Celcius above the ambient temperature. Credit: Jacob Miller

That's not, however, the end of the story. The researchers also report the limitation of biodiversity in rescuing biodiversity in a warmer world. While they did find a greater number of nematode species in the warmed plots with high plant diversity, those nematode species were also more closely related, or in other words, more similar, to each other. "The reason was that these species had all been selected for a common characteristic, namely tolerance to a warmer environment," Thakur explains. This increase in similarity can have implications for how well biological communities can respond to future environmental changes, potentially limiting the "insurance" effect inherent in a higher numbers of species," says Dr Jane Cowles, a co-author and postdoctoral researcher at the University of Minnesota. What will be the consequences for the stability of our planet's ecosystems? The authors encourage future research to solve this puzzle.

The monoculture meadow created for the experiment resembled meadows found in intensively managed agricultural land. These new research findings therefore support conservationists who are advocating for maintaining species-rich ecosystems and farmland to sustain biodiversity, and thus human well-being, in a warmer world. This may help to prevent negative effects of climate warming, although likely with some limitations.

Climate Risk and Vulnerability: A Handbook for Southern Africa: 2nd Edition

Claire Davis and Katharine Vincent

Current Address: South African National Biodiversity Institute, Cape Town, South Africa
Web Address: http://www.sanbi.org
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The second edition of the *Climate Risk and Vulnerability Handbook for Southern Africa* presents the latest available scientific knowledge on the nature of climate change and its implications for southern Africa. The handbook serves as an important guide for climate and development practitioners, researchers and students. An executive summary is targeted specifically at policy-makers.

Reliable and accessible climate information is an important tool in responding to the impacts of climate change and the development of robust response strategies (adaptation and disaster risk reduction). The Handbook was conceived and designed to provide decision-makers with up to date information, appropriate for country planning, on the impacts and risk of climate change.

The second edition updates and builds on the critically acclaimed first edition, which helped support Southern Africa Development Community (SADC) level engagement (partly through providing source material for the SADC Climate Change Think Tank in early 2012; as well as the SADC Climate Change Science, Technology and Innovation (STI) Response Framework and country-level capacity building in Malawi, Mozambique, Namibia, Zambia and Zimbabwe, among others.

The content of the second edition covers the likely physical manifestations of climate change in southern Africa, together with an understanding of how social vulnerability and adaptive capacity are likely to affect the ways in which such changes translate into impacts. A number of key sectors are selected to illustrate best practices in assessing vulnerability, agriculture and livestock, commercial forestry, terrestrial ecosystems and biodiversity, water resources, coastal zone, settlements, human health, energy and air quality.

The *Handbook for Southern African on Climate Risk and Vulnerability* is accompanied by a concise executive summary that will support decision-makers in southern Africa as they implement Nationally Determined Contributions (NDCs) under the UNFCCC Paris Agreement as well as national climate change policies and strategies.

The lead authors of this report are Claire Davis (Council for Scientific and Industrial Research, South Africa) and Katharine Vincent (Kulima Integrated Development Solutions, South Africa) with key inputs from a multi-disciplinary team that comprises climate scientists, social scientists with experience in impacts, vulnerability and adaptation, as well as communications experts.

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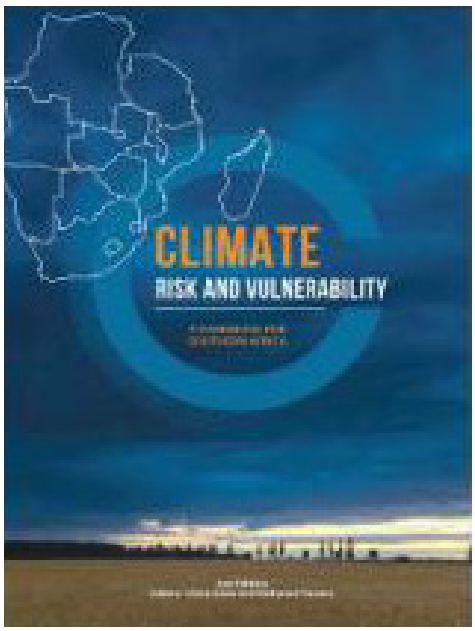

Figure 1: Climate Risk and Vulnerability Handbook for Southern Africa

Strengthening Agriculture to Face Climate Change

Sudhakar Srivastava[1]

sudhakar.srivastava@gmail.com, sudhakar.iesd@bhu.ac.in (S. Srivastava)
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'Climate change' is a phrase currently on everyone's lips, usually associated by the general public with more frequent heat waves or declining snowfall. However, climate change affects almost every facet of life on Earth [1]. Agriculture is one of most important human activities required for our survival on this planet and climate change is threatening the required growth and sustainability of agriculture at an increasing rate [2]. The rate of change outpaces the natural ability of plants to adapt to a changing environment as well as the breeder's attempts to develop more resilient varieties [3]. Therefore, it is vital that we understand the impacts of climate change on diverse aspects of agriculture to develop climate-smart and climate-resilient approaches [4]. To this end, *Climate Change and Agriculture Worldwide*, edited by Emmanuel Torque- biau, presents a comprehensive analysis of work by the French Agricultural Research Centre for International Development (CIRAD) and the French Development Agency (AFD) on climate change and agriculture. The book is a translation of the French language edition *Changement Climatique et Agricultures du Monde*. The main goal of the book is to discuss the steps that can be implemented presently or need to be adopted to prepare agriculture for future climate scenarios. Such a solution-based approach with relevant examples of successful case studies from developing countries is mostly missing in other books. An important feature of the book is that it focuses on developing countries, which are likely to be affected to a greater extent than countries elsewhere, owing to their larger human populations depending on smaller areas to make their living, grow food, and survive. The holistic nature of the book is reflected in the fact that its content comprises livestock farming and also forestry. Given that the book deals with a burning scientific and socio-economic issue, it should attract a wide audience beyond researchers and students, including officials in agriculture and forestry sectors, and members of the general public. One of the most important points raised in the book is the need to include agriculture as a point of discussion in international efforts targeted towards combating climate change.

The book begins with a focused discussion of the impacts of climate change on agriculture, with an emphasis on the situation faced by developing countries and suggestions for climate-smart agriculture. The remainder of the book is divided into four distinct parts. The first is devoted to understanding the agriculture responses to various abiotic and biotic stresses (i.e., heat, salinity, drought, pests, and diseases) in the context of climate change. This raises the reader's awareness of agricultural challenges in developing countries and also of how agricultural crops respond to various current stresses. It is obvious that several changes have already occurred to agricultural practices as a result of the challenges that farmers have faced in recent decades.

Hence, the second section of the book emphasizes novel or modified practices, and innovations that have been applied in research or in real field conditions, such as management of water resources or recycling of agricultural organic waste [4]. This instills hope that agriculture is ready to face climate change although we need to better understand the challenges ahead.

The remaining sections focus on what more needs to be done to manage effectively human nutrition and health, and ecosystem services, and how policies and research need to be framed and discussed in international forums and research initiatives. Perhaps unsurprisingly, nutritional aspects of agriculture take center stage.

These last two sections, entitled *Stimulating Change and Looking Ahead*, are written in such a way to motivate researchers, officials, and the general public to address climate change issues prevailing in developing countries.

Some innovations currently being researched or being applied by farmers might not have been covered in the book due to space constraints or lack of information. Nonetheless, *Climate Change and Agriculture Worldwide* presents the complex issue of climate change in the form of a compelling story that will be useful to guide research and policy initiatives to tackle the challenges ahead.

Acknowledgments

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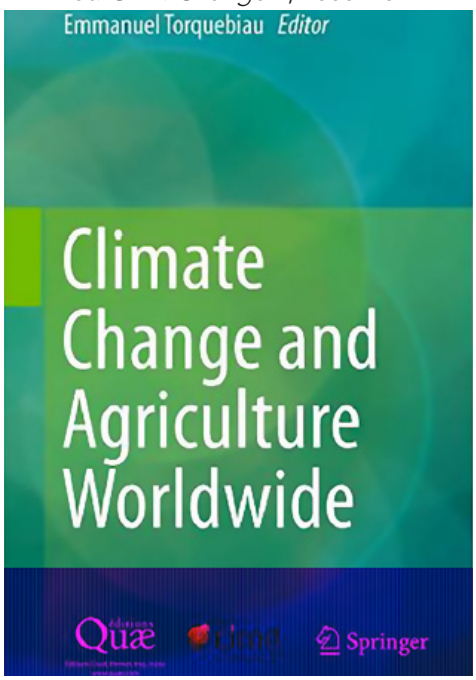
Climate Change and Agriculture Worldwide edited by Emmanuel Torquebiau. Springer, 2016. s101.14 eBook, s119.99 hbk (XXV + 348 pp.), ISBN 978-94-017-7462-8 (eBook); 978-94-017-7460-4 (hbk).

[1]Institute of Environment and Sustainable Development, Banaras Hindu University, Varanasi 221005, India

References

1. Oreskes, N. (2004) The scientific consensus on climate change. *Science* 306, 1686
2. Davidson, D. (2016) Gaps in agricultural climate adaptation research. *Nat. Clim. Change* 6, 433–435
3. Rippke, U. et al. (2016) Timescales of transformational climate change adaptation in sub-Saharan African agriculture. *Nat. Clim. Change* 6, 605–609
4. Lipper, L. et al. (2014) Climate-smart agriculture for food security. *Nat. Clim. Change* 4, 1068–1072



The influence of soil fertility on pasture growth

Craig Galloway
Woodlands Dairy, Woodlands Dairy Sustainability Project, 4 Boog Street, Humansdorp, 6300.
Trace & Save, 98 Dr AD Keet Road, Jeffrey's Bay, 6330.
craig@traceandsave.com

Abstract

The current research on soil quality does not sufficiently connect soil quality levels with actual pasture growth rates and yield. Understanding which aspects of soil quality most influence pasture yield is important in informing soil management on pasture-based dairy farms. This study made use of soil sampling results on pasture-based dairy farms in the Eastern Cape which also measure growth rates in order to assess the influence of soil fertility on pasture growth. Soils with ideal potassium levels were found to have higher pasture yields, and soil potassium levels (mg/kg) and base saturation percentage were correlated with pasture yield. There was no difference in pasture yield on soils where average pH, phosphorous, magnesium, calcium and sodium levels (mg/kg) and base saturation percentages fell within the norms and outside of the norms. Soil amendments which focus on addressing potassium shortages should therefore be prioritised on pasture-based dairy farms.

Introduction

Understanding factors which influence pasture growth and yield are imperative to achieving more sustainable production on dairy farms. One of the most practical, viable and significant opportunities to improve the sustainability of dairy farming is in increasing the productivity of the available land, increasing the milk production per hectare, while maintaining/decreasing the amount of inputs (i.e. water, fertiliser and feed) used to do so (Capper et al. 2009; Erasmus & Webb 2013).

There are numerous factors which influence pasture growth, most notably the genetic potential of the plants, environmental and climate factors, farm management practices, and soil quality (Swanepoel et al. 2016). The focus of this study is the influence of soil quality. Soil quality is defined as "is the capacity of soil to function, within ecosystem and land-use boundaries, to sustain biological productivity, maintain environmental quality, and promote plant, animal, and human health." (Doran et al. 1996). This capacity is influenced by the functioning of soil physical, chemical and biological properties (Doran et al. 1996). It is important to understand and acknowledge the complexity and extent of factors influencing plant growth when discussing soil quality. That said, it is sometimes impossible, and impractical to assess every aspect of soil quality, while there is value in focusing on certain aspects and exploring the influence of these aspects. The focus of this article is the chemical (fertility) aspect of soil quality.

Significant time, energy and money are put into taking soil samples on dairy farms every year. It is well understood, and widely accepted that improving soil fertility is imperative in improving pasture growth. Ideal soil parameters have been widely researched and many, many articles have been published concerning this topic. Over the past couple of years in the South African pasture-based dairy context, Swanepoel et al. (2014 & 2015) and Phohlo (2016) researched soil quality in dairy pastures in the Southern Cape, but this research did not link soil quality to pasture growth rates and yield. There is a lack in South Africa though with regards to establishing the link between soil fertility and actual pasture growth rates on farms (Phohlo 2016). More recently though Swanepoel et al. (2016) published research done on the Outeniqua Research Farm, near George in the Western Cape, on the effects of soil quality and tillage on pasture growth. They found tillage to influence pasture yield, but did not isolate any specific soil quality indicator's influence on yield, making the recommendation that further research needs to go into determining how soil quality indicators affect pasture production. This research aims to contribute to this conversation around the influence of soil fertility on pasture growth, with the hypothesis that pasture growth will be greatest on pastures with soil fertility levels within the ideal recommended parameters.

Methods

Study area

The seven farms included in this study are located in the western part of the Eastern Cape, four in the upper Tsitsikamma/Eerste Rivier region, two in the lower Tsitsikamma/Humansdorp region and one in the Gamtoos River region. The average rainfall of the area for the study period was 800mm. All of the farms participate in the Woodlands Dairy Sustainability Project (WDSP), which is operated in association with Trace & Save (an independent sustainable agriculture company; http://traceandsave.com/).

The seven different pasture-based dairy farms all employ management practices which vary to an extent with regards to fertilisation, irrigation, planting and tillage. The pastures included in the study are all under permanent irrigation, and are predominantly kikuyu, ryegrass and clover based. These factors are not accounted for in this study, which is a limitation, but this study is not intended to be a comprehensive assessment of what influences pasture growth, rather focussing on specific aspects of soil fertility. The management practices mentioned above are similar enough across the seven farms to make this possible. The seven farms were chosen as they both participate in the WDSP as well as use the program Fourth Quadrant to record pasture growths.

Data collection

Data was collected for camps on the seven farms which had both growth rate data for the specific camp, as well as a soil sample which was taken in that camp. With regards to the pasture growth measures, these are recorded for each camp individually, whereas in most cases composite soil samples cover more than one camp. Camps are grouped for composite sampling based on adjacent geographic location and forming part of shared management units. It is not possible to take a soil sample in each individual camp as this is not economically viable. Table 1 gives an indication of the total number of camps and soil samples which were taken on each of the farms.

Table 1: Total area, number of camps and number of composite soil samples used in the analysis

Farm	Area (ha)	Number of camps	Number of composite soil samples
A	206	46	16
B	244	39	11
C	477	32	31
D	48	24	13
E	38	9	4
F	486	57	17
G	268	98	35
Total	**1767**	**305**	**127**

Composite soil samples, taken at a depth of 15 cm, are taken on the farms which participate in the WDSP. A minimum of soil from eight sampling points are included in each composite sample. In areas where composite samples are taken on greater than four hectares, soil from at least 10 sampling points make up a composite sample. On areas greater than 25 hectares, soil from at least 16 sampling points make up a composite sample. These soil samples are analysed for pH (KCl), extractable phosphorous (P) (Bray I), exchangeable acidity, exchangeable sodium (Na), exchangeable potassium (K), exchangeable calcium (Ca) and exchangeable magnesium (Mg) at Bemlab, a South African National Accreditation System accredited laboratory. All seven of the farms included in the study make use of the program Fourth Quadrant to record farm production data. Part of this production data is pasture growth and fertiliser application rates. Pasture growth is measured with a rising plate meter. The total pasture yield (tons/ha), calculated from average monthly growth rates, and total nitrogen fertiliser applied (kg/ha) per camp was obtained from Fourth Quadrant for the 12 months prior to when the soil sample was taken for each camp on the seven farms. This resulted in a total of 231 irrigated pasture camps across the seven farms. Annual rainfall (mm) data for each farm is also collected as part of the WDSP.

Data analysis

A Shapiro-Wilks test for normality was conducted on the data in IBM SPSS Statistics 24, which showed a non-normal distribution of all the data. Spearman correlations were therefore calculated to test for association between pasture yield and the soil parameters, fertiliser application rates and rainfall, using IBM SPSS Statistics 24.

The pasture camps were grouped according to whether the soil fertility test results fell within recommended norms, or were at deficient or excessive levels. Soil results were first grouped according to soil parameter levels for pH, phosphorous Bray I, sodium, potassium, calcium and magnesium (Table 1). A second grouping was then done according to base saturation percentages (Table 2). There is a wide variety of recommended soil norms, with little exact agreement. The norms used in this study, indicated in Table 2 and 3, are what have been developed and used by Trace & Save on dairy pastures in the Eastern Cape. The average levels were calculated for each soil parameter for each of the groups, showing how many pastures' parameters fell within the norms and how many fell outside of the norms.

Table 2: Trace & Save soil norms based on ideal soil levels

Soil parameter	Ideal level
pH (KCl)	5.5 – 6.5
P Bray I (mg/kg)	> 30
Na (mg/kg)	20 - 70
K (mg/kg)	130
Ca (mg/kg)	> 850
Mg (mg/kg)	60 - 180

Table 3: Trace & Save soil norms based on base saturation percentages

Soil parameter	Ideal level
Na (BS %)	0.5% - 3%
K (BS %)	5% - 8%
Ca (BS %)	60% - 70%
Mg (BS %)	14% - 17%

The average (mean) yearly pasture yield (tons/ha) was calculated for each soil parameter, based on the groupings described above. A t-test was conducted in order to compare the mean pasture yields between the groups, using IBM SPSS Statistics 24.

Results

There was no correlation between annual rainfall and pasture yield ($R = 0.00$; $p = 0.96$). There was also no correlation between the amount of nitrogen fertiliser applied and pasture yield ($R = 0.01$; $p = 0.87$; $n = 148$). The only soil parameters which were positively correlated with pasture yield were potassium level ($R = 0.15$; $p = 0.03$) and percentage base saturation ($R = 0.18$; $p = 0.01$), and sodium level ($R = 0.13$; $p = 0.05$) and percentage base saturation ($R = 0.13$; $p = 0.04$). Pasture yield was negatively correlated with magnesium percentage base saturation ($R = -0.14$; $p = 0.04$).

The only soil parameter which appeared to significantly influence pasture yield was potassium. Based on soil potassium levels, an average of 18.1 tons/ha/year of pasture was grown on camps with average soil potassium levels of 216.6 mg/kg, and an average of 16.7 tons/ha/year of pasture was grown on camps with average soil potassium levels of 105.4 mg/kg, indicating a significant difference between the groups ($t = 2.56$, $p = 0.01$) (Table 4 and Figure 1). When based on percentage base saturation, an average of 18.3 tons/ha/year of pasture was grown on camps with average soil K levels of 6.4%, and an average of 17.2 tons/ha/year of pasture was grown on camps with average soil potassium levels of 4.95%, indicating a significant difference between the groups ($t = 2.05$, $p = 0.04$) (Table 5 and Figure 2). There were no differences between average pasture yields grouped according to any of the other factors tested.

Most notable of these was that even though phosphorous levels in the outside of soil norms group were on average 17.4 mg/kg (Table 4), this did not appear to influence pasture growth (Figure 1). Although sodium was positively correlated with pasture yield, and magnesium was negatively correlated with pasture yield, there were no differences in yield between the pastures with sodium and magnesium levels within or outside of soil norms (Figure 1 and 2). pH and calcium levels showed no correlation to pasture yield in this study.

In comparing Table 4 and 5, it is interesting to note that there are a lot more camps which had ideal levels for the soil parameters measured, than what had the ideal base saturation percentages. This is especially notable where the majority of the camps (68%) had ideal potassium levels, but the minority of camps (43%) had ideal base saturation percentages. The majority of camps, both based on soil levels and percentage base saturation, had too high magnesium levels.

Table 4: Distribution of soil results and average soil parameter levels as grouped according to whether soil parameter levels, in mg/kg, were within recommended norms, or outside of recommended soil norms

Soil parameter	Within soil norms			Outside of soil norms		
	Count	*Average*	*Std dev.*	*Count*	*Average*	*Std dev.*
pH (KCl)	111	5.8	0.3	120	5.1	0.2
P Bray I (mg/kg)	149	63.1	25.9	82	17.4	6.1
Na (mg/kg)	110	55.0	10.1	121	100.2	25.8
Na %	110	3.5%	1.2%	121	5.0%	1.8%
K (mg/kg)	157	216.6	66.8	74	105.4	20.0
K %	157	6.3%	1.6%	74	4.0%	1.0%
Ca (mg/kg)	136	1216.6	299.8	95	649.8	137.7
Ca%	136	62.%	6.5%	95	50.7%	6.3%
Mg (mg/kg)	47	129.3	29.1	184	258.2	58.8
Mg %	47	19.0%	2.7%	184	23.6%	2.6%

Table 5: Distribution of soil results and average soil parameter levels as grouped according to whether soil parameter levels, in base saturation percentage, were within recommended norms, or outside of recommended soil norms

Soil parameter	Within soil norms			Outside of soil norms		
	Count	*Average*	*Std dev.*	*Count*	*Average*	*Std dev.*
Na (mg/kg)	55	54.8	17.4	176	86.1	29.4
Na %	55	2.5%	0.4%	176	4.9%	1.6%
K (mg/kg)	99	209.4	61.0	132	159.6	80.1
K %	99	6.4%	0.9%	132	5.0%	2.1%
Ca (mg/kg)	89	1265.0	318.2	142	807.0	285.6
Ca%	89	65.0%	2.6%	142	52.8%	7.7%
Mg (mg/kg)	11	125.8	72.5	220	237.3	71.2
Mg %	11	15.6%	0.9%	220	23.0%	2.9%

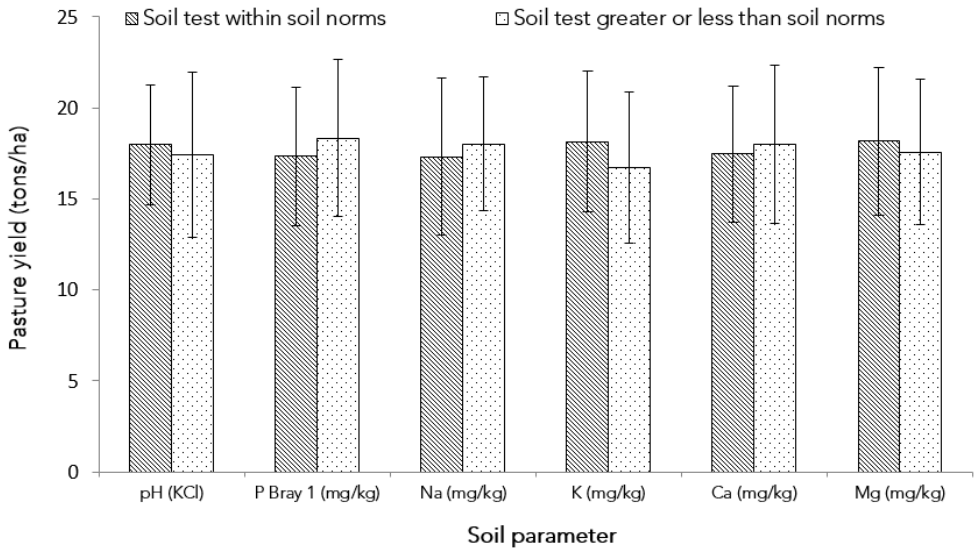


Figure 1: Pasture yields (tons/ha/year) on irrigated pastures grouped according to whether soil test results for various parameters, in mg/kg, were within standard soil norms

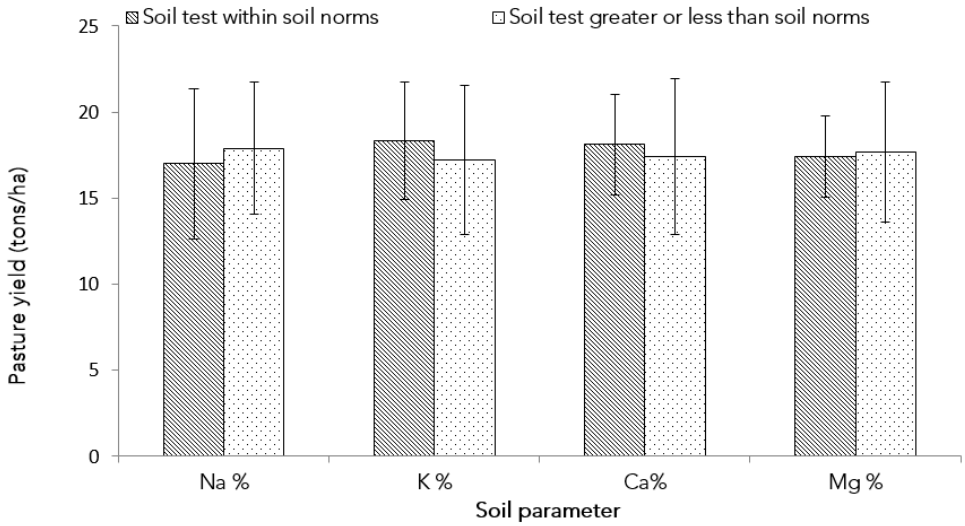


Figure 2: Pasture yields (tons/ha/year) on irrigated pastures grouped according to whether soil test results for various parameters, in base saturation percentage, were within standard soil norms

Discussion

The main focus of this article is soil fertility, but two of the other results stand out as notable. The lack of correlation between rainfall and growth is most probably due to all of the pastures included being irrigated pastures, which shows that irrigation can be used effectively to ensure good pasture yields. The fact that nitrogen fertiliser application rates were not correlated with pasture yield is important to point out. The justification for excessive nitrogen fertiliser use is often that the growth which it results in is required. As a pasture-based dairy industry we need to start looking beyond nitrogen fertiliser for effective pasture growth.

The most influential soil fertility parameter in terms of pasture yield on the farms included in this study was potassium. Magnesium and sodium levels were also shown to influence pasture growth. Magnesium deficiencies are very rare in pasture soils (Target 10 2005). Too high magnesium base saturation percentages are associated with soil compaction, decreased aeration, reduced rate of organic matter decomposition and poor drainage (Astera 2014). All of these would negatively impact pasture yield. Although sodium is an essential plant nutrient, focus in soil fertility is usually placed on too high sodium levels in soils causing salinity, sodicity and dispersion (Target 10 2005). The levels of sodium in the pasture soils included in this study did not show any negative effect on pasture yield, rather the opposite, most probably because the levels were not high enough for this. It was unexpected that phosphorous and calcium levels were not associated with differences in pasture yield. It should be noted that these are important plant nutrients and do influence pasture growth (Target 10 2005). This study probably did not have enough data to show the influence of these nutrients. As the influence of potassium was the most significant finding of this study, and the most notable result, the remainder of the discussion will focus on potassium in pasture soils.

Higher potassium levels were associated with higher pasture yields, and significantly higher pasture yields were grown in camps which had potassium levels within the recommended norms, and within the recommended base saturation percentages. This is not surprising as one of the main symptoms of potassium deficiency is reduced plant growth (Target 10 2005). It is notable that on camps where potassium base saturation percentages were too low, the average potassium levels (159.6 mg/kg) were above the ideal level (> 130 mg/kg). This reinforces the importance of using both soil levels and base saturation percentages when deciding whether to apply potassium fertiliser.

The majority (81%) of the potassium consumed by lactating dairy cows is excreted in the urine (Target 10 2005). This urine is often concentrated around water troughs, in yards and lost on roads and walkways. The urine that is deposited on pastures is also associated with high levels of leaching (During & Mcnaught 1961). Potassium in sandy soils is especially susceptible to leaching because of its weak bind in soil colloids compared to other bases. This makes it easy for potassium to be knocked off of exchange sites by other bases. Potassium leaching is also influenced by the amount of organic matter and clay there is in soils. Sandy soil with lower organic matter will therefore be the most susceptible to leaching of nutrients, especially potassium (Target 10 2005). It is therefore not surprising that potassium is becoming the most important soil nutrient on pasture-based dairy farms in the Tsitsikamma, with its sandy soils.

Swanepoel et al. (2014) and Phohlo (2016) found potassium levels to be correlated with soil carbon on sandy pasture soils in the southern Cape and Tsitsikamma regions of South Africa respectively. This emphasises the importance of soil carbon when it comes to holding potassium in soil that is low in clay content. Continuously applying potassium fertiliser is not a sustainable solution to optimising pasture yield. The long-term goal should be the increase of soil potassium levels, which requires the increase of soil carbon levels.

Conclusions

Soil potassium levels should not be neglected when indicated as lacking on soil test results, especially at the expense of nitrogen fertiliser. The results of this study show that soil potassium levels are more closely associated to pasture yield than nitrogen fertiliser application rates. Although it is costly to apply soil amendments for the improvement of soil potassium levels, it is worthwhile in terms of the resulting increased pasture yield. It is also important to ensure that potassium is at the correct base saturation in pasture soils. In this regard, the build-up of magnesium in sandy pasture soils should be monitored, as it has the potential to negatively affect growth in future.

References

Astera A. 2014. The ideal soil v2.0: A handbook for the new agriculture. Agricola.

Capper JL, Cady RA & Bauman DE. 2009. The environmental impact of dairy production: 1944 compared with 2007. *Journal of Animal Science* 87(6):2160-2167.

Doran JW, Sarrantonio M & Liebig MA. 1996. Soil health and sustainability. *Advances in Agronomy* 56:1-54.

During G & McNaught KJ. 1961. Effects of cow urine on growth of pasture and uptake of nutrients. *New Zealand Journal of Agricultural Research* 4(5-6):591-605.

Erasmus LJ & Webb EC. 2013. The effect of production system and management practices on the environmental impact, quality and safety of milk and dairy products. *South African Journal of Animal Science* 43(3):424-434.

Phohlo MP. 2016. Soil quality of kikuyu, ryegrass and clover pasture mixtures in the Tsitsikamma. Masters dissertation. D partment of soil, crop and climate sciences. Faculty of natural and agricultural sciences. University of the Free State.

Swanepoel PA, Du Preez CC, Botha PR, Snyman HA & Habig J. 2014. Soil quality characteristics of kikuyu–ryegrass pastures in South Africa. *Geoderma* 232:589-599.

Swanepoel PA, Botha PR, du Preez CC, Snyman HA & Habig J. 2015. Assessment of tillage effects on soil quality of pastures in South Africa with indexing methods. *Soil Research* 53:274–285.

Swanepoel PA, Habig J, Preez CC, Snyman HA & Botha PR. 2016. Tillage effects, soil quality and production potential of kikuyu–ryegrass pastures in South Africa. *Grass and Forage Science* doi:10.1111/gfs.12241.

Target 10. 2005. Fertilising Dairy Pastures, 2nd edition. Department of Primary Industries, Melbourne.

Assessment of veld condition in the Komga rangeland of the Eastern Cape Province of South Africa

Vuyisa A. Hlatini[1], Keletso Mopipi[1] and Ayodele Odularu[2]

[1]Department of Livestock and Pasture Science, Private Mail Bag X1314, University of Fort Hare, Alice, South Africa.

[2]Department of Chemistry, Private Bag X1314, University of Fort Hare, Alice, South Africa.

**Corresponding author, e-mail: kmopipi@ufh.ac.za*

Introduction

The health status of communal rangeland is in such a poor condition that it cannot support sustainable livestock production. Rangelands in South Africa are in danger of becoming degraded which can result in low quality forage production due to improper management practices (stocking rate, rest periods and fire). They were not practised based on the recommended carrying capacities (Tainton 1999). Therefore, it is vital to managers and advisors to determine the state of health of veld because it helps to make maximum use of resources without harm to the resources (Tainton 1988). The rangelands of the Eastern Cape are mainly composed of native pastures which are grass, grass-like and woody plants (Trollope 1989). More than half of the region is covered by grassland but lately bush encroachment (*Vachelia karroo*, formerly known as *Acacia karroo* dominating) is increasing. These fodder plants are usually consumed by domestic and game animals (Abate et al. 2012). Determination of the correct stocking rate based on the current rangeland condition still remains a big challenge to communal rangeland and livestock managers. Rangelands occupy about 50% of the world's land area (Mannetje 2012). Most of rangelands are suitable for livestock production and game ranching but unsuitable for cropping or other land uses due to poor soil quality (González-Roglich et al. 2012). In South Africa, there are different types of vegetation which support different types of animals' production and farming practices. In the Eastern Cape Province, most of the rangeland is unsuitable for cropping. In addition, rangelands are the main source of feed for domestic and wild animals. Plant species composition is commonly used to determine the health status of the rangeland, and also assists in deciding the suitable management system for the piece of land. It also affects the intake of forage by livestock which influences the animal performance (van Pletzen 2009). This is important for the economic and social livelihoods if the local communities because it is a source of revenue. Therefore, there is a need for assessing rangelands to keep sustainableNguni cattle production, while maximizing production to provide food to people in developing countries such as South Africa (Maczko et al. 2011; Mannetje 2012). This study will contribute towards documenting the conditions of communal rangelands and advise farmers and public at large. Advice will be based on how to manage these rangelands to minimize range degradation, how to restore the disturbed grazing lands and to have a productive and sustainable livestock production system. The main objective of the study was to assess veld condition at Komga and make recommendations for sustainable livestock (Nguni Cattle) production. Specific objectives were: (1) to determine herbaceous species composition, biomass production and basal cover in Komga private farm, (2) to determine the soil nutrient status of Komga private farm, (3) to formulate recommendations on appropriate veldmanagement practices for the sustainability of the Nguni cattle project.

Assessment of communal rangeland condition, sampling and analyses

Communal rangelands are used as sole source of food for livestock by most communal farmers. Assessment of communal rangeland reveals that forage production is reduced due to a number of factors such as overgrazing, soil erosion and high bush density such that livestock production is affected negatively (Hoffman and Todd 2000; Lesoli 2008). Veld condition assessment has long been used to estimate the productivity and carrying capacity of veld types on the farm and the seasonal duration of the grazing. Du Toit (2010) reported that veld condition assessments can also be used to assess the impact of past management practices on the veld. Assessment of communal rangeland condition was conducted at Komga. The levels of essential micronutrients at Komga rangeland were adequate for plant and animal production. Descriptive statistics was used to describe species composition. One-way descriptive statistics was used to describe species composition (Herbaceous and Woody vegetation). One-way ANOVA was also used with Generalized Linear Model (GLM) procedure to test homogeneous vegetation units (HVU) on dominant species. Least significant difference was used to compare the means.

Description of study area

The method for assessing rangeland condition was used where a 100 m x 50 m transect was laid out to determine species composition and soil sampling was done. Herbaceous species composition, basal cover and biomass production were estimated using the step point method, point-to-tuft distance and harvesting method. Woody species composition, density and tree equivalent were also estimated using a two meter rod. The grazing capacity and browsing capacity of the area were 8 ha/animal unit and 0.7 ha/small stock unit. The assessment is done to measure the spatial and temporal changes in the vegetation for both short and long-term productivity. This is important for the economic and social livelihoods because it is a source of revenue.

Results

The abundances of herbaceous species and woody species were significantly different between the four HVU with ($P > 0.05$) a total of 25 grass species identified in the Komga rangelands together with sedges and forb species. The biomass production was not significantly different ($P > 0.05$) between the HVU in the Komga farm. There was no significant difference in basal cover be-

tween the four HVU (P > 0.05). The following grass species were dominant in the four HVU's, namely; *Cymbopogon excavutus*, *Cymbopogon validus*, *Eragrostis plana*, *Eragrostis chloromerus*, *Themeda triandra* and *Sporobolus africanus*. A variety of species were recorded of which 19 were long lived perennial grasses, 2 weak perennial grasses, 3 creeping grasses and 1 annual grass species. A total of 22 woody species were identified in the study areas, of which fourteen of them were acceptable and eight were unacceptable to browsing. Five woody species were dominating in the Komga rangelands namely; *Vachellia karroo*, *Mytenus senegalensis*, *Coddia rudis*, *Lantana camaraand Lippia javannica*.

Soil pH

Soil pH ranged between 4.8 to 5.1. The pH of the study area is not the recommended pH for good forage growth because plants favour a pH of about 6.5. The results of the study showed that all the assessed HVU were associated with soils with adequate potassium (K) concentrations. Soil extractable K concentration less than 60 mg/kg are below the critical level. Using this as criterion, all HVU had a concentration that was higher than critical value and is adequate for normal plant growth. Soil phosphorus (P) was high in old cultivated lands, but grass-bush and mixed bush had a similar concentration. This could be due to excessive use of in-organic fertilizer and/or manure in the old lands before converted to grazing land.The mean available P was 15.2 mg/kg. The HVU had no significant effect on the concentration levels of both micronutrients (Fe, Mn, Zn and Cu) and macronutrients (P, K and Organic C). According to the analysed results micronutrients (Mn, Zn, Fe & Cu), the concentrations were high in old lands. This could be due to pH level in this HVU. In support of the results Miller and Hills (2006) reported that the availability of the nutrients was influenced by soil pH and plant production depends on these nutrients.

Conclusion and recommendation

Rangeland deterioration was observed from this study, therefore, proper management is required. The formulation of the carrying capacity should be based on the grazing capacity and browsing capacity. The abundance of bushes can be controlled by stocking with browsers such as goats and later burning can be applied to control bush encroachment. Veld burnings in Komga rangelands can be done after resting when there is enough fuel loads to support the fire.

References

Abate T, Ebro A, Nigatu L. 2012. Evaluation of rangeland in arid and semi-arid grazing land of South East Ethiopia. *Journal of Agricultural Sciences* 2(7): 221-234.

Du Toit PF, Aucamp AJ. 2010. Effect of continuous grazing in the Dohnesourveld on species composition & basal cover. *Journal of the Grassland Society of Southern Africa* 2(4): 41-45.

González-Roglich M, Southworth S, Branch LC. 2012. The role of private lands for conservation: Land cover change analysis in the Caldenal Savanna Ecosystem. *Applied Geography* 34(2012): 281-288.

Hoffman MT, Todd S. 2000. A national review of land degradation in South Africa: The influence of biophysical and socio economic factors. *Journal of Southern African Studies* 26(4): 743-758.

Lesoli MS. 2008. Vegetation and soil status, and human perceptions on the condition of communal rangelands of the Eastern Cape, South Africa. MSc Dissertation. University of Fort Hare, Private Box X1314, Alice 5700, p104.

Maczko K, Tanaka JA, Breckenridge R, Hidinger L, Heintz TH, Fox WE, Kreuter UP, Duke CS, Mitchell JE, Mc Collum DW. 2011. Rangeland ecosystem goods and services: values and land managers. *Society for range management* 33(5): 1-7.

Mannetje L. 2012. Global issues of rangeland management. Department of plant sciences, Wageningen University, pp. 1-8.

Rust JM, Rust T. 2013. Climate change and livestock production: A review with emphasis on Africa. *South African Journal of Animal Science* 43(3): 1-13.

Tainton NM. 1988. A consideration of veld condition assessment techniques for commercial livestock production in South Africa, *Journal of the Grassland Society of Southern Africa* 5(2): 76-79.

Tainton NM. 1999. Veld condition assessment: Veld Management in South Africa. University of Natal Press, Pietermaritzburg, South Africa.

Trollope WSW, Potgieter ALF, Zambatis N. 1989. Assessing veld condition in the Kruger national park using key grass species. *Koedoe* 32(1): 67-93.

Van Pletzen H. 2009. Beef production from the veld offers great opportunity. Voermol Product Guide.

Impact of using browsing and fire on species composition in the Coastal Thornveld of the Eastern Cape

Simphiwe Nobatyi[1], Keletso Mopipi[1] and Ayodele Odularu[2]

[1]Department of Livestock and Pasture Science, Private Mail Bag X1314, University of Fort Hare, Alice, South Africa.

[2]Department of Chemistry, Private Bag X1314, University of Fort Hare, Alice, South Africa.

**Corresponding author, email: kmopipi@ufh.ac.za*

Abstract

The challenges of bush encroachment would warrant seeking for potential preventive measures. The research involved using a biological disturbance (browsing) and a physical disturbance (fire) to control bush encroachment. Goats were used to browse the veld, whilst fire was used to burn it during summer and winter. The experimental design included six treatments: (goat and summer-fire, goat and winter-fire, summer-fire, winter-fire and a control) which were replicated twice in a complete randomized design. The step-point method was used to monitor the response of herbaceous plants to the treatments, while changes in woody plants were observed along two fixed 30 m long chains. The collected data were analysed using a two-way analysis of variance (ANOVA). Results revealed a significant increase in herbage production with the browsing and winter-fire treatment. It also showed that both browsing and fire reduced the growth and densities of the woody species even when acceptable species were extremely prevailing.

Keywords: Biological disturbance, physical disturbance, herbaceous and woody plants

Introduction

The problem of bush encroachment had been in existence in the grassland areas of the Eastern Cape and the world as a whole (Anteneh and Zewdu 2017). Chemical, mechanical and biological (fire and animals such as goats) controls can be used to control bush encroachment. One of the ways to control bush encroachment is disturbance. Disturbances are processes that modify ecosystems (Fischer et al. 2013). These disturbances can either be biological or physical (Svensson et al. 2013). Examples of biological disturbances are animal activities such as beavers' water management, herbivores browsing, insect outbreaks and wild boar's soil digging, while examples of physical disturbances are snow avalanches, snow outbreaks, storms, wind and fire (Fischer et al. 2013). Both disturbances have roles they play in species composition (Svensson et al. 2013). Browsing influences land use, the composition of ecosystems, as well as, the quality and quantity of species composition (Fischer et al. 2013). There are very little known about the impact of fire on species composition (herbaceous and woody) in the Coastal Thornveld savannahs in comparison with the well-studied inland savannahs (Kraaij et al. 2013). This might be due to differences in atmospheric conditions with particular reference to gale force winds that are prevalent in the coastal areas (Sheuyange et al. 2005). The major role of fire was to maintain bush at an appropriate height and acceptable state for the wild browsing species (Urs 1999). Bush encroachment is recognized as the major factor that causes reduction in animal production from grasslands and savannah regions worldwide (Kgosikoma et al. 2013). The study aimed at using browsing and fire as tools to control bush encroachment. The objectives were to determine the effect that browsing and fire had on species composition and to determine a suitable burning season (winter and/or dry summer). Findings of this study will assist in recommending economically viable means of suppressing woody species proliferation.

Materials and methods

Study site

Bathurst experimental farm is a governmental satellite research farm in Bathurst town which is located on the edge of the coastal plateau. It is approximately 18 km from the Indian Ocean coastline of Port Alfred (Raper 1989) and lies at an altitude of 122 km. Bathurst experimental farm can be divided into two broad vegetation types, which are Kowie Thicket and Albany Coastal Belt (Mucina et al. 2011). Kowie Thicket vegetation is characterized by closed canopy thickets dominated by evergreen trees and shrubs, woody lianas, and shrubby succulents with a poorly developed herbaceous layer (Puttick et al. 2011). In contrast, Albany Coastal Belt is savannah-type vegetation with short grasslands punctuated by bush clumps and *Acacia karroo* trees (Puttick et al. 2011). Albany Coastal Belt vegetation is mainly a result of cleared thicket for pasture establishments and is predominantly on the flatter central plateau areas of the farm. Kowie Thicket occurs mainly on slopes running off the plateau (Mucina et al. 2011). The woody component on the site was rolled by a Bosvark machine during the year 2000 and all the bush debris was left behind. The study site is characterised by a mild subtropical climate with mean minimum and maximum temperatures of 17 °C and 26 °C during summer and 10 °C and 21 °C during the frost-free winter. It receives a mean annual rainfall of approximately 720 mm (Henning et al. 1995). Most of the rainfall occurs during spring and autumn; whilst the summer periods are especially dry (Henning et al. 2006).

Experimental layout and treatments

This study was conducted on an ongoing long-term research trial on the Bathurst experimental farm as shown in Figure 1. The experimental design was a complete randomised design with six treatments and two replicates (Baldanzi et al. 2011). Therefore, the experimental site consisted of twelve field plots of 60 m by 30 m. The plots were separated by a goat-proof fence tied to a barbed wire fence of 1.4 m high.

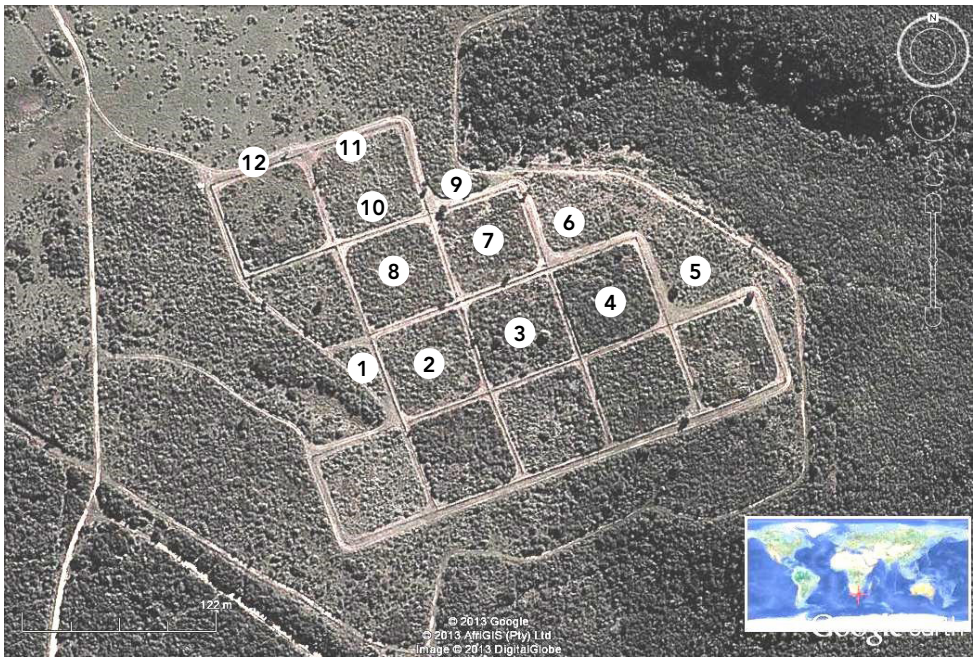


Figure 1: Satellite image of bush control trial at Bathurst experimental farm.

Table 1: Treatments applied in the experiment.

Treatments	Name of treatment	Field plot number	Field plot number
1	Control (Con)	2	6
2	Goats (G)	7	12
3	Goats and Summer-Fire (GSF)	5	8
4	Goats and Winter-Fire (GWF)	1	11
5	Summer-Fire (SF)	3	9
6	Winter-Fire (WF)	4	10

Control treatment

Two plots were left intact for the duration of the experiment to represent the trends of the natural environment (Massada et al. 2008).

Goat treatment

In the experiment goats were rotated between goat plots (1, 5, 7, 8, 11 and 12) to simulate an ever-present browsing situation in the practical farming environment. Goats were moved from one plot to another whenever the available browse was depleted to a level that caused goats to do more than sufficient browse.

Goats and summer-fire treatment/ Goats and winter-fire treatment

For these treatments, goats were used to first browse the plots to allow for the accumulation of grass species. It was then followed by burnt with head fire during the mid-summer drought (goat summer-fire treatment) or the conventional (winter) burning season (goat and winter-fire treatment) (Van Wilgen et al. 1990) A hot fire from at least 2500 kg/ha of grass fuel was also used to control bush species.

Fire during dry-summer and dormant winter periods

Fire treatments were used as head fires during the mid-summer drought and were the purpose for this study referred to as Summer-Fire. Another fire was used during the conventional burning season and was referred to as Winter-Fire (Ansley et al. 2010). A disc pasture meter was used to estimate the standing biomass of the grass sward (Little et al. 2015). The fires were applied once in two years to allow a minimal pressure or damage on the grass sward (Kirkpatrick et al. 2016). It also depended on whether there was enough grass fuel after each burn to support a hot fire for the subsequent burn (Davies et al. 2015).

Data collection

Two fixed belt transects of 30 m long were randomly placed in the trial where changes in the herbaceous and woody species were recorded at each field plot during data collection. The response from herbaceous species to treatments was explained using composition and biomass production, while response from woody species to the treatments was explained using the analysis of variance (ANOVA) on the variables measured (tree equivalents, browse units and density).

Botanical composition of herbaceous species

The step-point method was used to determine botanical composition (Beyene et al. 2012). It was done by inserting a rod every second step along the transect within the plot in the ground. The herbaceous species (grasses, forbs/sedges) stuck by the rod was recorded in the data sheet (Beyene et al. 2012). In the event where the rod struck a bare area, the nearest living herbaceous species to the rod was recorded. Botanical composition was expressed as the percentage frequency of the herbaceous species (Njau et al. 2016).

Basal cover

Percentage basal cover was also determined using the step-point method. It was calculated from the number of strikes with plant cover in relation to the total number of strikes recorded (Du Toit et al. 2011).

Botanical composition of woody species

Woody species were monitored along two fixed 30 m long chains (Okiror et al. 2012). A 3 m long rod was moved down the chain at its centre at an angle of 90°. Every woody plant within the breadth of 3 m along the chain was recorded in terms of species, lowest biomass browsing material, canopy height and canopy diameter. They were also classified as palatable or non-palatable. The recorded data provided an estimate of tree equivalents per hectare (TE/ha), number of woody plants per hectare (P/ha) and browsing units per hectare (BU/ha).

Statistical analysis of collected data

Two-way analysis of variance (ANOVA) and repeated measures of analysis at a significance level of 5% (0.05) were performed using the Generalised Linear Models (GLM) function in SAS (Van Coller et al. 2013). Mean separation was tested using the Least-Square Means (LSM) procedure in statistics.

Results and discussion

Composition of herbaceous species

Ten grass species of various forbs and sedges were grouped together and recorded to determine their relative abundances.

Effect of treatments on dominant herbaceous species overtime

Six herbaceous species identified as dominant within all treatments were *Cynodon dactylon*, *Digitaria eriantha*, *Eragrostis curvula*, forbs/sedges, *Panicum maximum* and *Sporobolus africanus*. The abundance of these species was compared within treatments, as well as between treatments overtime. No significant difference was observed between treatments overtime, but *Cynodon dactylon* and forbs differed significantly ($P<0.05$) between 2003 and 2010 in the control, goats, goat and summer-fire, goat and winter-fire treatments. Species of *C.Dactylon* showed a general increasing trend over the trial period.

Botanical composition of woody species overtime

7 had relatively high percentages of abundances within all the treatments, namely; *Acacia karroo*, *Diospyros lycioides*, *Lantana camara*, *Lippiajavanica, Rhus undulata*, *Scutia myrtina* and *Trimeria trinervis*. No significant difference ($P>0.05$) was observed in all selected dominant species even though they were subjected to different treatments over a period of time.

Conclusion and recommendation

Conversely, highly palatable species are most frequently recorded in grazing areas. The treatments applied showed no effect over time on the overall selected dominant herbaceous and woody species. In conclusion, study revealed that, goats are to be coupled with occasional use of fire, especially, during the mid-winter and post periods for herbage production.

Goats are good browsers because they can adapt to all weather conditions. Browsers and occasional fire are recommended to farmers to improve their pastures for cost effective livestock ranching.

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Conflict of interest

The authors declare no conflict of interest.

References

Ansley AR, Boutton TW, Mirik M, Castellano MJ, Kramp, BA. 2010. Restoration of C_4 grasses with seasonal fires in C_3/C_4 grassland. *Applied Vegetation Science* 13: 520-530.

Anteneh B, Zewdu KT. 2017. Mechanisms of bush encroachment and its inter-connection with rangeland degradation in semi-arid African ecosystems: A review. *Journal of Arid Land* 9: 299-312.

Augustine, DJ, Milchunas DG. 2009. Vegetation responses to prescribed burning of grazed short grass steppe. *Rangeland Ecology Management* 62: 89-97.

Baldanzi M, Andreotti L, Macchia M, Secchiari P. 2011. Bulk method selection with grazing treatments on segregating populations from *Avena sativa x A. sterilis* hybrids. *Euphytica* 182: 405-408.

Beyene ST, Mlambo V. 2012. Botanical and chemical composition of common grass species around dip-tank areas in semi arid communal rangelands of Swaziland. *Tropical and Subtropical Agro ecosystems* 15: 143-152.

Burkepile DE, Burns CE, Tambling CE, Mendola EA, Buis GM, Govender N, Nelson V, Thompson DI, Zinn DI, Smith MD. 2013. Habitat selection by large herbivores in a southern Africa savanna: the relative roles of bottom-up and top-down forces. *Ecosphere* 4: 1-19.

Cruzan MB, Weinstein BG, Grasty MR, Kohrn BF, Hendrickson EC, Arredondo TM, Thompson PG. 2016. Small unmanned aerial vehicles (micro-UAVs, drones) in plant ecology). *Applications in Plant Sciences* 4: 1-11.

Davies KW, Boyd CS, Bate JD, Hulet A. 2015. Winter grazing can reduce wildlife size, intensity and behaviour in a shrub grassland. *International Journal of Wildland Fire* 25: 191-199.

Du Toit G, Snyman HA, Malan PJ. 2011. Physical impact of sheep grazing on arid Karoo subshrub/grass rangeland, South Africa. S*outh African Journal of Animal Science* 41: 280-287.

Fischer A, Marshall P, Camp A.O. 2013. Disturbances in deciduous temperate forest ecosystems of the northern hemisphere: their effects on both recent and future forest development. *Biodiversity and Conservation* 22: 1863-1893.

Grant RCC, Peel MJS, Bezuidenhout H. 2011. 'Evaluating herbivore management outcomes and associated vegetation impacts' *Koedoe* 53: 1-15.

Henning WP, Barnard HH, Venter JJ. 1995. Effect of grazing cycle on milk production. *South African Journal of Animal Science* 25: 7-12.

Kgosikoma OE, Mogotsi K. 2013. Understanding the causes of bush encroachment in Africa: The key to effective management of savanna grasslands. *Tropical Grasslands* 1: 215-219.

Kirkpatrick JB, Marsden-Smedley, JB, Folco MD, Leonard SWJ. 2016. Influence of grazing and vegetation type on post-fire floristic and lifeform composition in Tasmania, Australia. *Plant Ecology* 217: 57-69.

Kraaij T, Cowling RM, van Wilgen BW. 2013. 'Fire regimes in Eastern Coastal Fynbos: Imperatives and thresholds in managing for diversity". *Koedoe* 55: 1-9.

Little IT, Hockey PAR, Jansen R. 2015. Impact of fire and grazing management on South Africa's moist highland grasslands: A case study of the Steenkampsberg Plateau, Mpumalanga, South Africa. *Bothalia-African Biodiversity & Conservation* 45: 1-15.

Massada AV, Gabay O, Perevolotsky A, Carmel Y. 2008. Quantifying the effect of grazing and shrub-clearing on small scale spatial pattern of vegetation. *Landscape Ecology* 23: 327-339.

Mucina L, Rutherford MC. (eds) 2011. *The Vegetation of South Africa, Lesotho and Swaziland*. *Strelitzia* 19. South African National Botanical Institute, Pretoria, South Africa. ISBN 978-1919976-21-1.

Mudzengi CP, Kativu S, Murungweni C, Dahwa, Poshiwa X, Shoko MD. 2013. Woody species composition and structure in a semi-arid environment invaded by *Dichrostachys Cinerea* (l.) Wight & Arn (Fabaceae). *International Journal of Scientific and Research Publication* 3: 1-10.

Njau FBC, Lwelamira J, Hyandye C. 2016. Ruminant livestock production and quality of pastures in the communal grazing land of semi-arid central Tanzania. *Livestock Research for Rural Development*.

Nyamukanza CC, Scogings PF. 2008. Sprout selection and performance of goats fed *Acacia karroo* coppices in the false thornveld of the Eastern Cape, South Africa. *South African Journal of Animal Science* 38: 83-90.

Okiror P, Chono J, Nyamukuru V, Lwanga J S, Sasira P, Diogo P. 2012. Variation in woody species abundance and distribution in and around Kibale, National Park, Uganda. *International Scientific Research Notices Forestry* 2012: 1-9.

Puttick JR, Hoffman MT, Gambiza J. 2011. Historical and recent land-use impacts on the vegetation of Bathurst, a municipal commonage in the Eastern Cape, South Africa. *African Journal of Range and Forage Science* 28: 9-20.

Raper PE. 1989. Dictionary of Southern African Place Names. *Jonathan Ball Publishers* 71. ISBN 978-0-947464-04-2.

Redjadj C, Duparc A, Lavorel S, Grigulis K, Bonenfant C, Maillard D, Saïd S, Loison A. 2012. Estimating herbaceous plant biomass in mountain grasslands: a comparative study using three different methods. *Alp Botany* 122: 57-63.

Sah JP, Ross MS, Snyder JR, Koptur S, Cooley HC. 2006. Fuel loads, fire regimes and post-fire regimes, and post-fire fuel dynamics in Florida Keys pine forests. *International Journal of Wildland Fire* 15: 463-478.

Santos L, Capelo J, Tavares, M. 2010. Germination patterns of soil seed banks in relation to fire in Portuguese littoral pine forest vegetation. *Fire Ecology* 6: 1-15.

Sheuyange A, Oba G, Weladji RB. 2005. Effects of anthropogenic fire history on savanna vegetation in northeastern Namibia. *Journal of Environmental Management* 75: 189-198.

Svensson JR, Lindegarth M, Pavia H. 2010. Physical and biological disturbances interact differently: Effects on floral and faunal richness. *Ecology* 91: 3069-3080.

Urs B. 1999. Fire as a tool in the management of a savanna/dry forest reserve in Madagascar. *Applied Vegetation Science* 2: 117-124.

Van Coller H, Siebert F, Siebert SJ. 2013. Herbaceous species diversity patterns across various treatments of herbivory and fire along the sodic zone of the Nkulu enclosures, Kruger National Park. *Koedoe* 55: 1-6.

Van Wilgen BW, Everson CS. Trollope, WSW. 1990. Fire management in Southern Africa: Some examples of current objectives, practices, and problems. *Ecological Studies* 84: 179-215.

Wright IA, Jones JR, Davies DA, Davidson GR, Vale JE. 2006. The effect of sward surface height on the response to mixed grazing by cattle and sheep. *Animal Science* 82: 271-276.

Summary of GSSA Congress 52 at Wits Rural 23-28 July 2017

Rina Grant

Research Associate, Department of Zoology, Nelson Mandela University, PO Box 77000, Port Elizabeth 6031, South Africa.

The 52nd annual congress of the Grassland Society of Southern Africa (GSSA) was held at the Wits Rural facility near Hoedspruit. The venue proved to be very close to perfect for the occasion, with a lovely bonfire at night to keep the company going. This rendered ample opportunity to form new networks and to catch up with old friends. The congress itself was very informative and we thank the organisers for successful congress despite all the challenges they faced.

The congress reported on progress in many fields and discussed new challenges, especially social challenges that we will have to face in future.

Some of the highlights were:

New insights on the importance of heterogeneity in rangeland and the importance of social demands and pressures on rangelands.

Improved understanding of the underlying factors that determine co-existence of trees and grasses.

Interventions to improve rangeland condition have had mixed results, and new approaches using the bush economically while restoring our rangelands were explored.

The importance of a social-ecological approach to tackling challenges in communal lands was emphasized, making use of participating research methods. An important new revitalised topic was the consequence of land transformation especially in the communal areas and the need for and approaches toward restoration and production.

Planted pasture management and production was not neglected in any way, and the need for a better understanding of legume establishment and survival of mixed pastures was emphasized.

Many post-grad students keen on rangeland science presented their work enthusiastically. That is the best news we can want for the future of our society. Let us build on this strength and take rangeland science and management forward into the future.

Plenary session

Heterogeneity as a basis for herbivore management

This presentation emphasised that we should start thinking about changing towards a paradigm that acknowledges the importance of heterogeneity. This will enable us to support our production needs and also embrace the increasing emphasis on biodiversity.

To incorporate the heterogeneity paradigm, we need to change our thinking from the traditional range management approach to a new paradigm of managing towards heterogeneity.

	from →	to
Goal	Traditional range management	Heterogeneity paradigm management
Outcome	Single use	Biodiversity
Distribution of animals	Even	Uneven
Ungrazed	Minimal	Substantial
Severely grazed	Minimal	Substantial
Rate of rotation	Fast	Slow
Fire application	Uniform	Patches
Use fire	Bush control	Critical for multiple biological processes

The principles of rangeland management involve the following:

1. Stocking rates: acknowledge the consequences of too many animals in too small areas with no options for alternative resources for the stock.
2. Classes of animals: making sure we have appropriate animals for the specific environment and production systems.
3. Utilization over space and time: addressing the challenges it brings to animal welfare and production.

We acknowledge that we need to change some of our outlooks to address these future challenges.

Sam Fuhlendorf suggested that we live in a state akin to phantasmagoria with a shifting series and succession of events and images, and we need to adapt our thought processes accordingly.

Biodiversity for society

Louise Swemmer emphasized that in the "biodiversity for society" approach we must acknowledge that benefits are perception based, with the benefits to one group often being a cost to another. If we can't solve these social issues we will not progress.

Rangeland ecology

Vegetation composition is constantly changing and we still don't fully understand rangeland dynamics although our knowledge has improved. Land tenure, farming systems and climate determine the extent of change in rangeland in complex ways. Therefore, active interventions to improve rangeland condition have mixed results.

We must acknowledge that land management interventions do not only change vegetation parameters but also hydrological factors.

Even though vegetation resilience is still high, land use impacts do not always override the impacts of climate on vegetation change.

Rangeland management

Human behaviour (and decisions) is the ultimate driver of ecosystems. Importantly, humans determine where and when fires burn as well as the density and distribution of herbivores. We must also acknowledge the importance of social factors that determine when and how fire is used, and legal liabilities are often not actually the reason that managers don't burn where fire is needed.

Apart from the important role of fire as a driver of rangelands, we must acknowledge the important role that herbivores play in creating heterogeneity and changing and maintaining the vegetation state under open and fenced-off management systems.

Tree-grass interactions: Consequences and control of bush densification

Overall this session focused on underlying factors driving the spread of woody plant species into what used to be pure grasslands. Underlying factors improving our understanding of the coexistence of trees and grasses will not only improve our theoretical insight but also the practical implications to enable us to drive the rangeland from woody dominated to grass dominated. Complex interactions of environmental (abiotic and biotic) factors are responsible for the spread of woody species and unpalatable shrubs such as *Seriphium plumosum* (Slangbos) into the grassland biome. We must recognise that active interventions to improve rangeland condition have mixed results. Control of woody densification is costly and we should consider how we can utilize harvested woody vegetation economically, but also achieve our restoration goals.

Rangeland assessment and monitoring

It is easy to degrade savannas, and competition between neighbouring plants is an important factor to consider. Although savannas can be harvested for feed, we also should ensure that all big trees remain to maintain the structure and competition that they provide.

Developing an effective biodiversity indicator is very important but it is not simple and more work needs to be done to find a practical way to assess biodiversity outcomes.

Rangeland Fire ecology

This session provided insight into the practical management of applying fire in protected areas. Fire may be used in conjunction with other control mechanisms, to control the resprouting and resultant densification of woody plant species.

Changes in plant distributions, such as the distribution of C3 and C4 plant species introduce substantially different fuel types that can alter the intensity, frequency, seasonality, or spatial extent of fire, with potential impacts on community succession and biodiversity. For example, high moisture fuels may introduce more variability within a burn patch. This information can be used to identify thresholds for fire impacts such as in the Renosterveld.

An interesting presentation was given on subterranean fires in peatlands, with important consideration for wetlands in South Africa. The interaction of land use change and climate change create novel situations for species and processes such as fire. For instance, the unprecedented fires in Knysna in June may have been started by a lightning strike in peatlands in April. The altered land uses and extreme events associated with El Nino set the scene for the most devastating fire in the history of South Africa. Leading to the loss of over 800 formal structures at R5.5 billion claims in insurance. The peatland fires in Indonesia in 2015/2016 resulted in a carbon release that is estimated to be more than the combined carbon outlet for all of Europe since industrialised times.

Attempts to control bush encroachment and undesirable resprouting of plant species using traditional dual-treatment combinations of prescribed fire and mechanical-chemical treatments is not a restoration panacea. Other novel methods of intervention are also needed that may prove ecologically useful and economically pragmatic in addressing problematic resprouting woody plants and restoring degraded savanna ecosystems. The need for new approaches is exacerbated by changing climates and landuse which are creating novel situations with which we often battle to deal.

Biodiversity initiatives and conservation planning.

Habitat loss and climate change are driving biodiversity loss globally, and different protected areas are important to maintain landscape connectivity through strategically planned corridors. Various provinces are also looking at expanding the number of hectares of land under formal protection through Biodiversity Stewardship and we need to work together for maximum effect. However, trade-offs can cause wins for some and losses for others.

The agricultural carbon tax is scheduled to be implemented in South Africa by the end of 2020.

Carbon offset strategies include no or minimum tillage practices, veld or pasture biomass and ecosystem protection, planting of trees and shrubs, and precision farming (for fertilization and animal feed). However, the projected effect of e.g. carbon tax can also be solved by farmers planting alien plantation trees, with the resultant biodiversity loss.

Planted pastures management and production

Despite the progress we have made with planted pasture research, we still require a better understanding of legume establishment and survival of mixed pastures, as well as nitrogen dynamics in mixed pastures. More information is also still needed on approaches to the reduction of nitrogen inputs on pastures while retaining productivity.

Weed control can be implemented using mixed forage crops, especially during the establishment phase of fodder

crops. These forage crops are useful cover crops in weed control. Forages with more canopy development being more effective in reducing weed growth than upright forages.

Fodder innovations in communal areas are important, but all stakeholders must be included in the planning stage. Fodder production in communal areas has the potential to raise family incomes and to improve livestock nutrition. Especially in communal rangelands, season greatly influences the production and quality of the forage.

Unfortunately, the quality of applied pasture research is declining due to the use of "easy" data without the necessary scientific rigor and understanding.

Livestock diet and nutrition

Strategies and technologies for optimum utilization of feed and forage is important, and animals should be managed to address challenges of low quality and quantity. The value chain should be looked at holistically and marketing options and costs of feeding animals in the communal areas should be considered. It is important to use appropriate animals for the environment, and to further adapt our management as required.

Land transformation and restoration

Unreliable rainfall and high frequency of drought have resulted in many farmers abandoning crop farming, resulting their dependence on livestock increasing. This has created large areas of previously cultivated lands, which are now used for livestock grazing along with undisturbed veld. Many of these areas are degraded by overutilization.

The most immediately valuable aspect of addressing concerns around such degradation is educational. Participants start to appreciate the value of soil stabilisation, the potential nutritive contribution of appropriate restoration forages and the value of seasonal use of rangeland. Successfull restoration is possible but it is should start at small scales with available resources, and involve the community.

Communal livestock farming systems

A social-ecological approach is important when tackling challenges in communal lands. The use of participating research methods that acknowledge local values, perceptions, experiences, knowledge and aspirations is very important.

Various challenges were identified:
1. Environmental change
2. Social: Crime, lack of interest from the youth
3. Economic: access to markets and information
4. Governance and support: very stretched or no extension services, poor maintenance and infrastructure

We need to recognise more fully that communal farmers are not ignorant, helpless victims of the challenges they face. To help them increase their adaptive capacity and livelihood sustainability, we need to work with them, building on their existing knowledge, adaptation strategies and capital.

Take home messages from the congress

We must recognise that social benefits are often perception based, and that the benefit to one group may be a cost to another group.

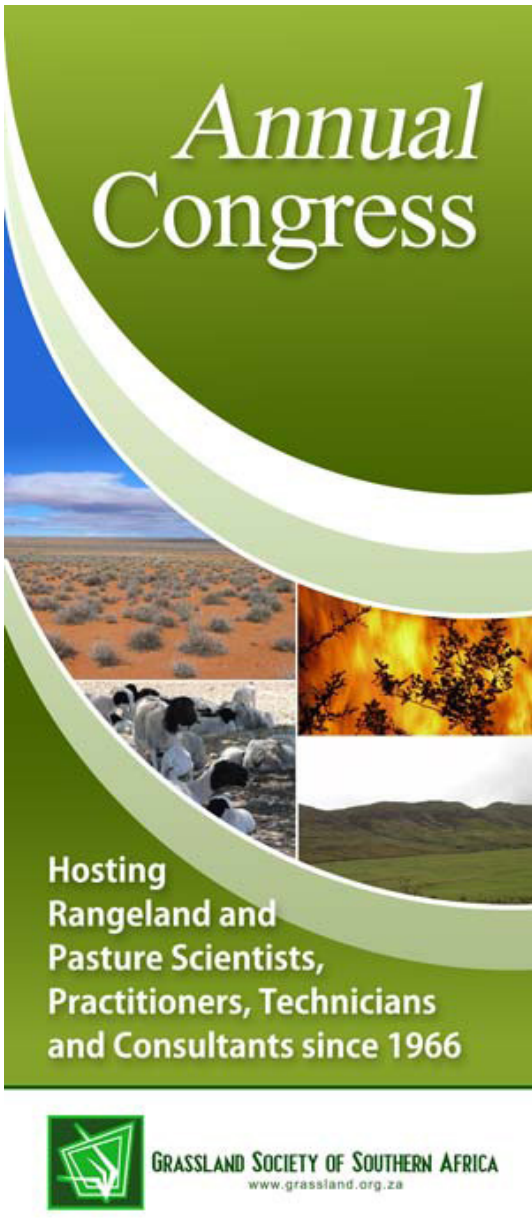
We urgently need to address multiple sociological issues to ensure the sustainability of the diversity and production of our rangelands for wider human benefits.

We live in a changing environment, with many shifts in established patterns. We need to acknowledge and be aware of these changes, and adapt our thought processes and management approaches taking these new and changing paradigms into account.

Participation of post-grad students presenting their work was encouraging. We had some outstanding presentations, but in some cases, it was obvious that the supervisors were not giving their students support. We would like to encourage all our supervisors to attend the congress with their students and to support them with the preparation of their contributions.

Acknowledgements

Thanks to all the session chairs who provided me with a summary of their sessions.



Invasive Alien Plant control and Biomonitoring: ecosystem restoration and custodianship from grasslands to rivers

Reuben Thifhulufhelwi[1]*, Jan Graf [1]*, Thabo Mohlala[1], and Silindile Mtshali[1]
[1] Association for Water and Rural Development (AWARD),
P.O. Box 1919, Hoedspruit, 1380, South Africa; www.award.org.za
* Corresponding author's email: jan@award.org.za | reuben@award.org.za

Overview of the restoration and biomonitoring GSSA 2017 tour

On the 27th July delegates from the 2017 GSSA annual symposium held at Wits Rural Facility joined a field tour to the Blyde and Klaserie Catchments. The objective of the tour was to highlight the restoration and biomonitoring work carried out in these catchments supported by AWARD through the USAID funded RESILIM-O programme, and the linkages between grassland degradation (and restoration) and river health (and monitoring). The tour was also aimed at stimulating discussions amongst congress delegates on the need for development of restoration techniques and local custodianship processes for grassland and aquatic ecosystems affected by plantation forestry and IAP invasion.

Background and overview of the Blyde area

IAPs are major drivers of global change, contributing to ecosystem degradation and biodiversity loss in grasslands worldwide, and with also significant impacts on aquatic ecosystems. At the local scale, both the upper Blyde and adjoining Klaserie catchments are of national significance, renowned for their biodiversity and strategic watersheds. However, many ecosystems in these catchments are affected by IAPs, which negatively impacts on both the biodiversity and the water based ecosystem services emanating from these ecosystems. Although partially protected through the Blyde River Canyon Nature Reserve along with a few smaller nature reserves, a large proportion of these catchments have been transformed through plantation forestry, utilizing alien plant species such as pine, eucalyptus and wattle (see figure1).

These plantations have functioned as seed sources for extensive invasions by the same species in untransformed or "natural" areas of the catchments, especially grasslands and riparian areas, including areas within the above protected areas. Approximately 30% of the grasslands have been permanently transformed by plantation forestry in these catchments, with an equivalent amount invaded by IAPs. The different grassland and riparian ecosystems involved are all nationally classified as Threatened Ecosystems under NEMBA, as a result of the above. At the same time water quantity and quality has also been negatively affected in the rivers and streams by these plantations and IAPs.

Historical and current restoration and invasive alien plant management

The first interventions to address the growing threats posed by IAPs in the Blyde and Klaserie catchments were initiated in the early 1990s, following the emergence of widespread evidence of the impacts of IAPs on water and grassland biodiversity during the preceding decades. This culminated in a major restoration effort by government's Working for Water (WfW) under the collaborative Save-the-Sand project (1999-2004) between WfW, AWARD, and other partners. The restoration effort continued expanding over the years, with several IAP control programmes under the Department of Environmental Affairs, commonly referred to as the Natural Resource Management Programmes (NRMPs) or "Working for" programmes[1].

The Blyde Restoration project

Through the USAID funded RESILIM-O programme[2], AWARD initiated the Blyde Restoration project in 2014, as a collaborative process with NRMP practitioners and other land managers in order to collectively address the IAP control and restoration challenges faced in the upper Blyde and Klaserie catchments. The main objective of this collaborative project is to support the restoration of degraded ecosystems, and the maintenance of these and adjoining healthy ecosystems, in order to sustain biodiversity and ecosystem services in this area in the long term. A key focus has been on the development of collective action amongst ecosystem restoration practitioners involved in restoration.

Building Custodianship through aquatic biomonitoring

Also through the USAID funded RESILIM-O programme, AWARD, in collaboration with the Department of Water and Sanitation is working with Private nature reserves in the Lowveld to build custodianship of reserve managers in monitoring their water resources. The objective is thus to strengthen a stewardship orientation to water resources management with landowners in protected areas in the lower Olifants River Catchment (including the Blyde and Klaserie rivers) through biomonitoring.

Reflections from the field tour

Two sites were visited during the tour (see Figure 1), with the 1st site at the Klaserie River focussed on biomonitoring, and the 2nd site on top of Mariepskop Mountain on restoration. Thabo Mohlala from AWARD introduced the work on river biomonitoring and custodianship to the delegates and gave a demonstration of the biomonitoring technique used. At the top of Mariepskop delegates were able to view the spectacular Drakensberg escarpment and the Blyde River Canyon, while Jan Graf, also from AWARD, gave an overview of the RESILIM-O programme and the restoration work.

The delegates, including practitioners and academics from different sectors, actively engaged in the field tour with various questions and comments on the work presented. During the biomonitoring discussion delegates specifically asked about the role that the Klaserie River played in the larger Olifants system, and Thabo noted the good quality of the water and the refuge role which the Klaserie plays for a number of aquatic species. Further questions focussed on AWARD's further work in relation to water resources management in the Olifants Catchment, with Thabo noting the support provided to, and the collaboration with, key partners such as SANParks and the Department of Water and Sanitation through sister projects under the RESILIM-O programme. During the restoration discussion the size of the restoration challenge was noted specifically by several delegates, and suggestions for potential ways of addressing this, such as utilization and value-adding, were made. Further discussions focussed on the importance of participation in restoration processes by all stakeholders, from practitioners, researchers, land owners and local land users.

Although the tour was not an in-depth learning event, the delegates appreciated the exposure to a new area and context in terms of natural resource management, and the challenges experienced locally and efforts made to address these. Delegates also noted the exceptional natural beauty and uniqueness of the area.

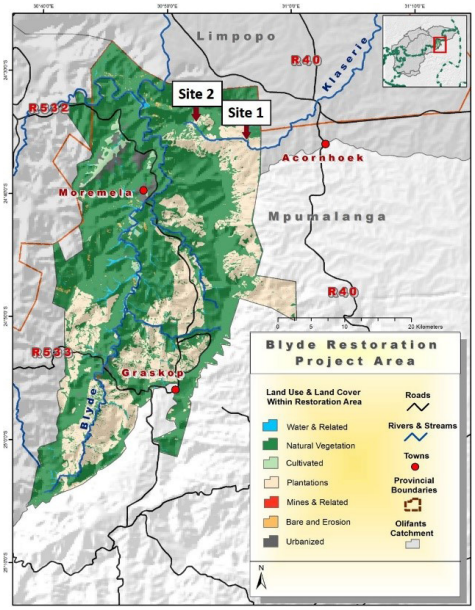


Figure 1: Map of the Blyde Restoration project area, showing the location of the Blyde and Klaserie Rivers and the two sites visited during the tour

Figure 2: Thabo Mohlala from AWARD introducing the river biomonitoring and custodianship work to GSSA participants during the tour, along with a demonstration of the SASS5 tool at the Klaserie River (site 1)

Figure 3: Jan Graf from AWARD introducing the restoration work in the Blyde and Klaserie Catchments to GSSA participants on top of Mariepskop Mountain (A), with a view of the alien plant invasions on the northern slopes of Hebron Mountain adjacent to Mariepskop (B) (site 2)

Figure 4: Photo of pines invading grassland on top of Hebron Mountain in the Blyde Catchment

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[1]https://www.environment.gov.za/projectsprogrammes

[2]RESILIM-O: Resilience in the Limpopo River Basin - Olifant's Catchment, see www.award.org.za

Lowveld protected areas

Mike Peel and Tony Swemmer

The savannas of the Lowveld support a large wildlife industry that provides significant socio-economic benefits to the state, individual landowners and rural communities surrounding the protected areas. The Kruger to Canyons Biosphere initiative where the Congress was held includes one of the few remaining relatively intact African savanna systems and contains part of the iconic Kruger National Park (KNP), a large network of privately owned protected areas and a number of Provincial protected areas. To the east, there are a number of conservation initiatives in neighbouring Mozambique.

The model we looked at included the KNP represented by Richard Sowry section ranger at Kingfisherspruit, the private sector represented by the Warden of the Timbavati Private Nature Reserve Bryan Havemann, and the Provincial model, the Manyeleti Game Reserve managed by the Mpumalanga Parks Board.

There is obviously great and increasing interest in environmental change and the need to formulate adaptive and mitigating management policies and practices covering a number of themes. The various representatives shared with us the challenges and opportunities within the different institutions within which they work. The uncertain nature of the work was highlighted by the fact that the Manyeleti representative, Mark Bourne was unable to join us due to a sudden crisis within the reserve.

The afternoon highlighted a number of management issues including discussion around the thickening of the woody layer and the impact this has on the grass layer, fire management as well as impact of the provision artificial water points in protected areas. For example, the density of artificially provided water within a 10 km buffer in the KNP is roughly one water point per 51 000 ha versus the situation in the adjacent private protected areas where there is roughly one artificial water point per 730 ha. The implications of the latter for savanna function is considerable. As we stood within the epicentre of the current rhino-poaching scourge, the day ended, as it so often does nowadays with some lively yet distressing discussion around the relentless attack on one of our iconic African game species.

Mark Bourne and Jimmy Thanyani of Manyeleti Game Reserve are thanked for facilitating the field visit.

Figure 1: Around 35 people attended the field visit.

Wits Rural Facility

Wayne Twaine

Figure 1: Delegates from the GSSA52 congress visiting the ongoing research sites at the Wits Rural Facility

For the more energetic, the Wits Rural Facility mid-congress tour provided participants the opportunity to stretch their legs, visit various ecological experiments on the property, and even get close to a giraffe! Wayne Twine from Wits University led the tour, which was enjoyed by both young (Max and Jake Du Toit) and old (no names mentioned).

The first site visited was a tree seedling/fire experiment, where the survival and growth of planted savanna tree seedlings of various species and three different ages will be exposed to fire in 2020. Nicola Stevens (one of the co-PIs on the study) from Stellenbosch University gave an overview of the project. Project field assistant, Craddock Ntabini, was also on hand to answer questions. After a brief interlude for a giraffe photo-shoot, the group then visited a nearby coppice experiment in which felled *Dichrostachys cinerea* and *Terminalia sericea* trees are exposed to different coppice harvest treatments. Wayne described the study and led the group through the site to show examples of the different treatments. A short walk brought the group to the third experimental site, where University of Pretoria PhD student, Katherine Gordon, and her field assistant, Frank Nyathi, were waiting for the group. Katherine described her termite suppression experiment, which aims to quantify the contribution of termites to key ecological processes such as decomposition, bioturbation and net primary productivity. Her props included an informative poster and a large preserved termite queen! The group then moved on to the fourth experiment being conducted in collaboration with colleagues from the University of Georgia and Kansas State University. This study will investigate how various savanna tree and grass species differ in their responses to variation in timing, duration, and depth of soil moisture. Wayne described the project and explained the elaborate irrigation treatment layout in the site.

The group then walked back to the conference centre, and those who were interested drove to the final site on the other side of the property. There, Nicola Stevens and Sally Archibald (Wits) described their tree seedling herbivory study which is investigating the survival and growth of seedlings of various savanna tree species and ages in response to simulated browsing. Each site visited elicited interesting discussion and useful suggestions from the tour participants.

Dr Tony Swemmer

Dr Tony Swemmer is currently a research manager with the South African Environmental Observation Network (SAEON), responsible for long-term research on major environmental changes occurring the north-eastern part of the country. He has a long history in ecological research in grasslands and savannas, and has had a deep interest in nature conservation, and the application of science to conservation, throughout his career. After obtaining BSc Honours in Botany from the University of Cape Town, he ventured into the real world to work as a game guide, and a later an ecologist, at a private game reserve in the Lowveld. Thereafter he returned to UCT completing an MSc on grazing-lawn grasses in the Hluhluwe-Imfolozi Park (KwaZulu-Natal). He then obtained a PhD at Colorado State University in the USA, where his research focused on how dominant grass species of South Africa and the American prairies respond to the timing of rainfall, and how these responses are affected by grazing. While studying overseas, he was exposed to the value of large-scale, long-term studies, and realized the importance of multi-year and even multi-decadal studies for understanding how ecosystems work, and how they are likely to change in the future. Currently based in Phalaborwa, Tony has been the manager of the SAEON Ndlovu Node since 2007. His job combines both research and management. Together with SAEON scientists, technicians, assistants and students, he works on projects spanning a wide range of environmental research disciplines. He is currently involved in projects that include research on the demography of bush-encroaching trees and shrubs, the impact of elephants on tall tree populations, the sustainability of natural resource use in communal rangelands, the effects of climate change on montane grasslands, the rehabilitation of mine dumps within semi-arid savannas, and the ecology and hydrology of the rivers of the Lowveld.

Malissa Murphy

I grew up on a farm in the Wolmaransstad district of the Northwest province. This is where my love for nature and conservation first developed. I went on to study at the University of Pretoria and received degrees in BSc Earth Sciences and BSc(Hons) in Environmental Soil Science. I was then offered the opportunity to do a MSc (Agric) degree in Pasture Science at the Outeniqua Research Farm close to George. Here the world of research, especially in the field of sustainable agriculture, opened up to me. I was not only exposed to scientific conferences, seminars and workshops where my scientific writing and research skills were developed, but I was also exposed to farmer's days and information days where I had the opportunity to interact with farmers and industry. This made me realise how important it is to form a strong bond between academia, industry and farmers. I have also realised that the future of agriculture lies in the hands of young upcoming farmers and researchers. Therefore, I currently lecture at the Elsenburg Agricultural College outside of Stellenbosch. I am also planning a PhD research study through Stellenbosch University on the link between wheat production and soil characteristics and are hoping to develop a soil potential index from it. My research interests are conservation agriculture, agronomy (small grains), pasture, soil and water.

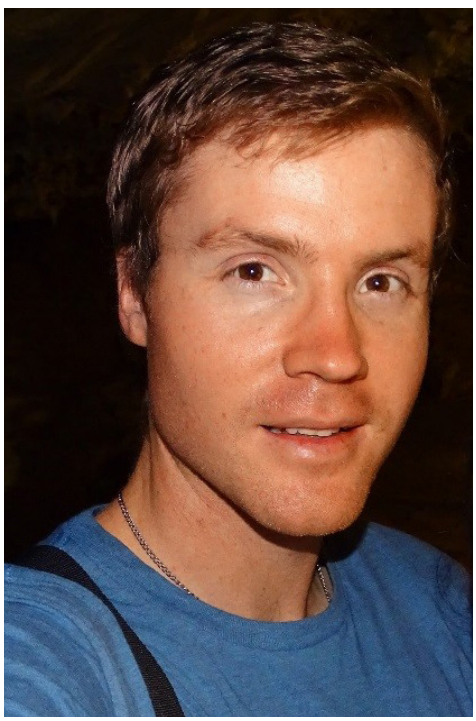
COUNCIL MEMBERS

John Mupangwa

I was born in a rural family of nine children from the eastern part of Zimbabwe. After completing high school in 1982 I enrolled at the University of Zimbabwe for a BSc Honours degree in Animal Science. I graduated with BSc Honours in Animal Science in 1985 from University of Zimbabwe, before completing an MSc in Grassland Science (Cum Laude) at University of Reading, United Kingdom. Between 1996 and 2000 conducted studies on 'Nutritive value, intake and utilisation of forage legumes in ruminants' with funding from the European Union culminating in graduating from the University of Zimbabwe with a PhD in Animal Science. I have more than 30 years of livestock and pastures teaching, extension and research experience. For over 17 years I have taught at University of Fort Hare, South Africa; University of Swaziland, Swaziland; Umutara Polytechnic University, Rwanda and Bindura University of Science Education, Zimbabwe. My first working experience was as a livestock and pasture extension specialist for Zimbabwe National Agriculture Extension Service (AGRITEX) for 15 years. During that time I was a member of the Grassland Society of Zimbabwe (GSZ) from 1990-1994 and served as coordinator of the Smallholder Pasture Competition. In November 2000 I joined the university academic world. I was the founding Dean of the Faculty of Agriculture and Environmental Science at Bindura University of Science Education, Zimbabwe. In 2012 participated in the development of curriculum for the first taught MSc Animal Science at University of Swaziland. As part of my community service I have been team leader and principal investigator for a number of developmental and research projects. Some of the projects include the Farm Applied Research Methods for Eastern and Southern Africa (FARMESA) dairy feed production and conservation improvement project in Zimbabwe, International Fund for Agriculture Development (IFAD) funded on-farm fodder production project for dairy and feedlot projects in Rwanda, East Africa Dairy Development Programme (EADD) clean milk production project funded by the Melinda & Bill Gates Foundation. I have also received professional training in Tropical Pasture Seed Production from the Queensland, Department of Primary Industries, Australia; Rangeland Management in Tropical Africa held at Egerton University, Kenya and Dairy Farming for Rural Development from the International Agricultural Centre, Wageningen, The Netherlands. Currently I have 54 publications in refereed journals and 25 papers in conference proceedings. I am married to Margaret, a teacher by profession, and have two sons Tendai John and Tinashe Clever, a lawyer and a quantity surveyor by profession, respectively.

Christiaan Harmse

Christiaan hold a M.Sc. degree in environmental sciences from the North-West University. During his scientific career, Christiaan has about 7 years of field work experience and he has undertaken extensive research in the Savanna Biome and Nama-Karoo Biome. He is currently employed as agricultural researcher on rangeland and pasture sciences at the Northern Cape's Provincial Department of Agriculture. His research interest lies in rangeland ecology and vegetation dynamics (particularly in bush thickening). Research focused on restoring productive rangelands by assessing selective and non-selective chemical shrub control practices in the semi-arid Kalahari savanna of South Africa. More recently he has developed a particular interest towards investigating the potential of remotely sensed imagery from satellites, as well as the use of remotely piloted aircraft's carrying remote-sensing payloads (such as multi spectral and hyper spectral sensors) as an assessment and monitoring tool in rangeland sciences in the arid environments of the Northern Cape Province. Christiaan is also exploring the use of other innovative technologies, such as GPS collars to monitor livestock movements within a controlled long-term stocking density trail to assess and monitor grazing pattern movements.



Save *the* Date

ELIGIBLE FOR CPD CPD POINTS

9th Research Skills Workshop	*22 - 23 July 2018*
53rd Annual Congress	*23 - 26 July 2018*
2nd Policy & Practice Workshop	*27 July 2018*

ARC • LNR

ARC Training Centre, Roodeplaat Vegetable and Ornamental Plant Institute, KwaMhlanga / Moloto Road (R573), Pretoria District

IMPORTANT DATES AND DEADLINES

Proposal and abstract submission opens:	**4 SEPT 2017**
Workshop and special sessions proposals due:	**30 OCT 2017**
Registration opens:	**1 NOV 2017**
Abstracts (platforms and standard posters) due:	**30 MAR 2018**
Student sponsorship applications due:	**30 MAR 2018**
Preliminary programme available:	**23 APR 2018**
Abstracts (research proposal posters) due:	**7 MAY 2018**
Early bird payments due:	**14 MAY 2018**
Cancellation and registration closes:	**29 JUN 2018**
Normal payments due:	**9 JULY 2018**

REGISTRATION: Sunday, 09:00 - 10:30; Monday, 14:00 - 17:00; Tuesday - Friday, 07:30 - 09:00
RESEARCH SKILLS WORKSHOP: Sunday, 10:00 - 18:00; Monday, 08:00 - 17:00
ANNUAL CONGRESS opens Monday, 18:00, then Tuesday - Thursday, 08:00 - 17:00
MID-CONGRESS TOURS will be on Thursday
POLICY & PRACTICE WORKSHOP: Friday, 09:00 - 16:00

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Abstract Submissions

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