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Grassroots

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Prosopis, a silent but deadly invasion

'Human factors' aggravated KZN floods

Can Holistic Grazing regenerate a biodiversity landscape?

New plant species discovered

Advancing Rangeland Ecology and Pasture Management in Southern Africa

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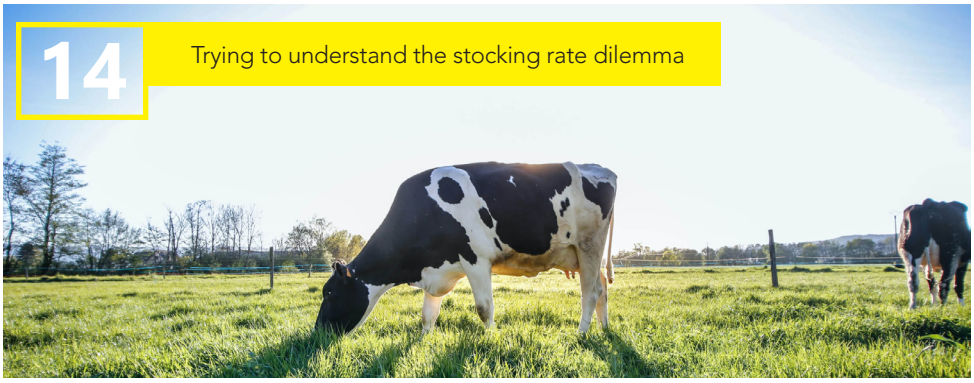

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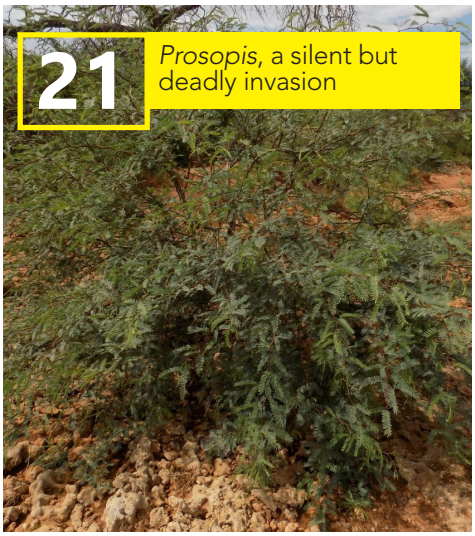

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From our editor

Dear reader,

Welcome to the second issue of Grassroots for 2022.

It is time for the annual Grassland Society of Southern Africa's Congress, and I hope it will be extra special since we can meet in person again.

About this issue

This issue highlights the role of grazing in restoring biodiversity. Craig Morris shares what he learned from investigating "Regenerative Grazing Management" in our feature article "Grazed and Conserved: can holistic grazing regenerate a biodiverse landscape".

According to Farmer's Weekly, regenerative grazing can also be profitable through ultra-high-density grazing. In another article, Craig Galloway answers the question of what the ideal stocking rate on a pasture-based farm should be in a case study "Trying to understand the stocking rate dilemma".

Ken Coetzee wrote a very insightful article on why we need to be concerned about *Prosopis* having already spread over 1.8 million hectares of South Africa. Read all about this in his article: "*Prosopis*, a silent but deadly invasion".

And if you have ever wondered how much water we can save by removing alien plants, you don't need to wonder anymore. A team of researchers from the ARC, Stellenbosch University and the University of Cape Town compiled a hydrological study to determine just how much alien trees threaten our water supply.

Learn more about how new technologies can give more detailed information on the Earth's land cover, how they can help to protect water supplies and determine soil carbon without taking soil samples.

On page 48, Saheed Jimoh shares some valuable advice on how to respond to reviewer's comment. Two new plant species have recently been discovered in South Africa, namely, a fynbos lily called *Cyrtanthus Novus-Annus* and a longleaf fountain bush, *Psoralea filifolia*.

This issue will also be my last as editor of Grassroots. It has been a wonderful journey to be part of the publications team!

Enjoy the read!

Best regards

Malissa

Contact us

If you have any feedback, comments, or suggestions, feel free to contact us at: info@grassland.org.za

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Figure 1. A Sweet thorn in flower.
Image: https://worldoffloweringplants.com/vachellia-karroo-sweet-thorn/

Vachellia karroo

Sweet thorn / Soetdoring (RSA Tree No. 172)

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The Sweet thorn is one of the most widely spread and common tree species in Southern Africa and is only absent from the winter rainfall and eastern coastal regions of South Africa. This medium-sized tree usually grows around 5-12 m high with a maximum height of 22 m, depending on the habitat. The species has a wide habitat tolerance and can be found growing in coastal dune veld, grasslands, woodlands, bushveld and Karoo scrubland. It is often associated with clay-rich soil banks of rivers and drainage lines.

Distinguishing features

Figure 2. Example of leaves and leaflets.

- The dark green leaves are bipinnate with elongated leaflets.
- The mature spines are white, straight or slightly curved and occur in pairs at the nodes.
- The flowers are golden yellow, sweet-scented, and borne in spherical heads. Flowers can be present several times throughout the summer.
- The fruit (pods) are flat, smooth and sickle-shaped. The pods turn from green to brown as they mature.
- Trees are generally single-stemmed. The bark is grooved and grey to black in colour.
- The species is semi-deciduous to deciduous.

Ecological value and uses

The tree is regarded as a good fodder tree as the leaves are readily consumed by livestock and game. The tree provides shelter for a number of bird, insect and mammal species and is an important provider of shade in arid regions. The flowers are rich in nectar and attract a large variety of insects and birds in the summertime.

The gum of the tree is edible hence the common name “sweet horn”. It can also be used as an adhesive. The seeds can be used as a substitute for coffee. The relatively dense and heavy wood can be used for building purposes and as a source of fuel. The bark is used to make strings and ropes as well as for tanning. Many cultures in South Africa use the gum, bark and leaves for the treatment of ailments including mouth ulcers, diarrhoea and oral thrush as well as for emollients.

Figure 3. Example of mature paired thorns.

Figure 4. The distinct bright yellow flowers.

References

- Smit, GN, 2008. *Veldgids tot die Akasias van Suid-Afrika*. Briza publikasies, Pretoria
- Treesa.org/ peltophorum-africanum/
- Van Rooyen, N & van Rooyen, G, 2019. *Flowering plants of the southern Kalahari*. Novus prints, Somerset West
- Van Wyk, B, Van Wyk & Van Wyk, B-E, 2008. *Fotogids tot Bome van Suider-Afrika*. Briza publikasies, Pretoria
- Images: https://treesa.org/vachellia karroo/, https://www.feedipedia.org

GRASS OF THE MONTH

Phragmites australis

Common Reed

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Phragmites australis is a very common water-loving grass that is found throughout South Africa, as well as in its neighbouring countries (Namibia, Botswana, Lesotho and Eswatini). It is a perennial grass species which can grow up to 4 m tall. The name *Phragmites* comes from the Greek word 'phragma', meaning hedge. This describes the long stems which are often used for making fences or determining a boundary around someone's property.

Ecology

- *P. australis* is a rhizomatous grass with solitary culms (doesn't tiller) and long, narrow grey-green leaves.
- It has a large (120-400 mm) compact inflorescence which is brown with silky white hairs. Flowering occurs between December and June.
- This reed occurs in wet areas (and has been found in water up to 1 m deep). *P. australis* can tolerate water of moderate salinity.
- *P. australis* can be very invasive in nature and, under good growing conditions, can create very dense stands. In a study by Weisser and Parsons (1981), a 135 % increase (from 0.74 – 2.94 ha) was noted in the Siyayi Lagoon of Mtunzini (KZN), over a time period of 19 years.

Figure 1. *P. australis* can grow in water up to 1 m deep. Insert: *P. australis* inflorescences are large, brown and covered with white hairs. Photos: R. Taylor (https://www.inaturalist.org/observations)

Uses

Although *P. australis* is recognized as a Decreaser species, it has a very low grazing value and is not used by many animals as a major source of food.

It does, however, still have a big ecological role: *P. australis* is known to control flooding, manage soil erosion and act as a water filter in wetland ecosystems.

P. australis acts as a great refuge for many animal species and often creates a good nesting site for birds.

Figure 2. Leaf-sheaths remain on the culm when a leaf falls off. Photo: R. Taylor

Figure 3. Leaves are long and flexuous with a filiform apex. Photo: R. Taylor

Figure 4. *P. australis* tends to create dense strands in wet areas, such as here in the lakes of Wilderness in the Western Cape. Photo: Y. van Wijk

Easily confused with:

P. australis can easily be mistaken for a similar species within the same genus: *Phragmites mauritianus*. Apart from *P. mauritianus* being far less widespread (and only found in the eastern parts of South Africa), another obvious characteristic is found in the leaf morphology.

- *P. australis* has a filiform (threadlike) leaf apex while *P. mauritianus* has a very sharp tip on the leaf.
- The leaf sheaths of *P. australis* remain on the culm after leaf fall, while the entire leaf and sheath fall off the *P. mauritianus* plant.

References

- Fish, L., Mashau, A.C., Moeaha, M.J. and Nembudani, M.T. 2015. *Identification guide to southern African Grasses. An identification manual with keys, descriptions and distributions.* Strelitzia 36. South African National Biodiversity Institute. Pretoria.
- SANBI PlantZAfrica.com (accessed: 02.06.2022). http://pza.sanbi.org/phragmites-australis
- Van Oudtshoorn, F. 2002. *Guide to grasses of Southern Africa.* Briza Publications. Pretoria
- Weisser, P.J.& Parsons, R.J. *Monitoring Phragmites australis increases from 1937 to 1976 in the Siyai Lagoon (Natal, South Africa) by means of air photo interpretation.* Bothalia 13: 3&4: 553-556.

KAROO PLANT OF THE MONTH

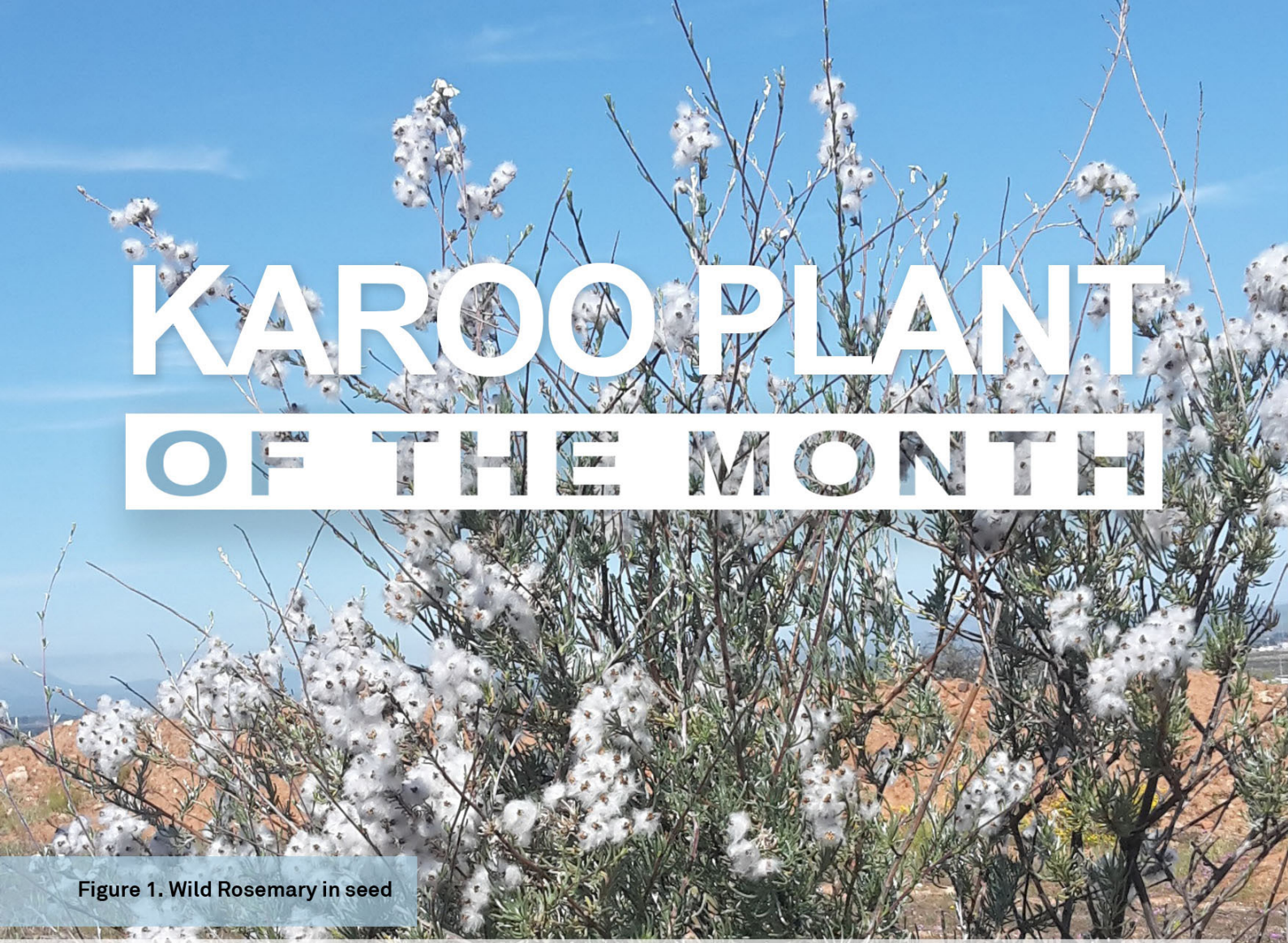

Figure 1. Wild Rosemary in seed

Eriocephalus africanus
Wild Rosemary

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Wild Rosemary is a silvery-grey, twiggy shrub growing up to 1 m tall. This widespread species occurs commonly in lowlands from the West coast to the Eastern Cape. It is found in a variety of soils, from rocky clay to sandy or loamy soils. Wild Rosemary has been used as a medication for colds and flu, as well as for culinary uses as a replacement for ordinary rosemary. Wild Rosemary is also an excellent choice for a water-wise garden.

Diagnostic features

- The leaves are narrow, slightly succulent and covered in fine hairs.
- Leaves have a strong odour, similar to ordinary rosemary.
- Wild Rosemary shrubs have an overall silvery-grey appearance.
- Flowerheads are borne in clusters, each approximately 10 mm in diameter.
- Seeds are enclosed in fluffy, white hairs.
- During flowering and seeding plants are often entirely covered and appear white.

Ecological value

Wild Rosemary is palatable to both game and livestock. The flowers attract bees and other pollinators, while birds use the woolly seeds as nesting material. Wild Rosemary growing in the winter-rainfall region flower from August to early October, but will also flower opportunistically after rain. The seeds are easily harvested, however, many may remain dormant for a few months after harvest and only germinate during the next rainy season. This species is suitable for re-seeding degraded, overgrazed rangelands in the Karoo. It is also a useful indicator of veld condition, with large numbers indicating veld in good condition.

Figure 2. Wild Rosemary flowers

Figure 3. Wild Rosemary seeds

Figure 4. Wild Rosemary shrub in flower

References

- Vlok, J. & Schutte-Vlok, A. 2010. *Plants of the Klein Karoo*. Umdaus Press, Hatfield.
- Curtis-Scott, Goulding, Hleme, McMaster, Privett & Stirton, 2018, *A Field guide to Renosterveld of the Overberg*. Struik, Century City.

Grazed and Conserved – can Holistic Grazing regenerate a biodiverse landscape?

Craig Morris

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"They want to bring what into the Drakensberg!?" I spluttered, almost choking on my cup of hand-ground, gluten-free coffee. "Big herds of cattle," she replied, "to regenerate the montane grasslands that are rapidly deteriorating because of frequent and the absence of large, stomping, grazing, herbivores." "Don't they know that fire is keeping the Berg grasslands stable and that the trampling of dense cattle herds, will wipe out the rich diversity of indigenous forbs. Don't they read Grassroots?" (e.g., Morris 2018 & 2021a), I groaned, despairingly. "But don't you know about Regenerative Grazing and how it can heal the land and restore biodiversity?" she responded, "go educate yourself before so quickly dissing a potentially valuable tool for conservation and rangeland management."

So off I went to investigate this apparently new wondrous new method of grazing called Regenerative Grazing Management (ReGM), and I learned quite a few things. First, ReGM is not new. It's just a repackaging of the old method of Holistic planned grazing (aka cell, adaptive multi paddock, mob, time-controlled -grazing, etc), first proposed by Alan Savory in Rhodesia more than half a century ago as a means of mimicking the impacts achieved by bunched mobs of herbivores being chased by predators across the landscape. Second, ReGM is part of the wide suite of 'nature-friendly' Regenerative Agricultural approaches that have become wildly popular in the last five years or so (Figure 1) because of claims that they are the only way to restore degraded soils, boost sustainable, profitable production, and reverse climate change. Third, I learned that while researchers are mostly circumspect about the potential of ReGM to promote and sustain biodiversity, advocates and practitioners of ReGM are not

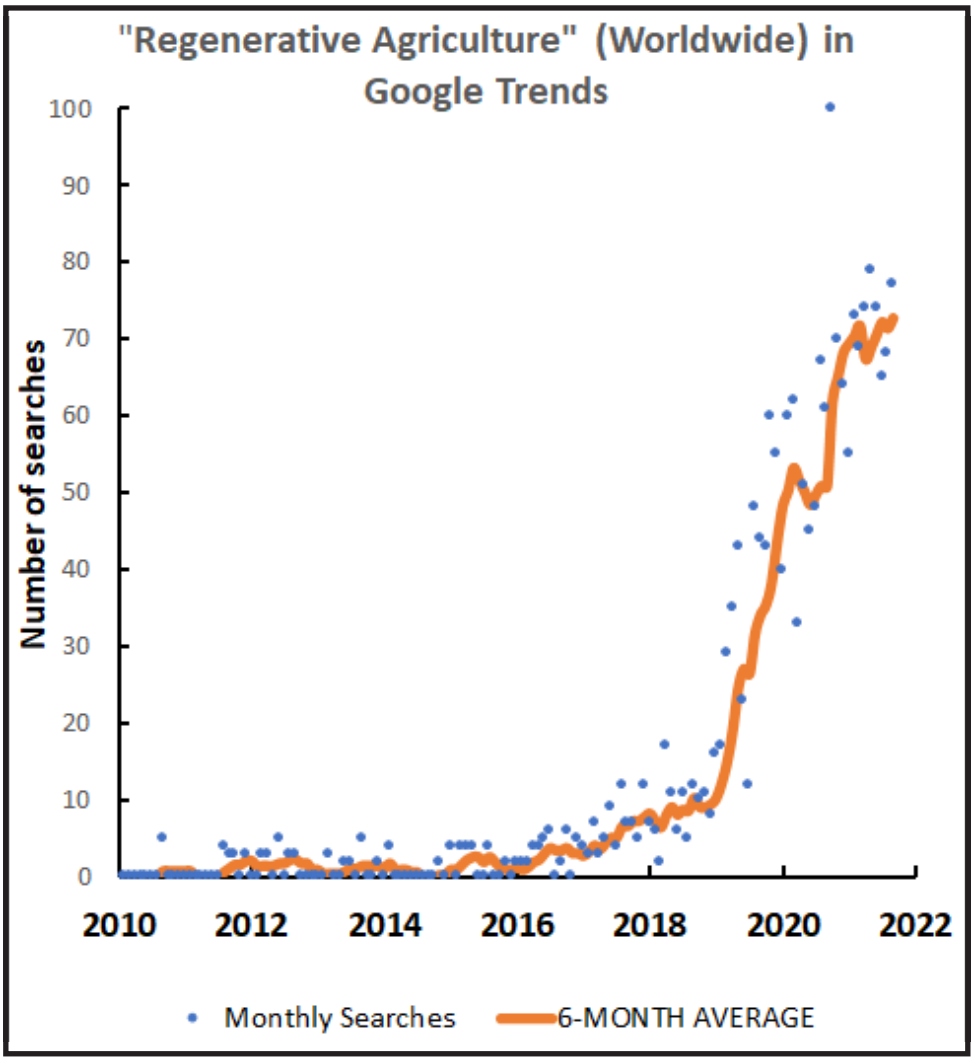

Figure 1. Rise in Google searches for "Regenerative Agriculture" since 2010.

reticent, bold proclaiming, without citing evidence, that, for example:

"*[Researchers have demonstrated that] the appropriate time-managed grazing systems will not kill a single plant and will increase the biodiversity of native plants, animals, insects, and microorganisms in the farm ecosystem.*" https://regenerationinternational.org/2021/03/29/regenerative-grazing-increased-production-biodiversity-resilience-profits-and-a-climate-change-solution/

Figure 2. Nightly penning of livestock in a temporary mobile kraal used for regenerative grazing and restoration in the Nama-Karoo (photo: The Herding Academy, www.herdingacademy.co.za).

I also undertook a review of the literature, examining 58 studies from five continents for reported positive, neutral, and negative effects of ReGM (Morris 2021b). The results were varied and sometimes surprising. Very briefly (see Figure 1 in Morris 2021b): soil microbes, especially fungi, responded mostly positively to ReGM as did wildlife. Plants, invertebrates, and birds displayed a range of responses from markedly negative, and unresponsive, to the enhancement of numbers and diversity. Regenerative grazing did not consistently promote the diversity and abundance of numerous taxa, as claimed: certain groups and species were favoured while others were disadvantaged by the way ReGM periodically disturbed ecosystems.

Positive diversity responses to ReGM generally arose when organisms benefited from increases in nutrient cycling and soil water retention under by ReGM and/or from the long rests afforded soil, plants, and animals between short bouts of intense grazing. Dung and urine are deposited relatively evenly across the landscape through the movement of livestock by herding or through permanent or temporary paddocks, coupled with intense trampling, which serves to redistribute carbon and nutrients from plants back into soils. Some plants, especially productive grasses and non-native, invasive forbs are favoured when soil fertility is increased under ReGM.

The infrequent stocking under ReGM gives plants and animals some time to recover from intense grazing and trampling. Furthermore, confining livestock to just a small portion of the total landscape at any one time leaves large areas for life to continue undisturbed. A striking example of the benefit of such spatially restricted stocking comes from the Nama-Karoo near Graaff-Reinet, where ReGM is implemented through mobile, temporary kraaling and herding (Figure 2). There, the richness of large herbivores and their predators increased by 33% and 24%, respectively, in the few years after most fences were removed, lethal predator control ceased, and holistic planned grazing was implemented (Schurch et al. 2021).

Figure 3. A mesic grassland under Regenerative Grazing that has been unburned for 18 years and is now dominated by large, unpalatable grasses (right), and cattle grazing on fresh forage after an unplanned winter fire (left) (Photo: Clive Henderson).

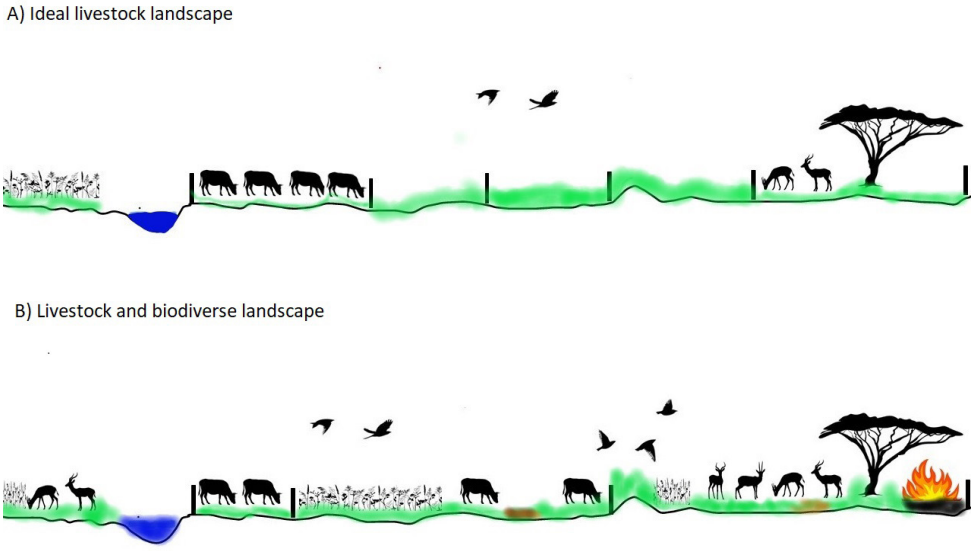

Figure 4. A homogenous landscape optimised for livestock production (A), and (B) a heterogeneous landscape for livestock production and biodiversity conservation.

Periodic, intense trampling – Savory's 'hoof-effect' – is regarded by regenerative grazers as a *sine qua non* for restoring and maintaining ecosystem processes and productive, profitable ranches. Although trampling can improve seedbeds for germination and open swards to allow easier foraging by some ground-dwelling birds, few organisms appear to enjoy being trodden on, torn, shredded, or in other ways disturbed by the sharp hooves of dense herds or flocks of livestock. As the comedian, Dave Barry wisely quipped, "*Life is anything that dies when you stomp on it.*" Trampling can destroy or reduce the intact grass and herbaceous canopies required by many invertebrates and birds for hunting, foraging, and nesting (e.g., web-building spiders, ground-breeding birds), or shelter from predators. Indigenous forbs and biological soil crusts can be markedly reduced by recurrent trampling. Therefore, periodic palliative recovery rests of a year or more, longer than those currently used in ReGM systems (i.e., many weeks to months), could be essential to maintain viable populations of plants, invertebrates, and animals in grazing areas.

One of the conclusions of the review (Morris 2021b) was that, similar to the inconsistent effects of Holistic grazing on vegetation structure and composition and livestock production, multi-taxa biodiversity does not always respond positively to ReGM wherever it is applied. Regenerative grazing is not a silver bullet to simultaneously achieve both conservation and production. Another important conclusion was that fashioning a productive and resilient landscape best suited to livestock will not inevitably create the heterogeneous habitats required to harbour and conserve a wide range of living creatures. However, because ReGM systems exert quite strong control over the timing, place, and duration of livestock impacts, they could be modified to create more biodiverse grazing areas by becoming more holistic, adaptive, and strategic.

Grazing and trampling by large herds moving quickly are just one of the many spatially and temporally variable impacts at play in 'natural' ecosystems (Franke and Kotze 2022). Fire, often eschewed by Holistic and now Regenerative grazers is another important disturbance with which many plants and animals in more mesic grasslands have evolved and are still dependent on. Excluding fire exacerbates selective grazing and plant dominance, even under ReGM (Figure 3), whereas the synergistic application of burning and grazing can engender a [shifting] heterogeneous landscape mosaic (Fuhlendorf and Engle 2001). A greater variety of special habitats could also be created by shifting from the relentless application of high density, short-duration stocking to allow animals to linger longer in some places to deliberately create small 'overgrazed' bare patches that some burrowers and foragers require, letting animals loiter in some large areas to provide moderate, variable impacts, and to set aside sensitive (and overused) areas for long restorative rests or for woody refuges.

A dense, nutritious, and productive grass sward with high cover, most suitable for livestock production, would not necessarily promote biodiversity. Therefore, creating conservation-friendly ranches (Figure 4) would take some different thinking and careful strategic planning, combined with thorough monitoring to assess whether a grazing landscape has been formed that indeed provides "… room for many things."

"How the shape of the fire's wake
is echoed by livestock, noses
to the new green shapes
the uneven scatter of habitats,
the shatter of seeds to renewed soil:
a landscape with room for many things."
"The Choice of Fire Grazers" by Cedar Brant (in Smith et al. 2021).

References

Franke AC, Kotzé E. 2022. High-density grazing in southern Africa: inspiration by nature leads to conservation? *Outlook on Agriculture* January 24 https://doi.org/10.1177/00307270221075060

Fuhlendorf SD, Engle DM. 2001. Restoring heterogeneity on rangelands: ecosystem management based on evolutionary grazing patterns. *BioScience* 51: 625-632 https://doi.org/10.1641/0006-3568(2001)051[0625:RHOREM]2.0.CO;2

Morris CD. 2019. Key forbs indicate the condition of mesic grassland. *Grassroots* November 2019, 19(4): 7-8.

Morris CD. 2021a. To kill a grassland forb. *Grassroots* July 2021 21(2): 9-11.

Morris CD. 2021b. How biodiversity-friendly is Regenerative Grazing? *Frontiers in Ecology and Evolution* 9:816374. https://doi.org/10.3389/fevo.2021.816374

Schurch MP, McManus J, Goets S, Pardo LE, Gaynor D, Samuels I, Cupido C, Couldridge V, Smuts B. 2021. Wildlife-friendly livestock management promotes mammalian biodiversity recovery on a semi-arid Karoo farm in South Africa. *Frontiers in Conservation Science* 2:652415. https://doi.org/10.3389/fcosc.2021.652415

Smith AP, Epstein K, Gosnell H. 2021. Grazing the Fire – poetry of rangeland science: a review

Regenerative grazing: realising maximum sustainable profit/ha

Although ultra-high-density grazing is still quite controversial in some circles, many farmers have had good results when using it as a means to restore veld and increase carrying capacity.

Susan Marais

Current Address: Farmer's Weekly
Reprinted From: https://bit.ly/3IX0cLB

In a society where 'economies of scale' has been the buzz phrase for decades, it seems strange that a farmer could be more profitable on a smaller scale.

Yet this is exactly what happened when Hannes Botha, a farmer running a mixed enterprise near Carolina, Mpumalanga, introduced regenerative farming practices on his farm, Fairview.

"I was able to double my farm's carrying capacity in a single season; it was like buying a second farm," Botha said during a recent regenerative agriculture webinar.

A few years prior to this journey towards restoration, Botha had tried to implement precision farming. It had cost an arm and a leg, yet had brought very little improvement to his operation. He began researching alternative farming techniques and started learning from regenerative farming pioneers, including Allan Savory, Elaine Ingham and Dr Christine Jones.

"This opened a new world to me. I came to realise that conventional agricultural practices have a negative impact on the environment and people."

Botha, a third-generation farmer, has been practising regenerative agriculture for three seasons.

"I moved away from conventional agricultural farming practices when I realised it doesn't make sense to spend more and more for the same or smaller profit. I also realised that higher yields don't necessarily equate to higher profits."

By implementing the knowledge that he gained and using the tools he already had, he changed his livestock management programme to an ultra-high-density grazing (UHDG) system and, within a single season, was able to double the veld's carrying capacity.

Healthy soil, healthy cattle

North West cattle farmer DF Fyfer, owner of Bhetjane Cattle Co, also uses UHDG on his farm near Louwna. He says that one of the most important departure points of regenerative agriculture is the realisation that healthy veld does not start and end with good grass cover, but that the health of the soil is equally important. Moreover, healthy soil and cattle are interconnected.

"Everything we do on our farm is aimed at increasing the veld's carrying capacity and adding value to our products."

The objective of such a UHDG system is to create smaller camps to be utilised by ultra-high stock rates for short periods.

After grazing, each camp is allowed to rest for longer periods.

Figure 1. A homogenous landscape optimised for livestock production (A), and (B) a heterogeneous landscape for livestock production and biodiversity conservation. DF Fyfer uses a special cattle breed, Adaptor, which has been bred for the veld conditions on his farm near Louwna in North West. Photo: Bhetjane Cattle Co

Genetics was a major solution to the challenges Fyfer experienced. He explains that regenerative farming requires animals that can adapt quite easily, which led him to realise that he needed a hybrid animal.

"The body condition score [BCS] is one of the most important indicators of our business. Genetics is the easiest way to address issues concerning BCS."

Fyfer started farming with the Adaptor, a breed formed by combining the Beefmaster, Boran, Nguni and Mashona. This composite was bred according to Johann Zietsman's Veldmaster principles and specifically developed for UHDG.

Fyfer also realised that farming entailed the entire ecosystem, not just cattle. He therefore decided to include chickens in his system, and have them feed on the same veld as the cattle.

The chickens are kept in moveable chicken coops, known as TrEGGers, which are moved regularly, allowing the chickens to contribute to improving the veld by spreading their own, as well as the cattle's, manure and by combating pests.

Fyfer also farmed bees and planted pollination strips near watering points. The bees help pollinate all the plants in the ecosystem.

Measuring the impact

Grazing specialist Frits van Oudtshoorn has drawn similar conclusions over the few seasons he has helped and observed the results obtained on Reitz-based Danie Slabbert's farm in the Free State.

Slabbert runs about 500 head of Drakensberg cattle on his farm and started using a UHDG system in December 2017. He fenced rectangular cells within a 100m-wide electrified strip. Depending on the biomass, the camp sizes vary from 100m x 7m to 100m x 15m.

During summer, the animals are moved hourly between 6am and 7pm, which equated to an average animal density of about 5 000 LSU/ ha/ hour, extrapolated to a carrying capacity of 6 LSU/ ha/year. (The official government recommendation for this farm is 4 LSU/ha/ year.)

"UHDG leads to non-selective grazing, a high degree of trampling and a high concentration of manure and urine," says Van Oudtshoorn.

The same system is used during winter, but the animals are moved to graze on maize and soya bean residue and cover crops specifically planted for them.

"It's important to realise that the sandy and loam soils these animals are grazing on are the farm's marginal lands. The better soils are used for crop production," says Van Oudtshoorn.

To track the progress, he identified seven monitoring points in the area. Four of these were set on the main farm, where the UHDG (or non-selective grazing) was taking place, while the rest formed a control group. Two of the control group sites were based on a neighbouring farm, where animals were moved between the two camps on roughly a monthly basis.

This grazing approach led to a high degree of selective grazing, and the sites were collectively known as the "selective grazing control sites". The third site of the control group was a portion of veld where no grazing took place; it was called the "zero-grazing control site".
"We determined the grass species composition by using the so-called line transect method," says Van Oudtshoorn.

"With this data on hand, we looked at the grass species diversity, ecological status groups, veld condition score percentage and grazing capacity. Finally, the biomass production [kg/ha] was also an important factor to look at during this study."

The grasses were categorised into four ecological status groups, namely decreasers, increaser 1, increaser 2 and increaser 3 (see Table 1).

"In 2019, the decreasers at the UHDG sites stood, on average, at 19,7%. By 2021, they had increased to 32,1%, an increase of 12,4% in two years. When looking at the selective grazing control sites, the decreasers had grown by 5,7% from 8% to 14,9% over the same period. The decreaser grasses declined from 13,2% to 0% over the same period at the zero-grazing control sites."

The increaser 1 grasses increase when veld is underutilised. At the UHDG sites, this group increased by 1,8% from 17,6% to 19,4%. Interestingly, they did not increase at all in the selective grazing sites, while they increased by 20% in the area where no grazing took place.

"The increaser 2 species declined by 1,9% from 23% in 2019 to 21,2% in 2021 at the UHDG sites, while it declined by 38,7% from 82% to 43,3% in the selective grazing sites," says Van Oudtshoorn. "At the zero-grazing sites, the figure declined by 1,5% from 7,5% to 6%. The UHDG sites were the only sites where the grass species diversity increased during the two-year study period. "It's still too early to draw any definite conclusions, as we only have two years' worth of data. However, almost all veld condition assessment criteria used in this study indicate higher average values at the non-selective grazing [UHDG] sites compared with the control groups. We'll continue monitoring the situation and even expand our ecological parameters further."

E-mail DF Fyfer at df@bhetjane.com, or Frits van Oudtshoorn at frits@alut.co.za.

TABLE 1: CATEGORISATION OF GRASSES INTO FOUR ECOLOGICAL STATUS GROUPS

Group	Description 1	Description 2
Decreasers	Grasses common in good veld	Palatable perennial grasses
Increaser 1	Grasses common in undergrazed veld	Unpalatable perennial grasses
Increaser 2	Grasses common in disturbed veld	Pioneer and subclimax grasses
Increaser 3	Grasses common in selectively overgrazed veld	Extremely unpalatable perennial grasses

SUPPLIED

Trying to understand the stocking rate dilemma

Craig Galloway

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Reprinted from: https://bit.ly/3yX4L3Y

What is the ideal stocking rate on a pasture-based dairy farm? This question has caused numerous unresolved debates. There are many contradictory opinions, backed by data, about whether to aim for a higher or lower stocking rate. I used data from the Trace & Save database to gather further insight by looking at 91 farms from 2012 – 2021. Some farms participating with Trace & Save for all nine years, with other farms only participating since 2021. This gave a total of 373 observations, with observation being a farm's data for a year. I removed all the farms which do not raise their heifers on-farm, to ensure better comparability between similar farm systems. This left me with 316 observations to work with.

If anyone is interested in knowing exactly what each measure entails, you can see the case study which Trace & Save published with WWF and Nedbank in 2021, where similar measures were used (Making a business case for sustainable dairy production).

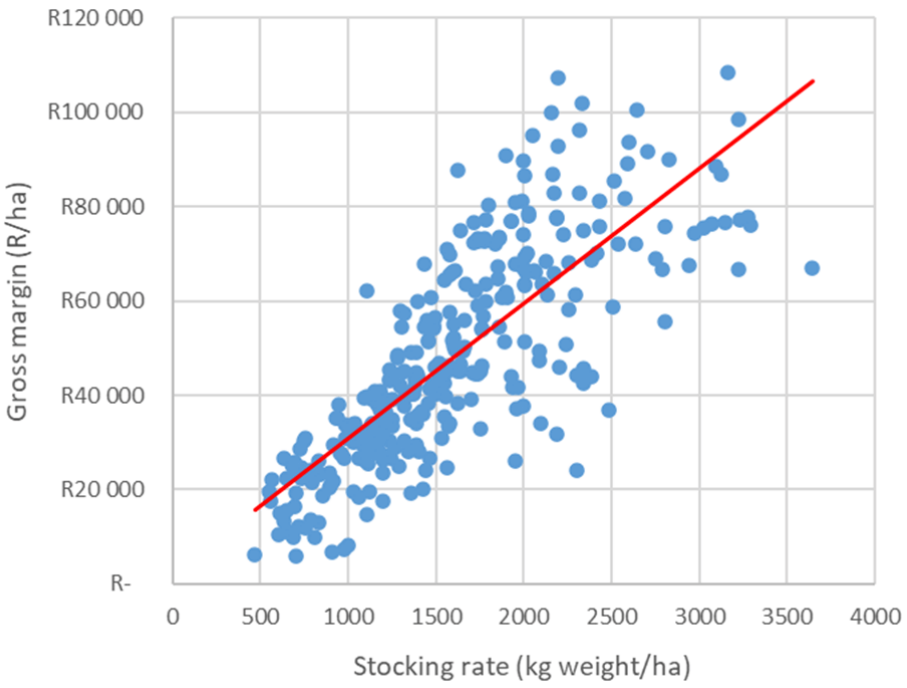


Figure 1. An example of one of the advantages of higher stocking rate is the positive correlation with higher gross margin.

Broad Analysis

To start trying to understand the stocking rate on pasture-based dairy farms I used the total liveweight of animals (kg of cows in milk, dry cows and heifers) per total hectare of land on the farm (irrigated pastures, drylands and lands used to grow roughage), i.e. kg LW/ha as the main measure of stocking rate. Using various indicators of productivity, profitability, and sustainability I found some insightful significant correlations with stocking rate. What I found was that higher stocking rates are associated with (see Table 4 for actual results):

- higher nitrogen fertiliser application rates (kg N/ha)
- lower costs of NPK fertiliser per litre (R/l)
- lower proportion of pasture in the overall farm diet and higher proportion of bought feed (% contribution)
- higher pasture utilisation, in terms of pasture required based on a back-calculation as a percentage of pasture grown (tons req./tons grown)
- higher gross margin per hectare (R/ha)
- lower carbon footprint (kg CO_2e/kg FPCM)
- higher nitrogen use efficiency (%)

At first glance, this would clinch the argument that a higher stocking rate is better. It shows that, on average, a low stocking rate is less profitable per hectare and results in a higher environmental impact. But there are still a lot of questions in terms of how high the stock rate should therefore be? Surely there is a point where the stocking rate is too high?

Refining the data

To try and understand the dynamics around stocking rate better I decided to refine the dataset further. I removed all the farms where there was home-grown roughage, and where there were areas on the farm which are not pastures. Although these farms are important to understand, I wanted to see what we could learn from farms which are predominantly pastures, because they are more directly comparable to each other. This left me with 176 observations.

Using this refined data set, I found that higher stocking rates per total hectare are associated with (see Table 5 for actual results):

- all the same results as the analysis

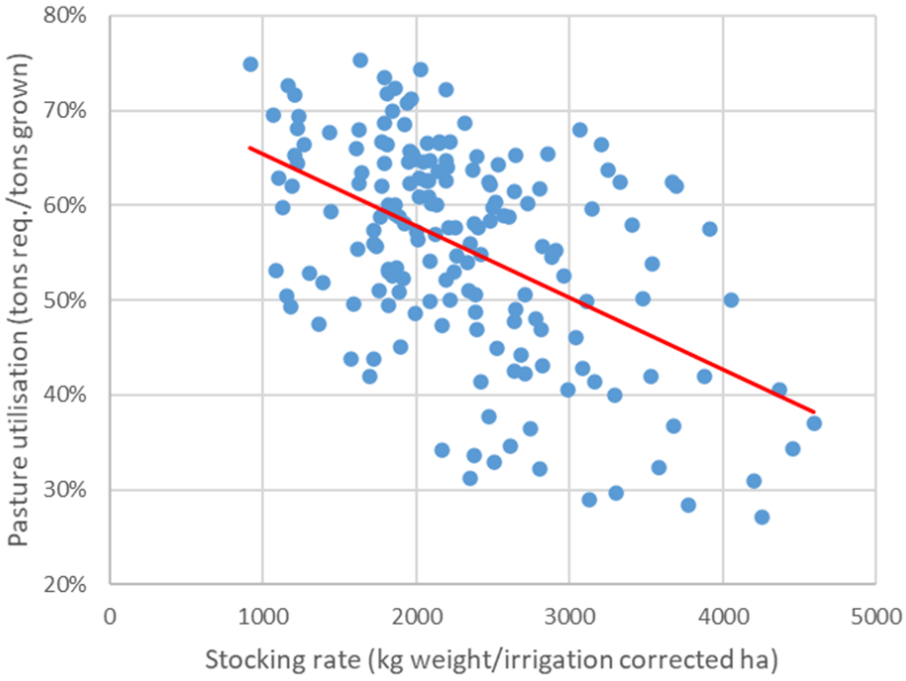


Figure 2. An example of a disadvantage of higher stocking rates is the negative correlation with pasture utilisation.

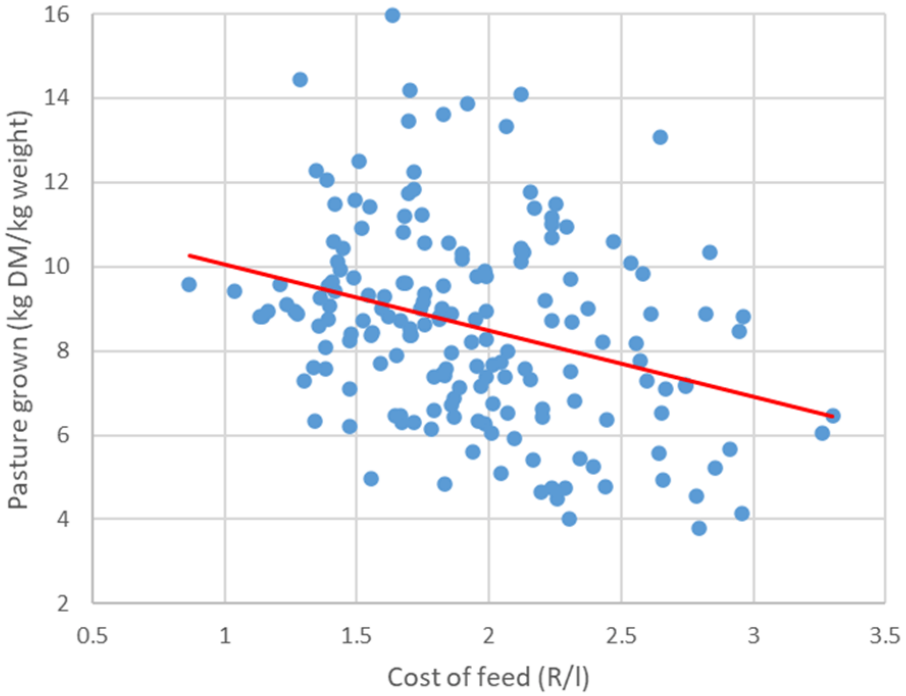


Figure 3. An important reason to provide as much pasture per cow as possible is that it is associated with a lower cost of feed per litre produced.

above, therefore showing that the trend discussed above is true even when we use a smaller dataset with more directly compared farm systems
- higher gross margin per litre, which was not found in the previous data set

These results further strengthen the argument for a higher stocking rate being better.

One of the factors that could skew these results is that farms which are able to have a higher stocking rate are the ones which have more irrigated areas. When looking at the results in terms of stocking rate per irrigation corrected hectare. To overcome this bias I added another measure of stocking rate – total liveweight per irrigation corrected hectare. I did this by counting each irrigated hectare as one hectare, and each dryland hectare as half a hectare. Using the irrigation corrected stocking rate, I found that higher stocking rates are associated with (see Table 5 for actual results):

- all the same results as in the previous two analyses, except for nitrogen use efficiency, which was not correlated with stocking rate, and as with the first analysis, gross margin per litre was not correlated with stocking rate
- lower production of milk solids (kg solids/100 kg weight)
- higher concentrates fed to the cows in milk per litre of milk (g/l)
- lower phosphorous fertiliser application rates (kg P/ha)
- higher cost of feed (R/l)

These results are indicative of the stocking rate dilemma being a little bit more complicated than purely a higher stocking rate is better. The results still point towards a higher stocking rate being more profitable, but it also shows a higher cost to milk production. Many people might say that doesn't matter because it is still more profitable, but a higher cost of production is a dangerous path in the long term because it means more risk of exposure to inflation. This is a big reality in South Africa and must be taken into consideration when deciding on the most sustainable farm system for the future.

The role of pasture

I decided to explore this dilemma further. A seemingly clear assumption is that the lower the stocking rate, the more pasture there will be available for each animal on the farm. This should mean greater profitability. But is this the case? It seems a bit more complicated than that in view of the data which has been presented in this case study.

I decided to calculate a figure for how much pasture there is grown and therefore available for each animal – kilogram of pasture per kilogram of liveweight on the farm. I wanted to see how this figure correlated with the other parameters. The more pasture there is available per animal the (see Table 6 for actual results):

- lower the stocking rate, both in terms of total hectares (kg weight/ha), and in terms of irrigation corrected hectares (kg weight/irrigation corrected ha)
- higher the milk solids (kg solids/100 kg weight)
- lower concentrates fed to the cows

Table 1. The results of this Mann-Whitney U test comparison contrasting the farms with a higher stocking rate to the lower stocking rate farms (see Table 7 for actual results).

Higher stocking rate farms have a:	Higher stocking rate (n=58)	Lower stocking rate (n=118)
Higher stocking rate (kg weight/ha)	2 277	1 301
Higher stocking rate (kg weight/irrigation corrected ha)	2 826	2 060
Higher pasture utilisation (%)	83	64
Lower pasture grown per cow (kg DM/kg weight)	7.4	9.2
Lower proportion of pasture in the diet (%)	52	57
Higher proportion of bought feed in the diet (%)	46	41
Higher N application rate (kg N/ha)	218	172
Lower cost of fertiliser (R/l)	0.16	0.24
Higher gross margin per hectare (R/ha)	68 601	39 859
Higher nitrogen use efficiency (%)	32	29

Table 2. Significant differences in sustainability parameters between top performing farms and rest of farms.

The best performing farms have a:	Top farms (n=15)	Rest of farms (n=161)
Higher stocking rate (kg weight/ha)	1 933	1 594
Higher milk production (l/100 kg weight)	1 264	1 178
Higher milk production (kg solids/100 kg weight)	103	92
Lower concentrates fed to cows in milk (g/l)	281	357
Higher proportion of pasture in the diet (%)	63	55
Lower proportion of bought feed in the diet (%)	36	43
Lower cost of feed (R/l)	1.48	1.98
Lower cost of fertiliser (R/l)	0.13	0.22
Higher gross margin per litre (R/l)	3.99	2.98
Higher gross margin per hectare (R/ha)	81 619	46 323
Lower carbon footprint (kg CO2e/kg FPCM)	0.88	1.15
Higher nitrogen use efficiency (%)	43	28

Table 3. Other notable differences in sustainability parameters between top performing farms and rest of farms.

The best performing farms have a:	Top farms (n=15)	Rest of farms (n=161)
Higher pasture utilisation (%)	78	70
Higher pasture grown per cow (kg DM/kg weight)	9.4	8.5
Lower N application rate (kg N/ha)	166	189

Table 4. Correlations between stocking rate and various profitability, productivity, and sustainability indicators using data from the Trace & Save research database on all the farms which raise heifers on the farm (n=316).

Parameters	Stocking rate (kg weight/ha)	
	Spearman's rho	*p-value*
Milk production (l/100 kg weight)	0.09	0.13
Milk production (solids/100 kg weight)	0.04	0.54
Concentrates to CiM (g/l)	-0.08	0.15
Pasture utilisation (tons req./tons grown)	**0.32**	< 0.001
Pasture in diet (%)	**-0.24**	< 0.001
Home-grown roughage in diet (%)	0.01	0.83
Bought feed in diet (%)	**0.25**	< 0.001
Fertiliser (kg N/ha)	**0.47**	< 0.001
Fertiliser (kg P/ha)	0.07	0.22
Fertiliser (kg K/ha)	0.05	0.34
Cost of feed (R/l)	-0.06	0.33
Cost of fertiliser (R/l)	**-0.28**	< 0.001
Gross margin (R/l)	0.10	0.08
Gross margin (R/ha)	**0.83**	< 0.001
Carbon footprint (kg CO2e/kg FPCM)	**-0.21**	< 0.001
NUE (%)	**0.22**	< 0.001

in milk per litre of milk (g/l)
- lower pasture utilisation (tons req./ tons grown)
- higher proportion of pasture in the overall farm diet and lower proportion of bought and home-grown feed (% contribution)
- lower N application rate (kg N/ha)
- lower cost of feed (R/l)
- higher cost of fertiliser (R/l)
- higher gross margin per litre (R/l)
- lower gross margin per hectare (R/ha)

These results are the epitome of why this conversation is so complex. Having a higher amount of pasture available per cow has obvious advantages. Especially in terms of limiting the total cost of production. But two of the results – lower pasture utilisation and lower gross margin per hectare are problematic.

The relationship with stocking rate can be seen here. A higher stocking rate gives you less pasture per animal, but it results in better pasture utilisation. In other words, although there is a lot of pasture available at a lower stocking rate, a lot of this pasture is wasted. The higher stocking rate also means more feed must be brought onto the farm, at a cost, but it results in a higher gross margin per hectare.

Is there an ideal stocking rate?

Although correlations using a large dataset are insightful and can teach us a lot about the relationship between various factors making up a farm system, it does not always provide absolute clarity on what the best system is. The data we have looked at so far points towards a higher stocking rate being better across most measures, but is there a specific stocking rate which is ideal?

To further explore this question, let's look at specific farm systems. Since the data so far has indicated that a higher stocking rate is better, I thought to compare all the parameters we have been looking at between the observations with the highest stocking rate (top 33% or top 58 farms) with the rest of the farms with a lower stocking rate. I used the smaller, 176 farm dataset, since these farms are more directly comparable to each other.

These results follow a very similar trend to those shown by the correlation data, but it is interesting to see the actual numbers for each parameter. The advantage of higher stocking rate is re-emphasised here with the higher pasture utilisation, but there is still the disadvantage of lower pasture per cow and lower pasture in the diet. There is also the disadvantage of a higher nitrogen application rate, but the overall cost of

Table 5. Correlations between stocking rate and various profitability, productivity, and sustainability indicators using data from the Trace & Save research database on farms which raise heifers on the farm and do not grow any home-grown roughage, and have predominantly pasture areas (n=176).

Parameters	Stocking rate (kg weight/ha)		Stocking rate (kg weight/irrigation corrected ha)	
	Spearman's rho	*p-value*	*Spearman's rho*	*p-value*
Stocking rate (kg weight/irrigation corrected ha)	**0.671**	< .001		
Milk production (l/100 kg weight)	0.06	0.43	-0.11	0.14
Milk production (solids/100 kg weight)	0.05	0.55	**-0.22**	0.00
Concentrates to CiM (g/l)	-0.14	0.06	**0.18**	0.02
Pasture utilisation (tons req./tons grown)	**0.35**	< 0.001	**0.16**	0.04
Pasture in diet (%)	**-0.28**	< 0.001	**-0.45**	< 0.001
Home-grown roughage in diet (%)	0.08	0.28	0.06	0.40
Bought feed in diet (%)	**0.26**	< 0.001	**0.43**	< 0.001
Fertiliser (kg N/ha)	**0.37**	< 0.001	**0.21**	0.01
Fertiliser (kg P/ha)	0.00	0.97	**-0.18**	0.02
Fertiliser (kg K/ha)	0.02	0.77	0.08	0.28
Cost of feed (R/l)	-0.08	0.28	**0.17**	0.03
Cost of fertiliser (R/l)	**-0.34**	< 0.001	**-0.25**	< 0.001
Gross margin (R/l)	**0.15**	0.04	-0.12	0.12
Gross margin (R/ha)	**0.80**	< 0.001	**0.44**	< 0.001
Carbon footprint (kg CO2e/kg FPCM)	**-0.21**	0.01	**-0.16**	0.03
NUE (%)	**0.24**	0.00	0.00	0.99

Table 6. Correlations between pasture grown per cow and various profitability, productivity, and sustainability indicators using data from the Trace & Save research database on all the farms which raise heifers on the farm (n=316)

Parameters	Pasture grown (kg DM/kg weight)	
	Spearman's rho	*p-value*
Stocking rate (kg weight/ha)	**-0.37**	< 0.001
Stocking rate (kg weight/irrigation corrected ha)	**-0.65**	< 0.001
Milk production (l/100 kg weight)	0.07	0.22
Milk production (solids/100 kg weight)	**0.20**	< 0.001
Concentrates to CiM (g/l)	**-0.24**	< 0.001
Pasture utilisation (tons req./tons grown)	**-0.34**	< 0.001
Pasture in diet (%)	**0.85**	< 0.001
Home-grown roughage in diet (%)	**-0.34**	< 0.001
Bought feed in diet (%)	**-0.60**	< 0.001
Fertiliser (kg N/ha)	**-0.13**	0.03
Fertiliser (kg P/ha)	-0.03	0.64
Fertiliser (kg K/ha)	0.09	0.13
Cost of feed (R/l)	**-0.28**	< 0.001
Cost of fertiliser (R/l)	**0.12**	0.04
Gross margin (R/l)	**0.27**	< 0.001
Gross margin (R/ha)	**-0.15**	0.01
Carbon footprint (kg CO2e/kg FPCM)	0.07	0.20
NUE (%)	0.07	0.21

fertiliser per litre is lower than the rest of the farms. Only the gross margin per hectare is higher on the higher stocking rate farms, not the gross margin per litre, so there is still the issue of exposure to the risk of inflation. The biggest reason for this is the high feed that is still being relied upon on these farms.

The holistic, sustainable farm system

I have one more step to explore in this data, since just looking at the highest stocking rate farms did not yield much extra insight. Once again using the smaller 176 farm dataset, I used four measures to rank farms: gross margin per litre; gross margin per hectare; carbon footprint; and nitrogen use efficiency. I ranked all the observations from 1-176 for each measure. Then I looked at which observations were in the top third (i.e. top 33%) in all four categories. This resulted in 15 observations (out of interest from 10 different farms) of farms which I would argue are the most sustainable based on overall measures. Hence, they are the farms we should be looking to as examples of an ideal system.

Using these 15 observations I wanted to see if there was anything to learn from their stocking rates and other parameters. So I compared the average of all the parameters we have been looking at between these 15 observations and the other 161 observations (using a Mann-Whitney U test). The best-performing farms were distinct from the other farms (see Table 8 for actual results).

Some of the other differences which are not statistically significant, but are still important to point out since any farmer would recognise that these results are meaningful, are presented in Table 3 below.

I find these results to be fascinating in our quest to understand stocking rates better. Other than higher stocking rates, there are some very important additional aspects of their farms. Although the stocking rates of these farms are higher than the rest of the farms, their stocking rate is nowhere close to as high as the highest stocking rate farms in the previous analysis (i.e. 1 933 vs 2 277 kg weight/ha). And the stocking rate per irrigation corrected hectare, although higher, was not statistically significantly higher on these top-performing farms. Chasing the highest possible stocking rate is not the answer. Too low of a stocking rate is an obvious problem, but so too is too high of a stocking rate.

One of the distinct advantages of a higher stocking rate throughout this case study has been that a higher stocking rate is associated with a higher gross margin per hectare. These 15 observations show that a more balanced approach blows a high stocking rate out of the water. These farms had an average gross margin of R81 619 R/ha, whereas the average for the highest stocking rate farms was R68 601. And these top-performing farms had a much higher gross margin per litre as well.

The important things that these top-performing farms were able to achieve, which are different to the highest stocking rate farms, are a combination of:

- Optimal milk production – better milk production per weight and higher solids per weight are important aspects of a sustainable dairy farm. Since these are not correlated with stocking, they are independent of the stocking rate and are therefore an important distinguishing factor on top-performing farms.
- Better feed conversion in terms of lower concentrates, lower proportion of bought feed, higher pasture utilisation and lower cost of feed. This is also a different balance than what is found with high stocking rates. This means these farms buck the trend of less pasture with higher stocking rates, which allows them to get away with less bought feed and hence a lower cost of feed. This is such an important distinction. The danger of too high stocking rate is too high cost of bought feed. Farmers must figure out how to strike

this balance on their farms – it is not straightforward and takes a high level of management to get right.
- Lower fertiliser costs, with a lower nitrogen application rate. The lower cost of fertiliser is consistent with a high stocking rate, since even high N application rates per hectare are diluted by high milk production per hectare on these farms. What is distinct about the top performing farms is that they achieved an even lower cost of fertiliser per litre by having a lower N application rate than the other farms. This can only be achieved through improved soil health, which has been discussed in detail in the WWF-Nedbank case study mentioned earlier.

Table 7. Comparison of average values of various profitability, productivity, and sustainability indicators on top third of farms in terms of highest stocking rate versus the rest of the farms using data from the Trace & Save research database on farms which raise heifers on the farm and do not grow any home-grown roughage, and have predominantly pasture areas (n=176).

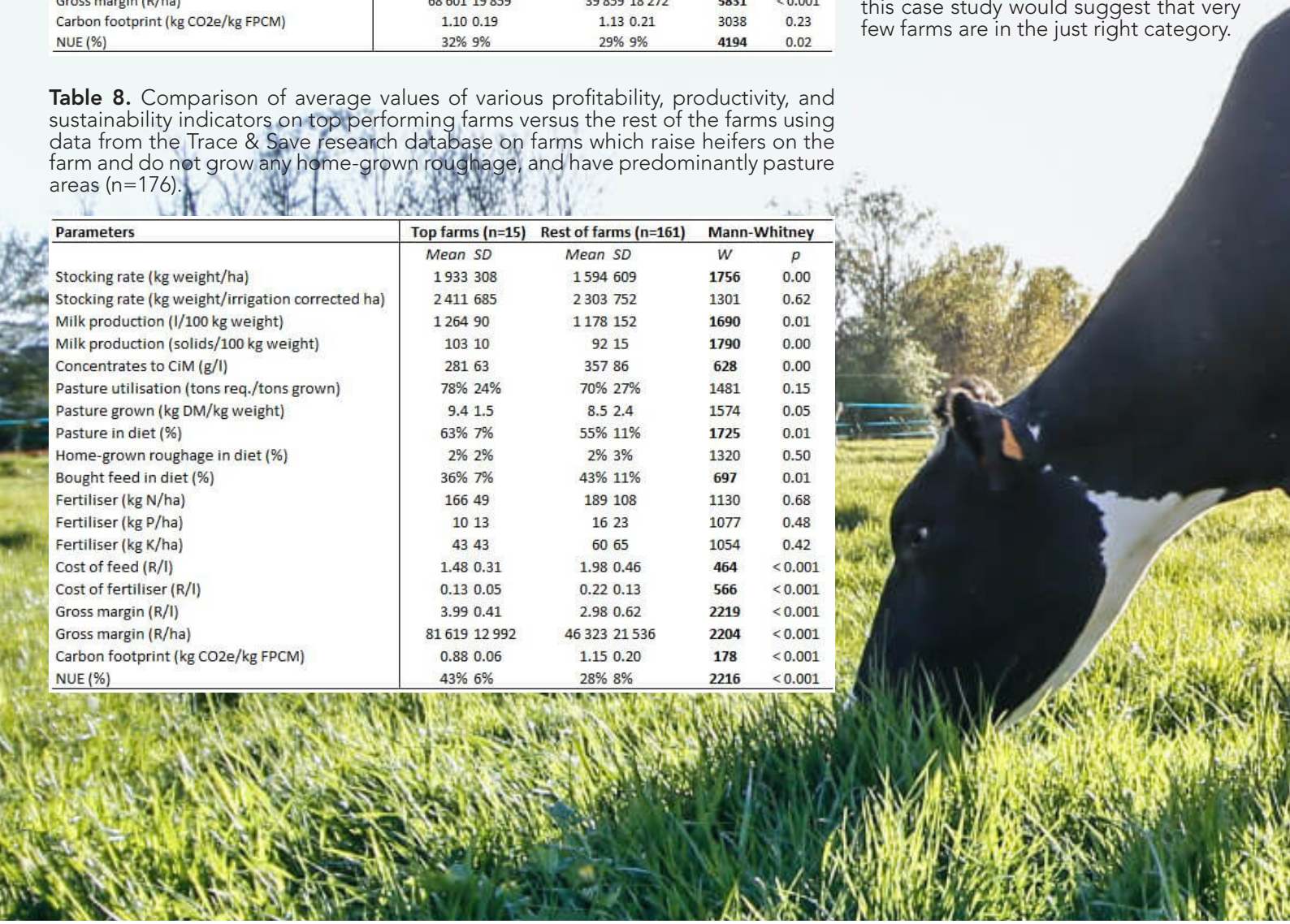
Parameters	Highest stocking rate (n=58)		Rest of farms (n=118)		Mann-Whitney	
	Mean	*SD*	*Mean*	*SD*	*W*	*p*
Stocking rate (kg weight/ha)	2 277	427	1 301	355	**6844**	< 0.001
Stocking rate (kg weight/irrigation corrected ha)	2 826	747	2 060	604	**5446**	< 0.001
Milk production (l/100 kg weight)	1 195	145	1 180	151	3736	0.32
Milk production (solids/100 kg weight)	93	15	92	15	3586	0.61
Concentrates to CiM (g/l)	340	94	355	83	3159	0.41
Pasture utilisation (tons req./tons grown)	83%	22%	64%	27%	**4954**	< 0.001
Pasture grown (kg DM/kg weight)	7.4	1.9	9.2	2.3	**1959**	< 0.001
Pasture in diet (%)	52%	12%	57%	10%	**2419**	0.00
Home-grown roughage in diet (%)	2%	3%	2%	3%	3621	0.47
Bought feed in diet (%)	46%	12%	41%	11%	**4355**	0.00
Fertiliser (kg N/ha)	218	104	172	101	**4394**	0.00
Fertiliser (kg P/ha)	18	24	14	21	3473	0.87
Fertiliser (kg K/ha)	58	70	59	61	2990	0.17
Cost of feed (R/l)	1.93	0.50	1.94	0.45	3480	0.86
Cost of fertiliser (R/l)	0.16	0.09	0.24	0.14	**2056**	< 0.001
Gross margin (R/l)	3.15	0.67	3.03	0.67	3675	0.43
Gross margin (R/ha)	68 601	19 859	39 859	18 272	**5831**	< 0.001
Carbon footprint (kg CO2e/kg FPCM)	1.10	0.19	1.13	0.21	3038	0.23
NUE (%)	32%	9%	29%	9%	**4194**	0.02

Table 8. Comparison of average values of various profitability, productivity, and sustainability indicators on top performing farms versus the rest of the farms using data from the Trace & Save research database on farms which raise heifers on the farm and do not grow any home-grown roughage, and have predominantly pasture areas (n=176).

Parameters	Top farms (n=15)		Rest of farms (n=161)		Mann-Whitney	
	Mean	*SD*	*Mean*	*SD*	*W*	*p*
Stocking rate (kg weight/ha)	1 933	308	1 594	609	**1756**	0.00
Stocking rate (kg weight/irrigation corrected ha)	2 411	685	2 303	752	1301	0.62
Milk production (l/100 kg weight)	1 264	90	1 178	152	**1690**	0.01
Milk production (solids/100 kg weight)	103	10	92	15	**1790**	0.00
Concentrates to CiM (g/l)	281	63	357	86	**628**	0.00
Pasture utilisation (tons req./tons grown)	78%	24%	70%	27%	1481	0.15
Pasture grown (kg DM/kg weight)	9.4	1.5	8.5	2.4	1574	0.05
Pasture in diet (%)	63%	7%	55%	11%	**1725**	0.01
Home-grown roughage in diet (%)	2%	2%	2%	3%	1320	0.50
Bought feed in diet (%)	36%	7%	43%	11%	**697**	0.01
Fertiliser (kg N/ha)	166	49	189	108	1130	0.68
Fertiliser (kg P/ha)	10	13	16	23	1077	0.48
Fertiliser (kg K/ha)	43	43	60	65	1054	0.42
Cost of feed (R/l)	1.48	0.31	1.98	0.46	**464**	< 0.001
Cost of fertiliser (R/l)	0.13	0.05	0.22	0.13	**566**	< 0.001
Gross margin (R/l)	3.99	0.41	2.98	0.62	**2219**	< 0.001
Gross margin (R/ha)	81 619	12 992	46 323	21 536	**2204**	< 0.001
Carbon footprint (kg CO2e/kg FPCM)	0.88	0.06	1.15	0.20	**178**	< 0.001
NUE (%)	43%	6%	28%	8%	**2216**	< 0.001

Conclusion

These findings make it clear to me that there is a lot more to sustainable dairy farming than finding the perfect stocking rate. An ideal stocking rate is one which is high, but not too high. But more important than this is that a farmer can optimise milk production, achieve good feed conversion, and reduce fertiliser costs. For some of these, a higher stocking rate is an advantage, for example reducing fertiliser costs and increasing pasture utilisation, but in other areas, a higher stocking rate is a challenge, for example feeding less bought feed and having higher pasture intake. Therefore, every farmer should assess their system and see where they still have opportunities to improve. This will probably show them whether their stocking rate is too low, too high, or just right. The data in this case study would suggest that very few farms are in the just right category.



A fledgling environmental observation platform in the arid lands at the Square Kilometre Array

Helga van der Merwe, Sue Milton, Richard Dean, Tim O'Connor and Joh Henschel

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The establishment of the Square Kilometre Array (SKA) presents an opportunity to promote and expand long-term environmental research in the drylands of the Karoo. The National Research Foundation (NRF) now owns about 135 000 ha of land where the highest concentration of the SKA radio astronomy infrastructure will be placed (Figure 1).

This land is located within an area declared as the Karoo Central Astronomy Advantage Area (KCAAA – Astronomy Geographic Advantage Act). Furthermore, the SKA property was declared as the Meerkat National Park in March 2020, managed by the South African National Parks (SANParks).

Livestock, predominantly sheep, were removed from the NRF property, resulting in a marked reduction in stocking pressure. The SKA infrastructure development will be accompanied by the removal of internal fencing, artificial water points and extensive stands of alien mesquite (Prosopis spp.) trees, and a gradual increase in wildlife numbers over time under the management of SANParks. Thus, the SKA property and neighbouring farmland can serve as a large-scale, long-term landscape-level experiment manipulating stocking rate, animal type, animal distribution and direct vegetation management.

This development is an excellent opportunity to investigate gradual natural or assisted rehabilitation of areas disturbed in the past or due to current developments. The reduction of the stocking rate and a switch from rotational

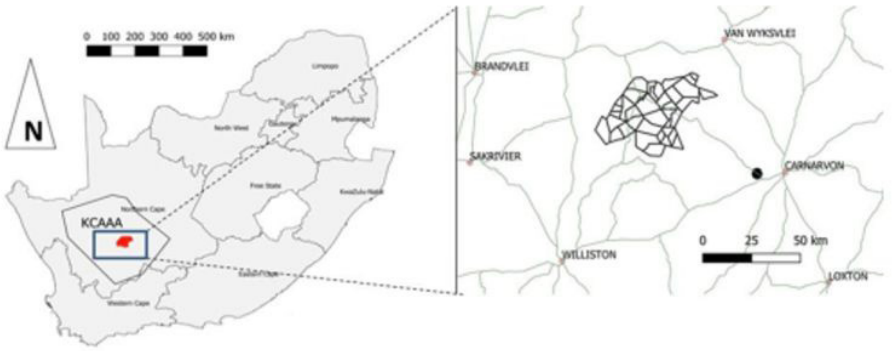

Figure 1. The location of the Square Kilometre Array (SKA) area, Northern Cape, South Africa. National Research Foundation property boundaries are indicated in black. (*KCAAA, Karoo Central Astronomy Advantage Area*[25])

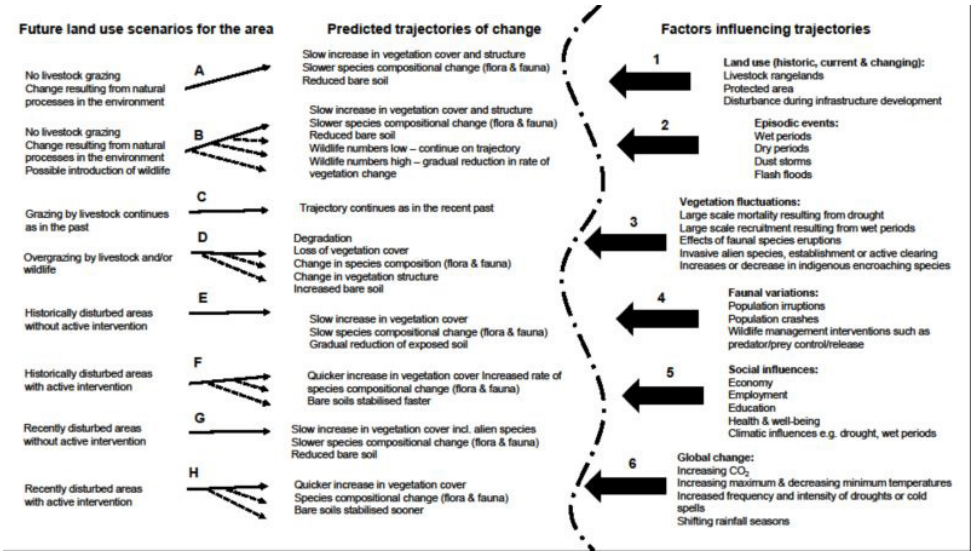

Figure 2. The conceptual model of future land-use scenarios predicted trajectories of change and factors that could influence the predicted trajectories. (Source: Van der Merwe *et al.*, 2021)

Figure 3. The shrubby plains and inselbergs of the SKA region. (Photo: Helga van der Merwe)

Figure 4. Grassy patches on deeper sandy soils. (Photo: Helga van der Merwe)

Figure 5. Historically disturbed areas without active rehabilitation. (Photo: Helga van der Merwe)

domestic stock grazing systems for commercial purposes to a continuous grazing system for large-scale wildlife management by a conservation entity is a great opportunity to learn about the complex responses of ecosystems to changes in land management.

In planning to develop an environmental observation research platform, NRF-SAEON collated relevant information on the area in a comprehensive environmental baseline report (Milton et al. (2020). Using available information and possible future land-use scenarios, Van der Merwe et al. (2021) developed a conceptual model predicting trajectories of change under these scenarios and the factors influencing them (Figure 2).

NRF-SAEON aspires to investigate the changes taking place in the larger SKA landscape and invites collaboration with researchers already present in the landscape, for example, the South African Radio Astronomy Observatory (SARAO) and SANParks, as well as researchers from a diversity of fields from other organisations wishing to contribute to our understanding of Karoo rangelands.

Further reading

Milton SJ, Henschel JR, Van der Merwe H, Dean WRJ, Meyer-Milne E, Gerber H. *Environmental baseline review of the core area and surrounds of the Square Kilometre Array (SKA).* SAEON report and appendices. Pretoria: South African Environmental Observation Network (SAEON); 2021. https://doi.org/10.15493/saeon.arid.10000001

Van der Merwe H, Milton SJ, Dean WRJ, O'Connor TG, Henschel JR. Developing an environmental research platform in the Karoo at the Square Kilometre Array. *S Afr J Sci.* 2021;117(11/12), Art. #10511. https://doi.org/10.17159/sajs.2021/10511

Figure 6. Assessment of possible long-term monitoring sites. (Photo: Joh Henschel)

Prosopis, a silent but deadly invasion

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Travelling anywhere north and west of Beaufort West reveals an increasingly dominant feature in the landscape, a feature that does not belong, the invasive alien *Prosopis* or honey mesquite tree (*Prosopis glandulosa* var. *torreyana*). Previously they could be observed as occasional trees along some of the watercourses, now they completely dominate the drainages, and also well beyond them.

They have benefitted from degraded veld conditions, exacerbated by drought and they are here to stay. Forming dense thickets, to the almost complete exclusion of the local indigenous vegetation, in some areas it is all that can be seen for long distances along the roadsides.

The *Prosopis* has been classified as a Class 1 invader species due to its aggressive spread and the threat that it represents to natural rangelands and water security in arid areas.

The *Prosopis* is native to northeastern Mexico and the southwestern United States of America. It was first introduced into Southern Africa in 1897 in South West Africa (now Namibia) where German settlers planted it for shade and livestock feed. It was found to be very useful but by 1912 it had established itself in the wild and by the 1960's, dense invasions, that were very difficult to control, were already a recognized problem. The invasion had begun.

In South Africa, it was planted for windbreaks and shade in Upington from where it has spread into the Great Karoo and the Kalahari Thornveld. There are approximately 45 species of *Prosopis* and some species have become a worldwide problem, invading rangelands in the USA, Australia, Namibia, East Africa, India, Hawaii and the Middle East regions. *Prosopis juliflora* is a rampant alien invasive tree problem in Central and northeast Africa and most particularly in Kenya. Some *Prosopis* species are native to Africa including the djembe (*Prosopis africanus*).

Figure 1. A young *Prosopis glandulosa* shrub, establishing away from (escaping) the dense infestation along the watercourse in the background.

Prosopis is an extremely successful invader. Originating from an arid region, it is well equipped to survive drought and it flourishes under conditions of rangeland overgrazing and extended drought.

Should we be overly concerned? and should more be done to combat this invasion? One gets the feeling that nobody seems to be really concerned or to care enough about this problem. Can this be because of ignorance? or a lack of awareness? or simply an apathetic attitude to an apparently unsolvable problem?

I have observed that many landowners who have low density, scattered *Prosopis* on their properties, fail to recognize the impending threat or to be moved to control these precursors to the invasion that will follow. These low-density *Prosopis* trees need to be quickly (and continuously) removed before they become dense invasions which are costly, and almost impossible to control.

Whatever the reasons behind this apparent lack of concern, it is quite clear that a fresh approach to the *Prosopis* problem is urgent, an approach that will inspire both the land management authorities and landowners to take action.

Why we need to be concerned

Prosopis has already spread over 1.8 million hectares of South Africa, this represents 1.8 million hectares of grazing rangelands lost. The size of this

Figure 2. *Prosopis glandulosa* trees dominate riverbank vegetation.

invasion can double every 5 to 8 years based on the rate of spread to date and the invasion can increase at a rate of 18% per year. Do the calculation, the result is frightening!

Prosopis replaces the locally indigenous vegetation, it out-competes other arid-adapted trees (such as *Acacias*) by making use of water more effectively. Dense invasions of *Prosopis* can actually lower the water table, putting groundwater beyond the reach of the natural local vegetation. It is also allelopathic, which means that it "poisons" the soil under it and by so doing prevents the germination of seeds and the establishment of indigenous plants that may compete with it.

Prosopis uses more water than most of the indigenous trees, and where it occurs in extensive and dense infestations, has been labelled a water "waster". *Prosopis* typically invade overgrazed, eroded and drought-affected areas. Unfortunately, these are conditions that are typical of most of the arid rangelands of South Africa. Climate change and global warming will create even more favourable conditions for the spread of this plant invader.

The deep-rooted *Prosopis* can damage borehole pipes, can block boreholes and it can also dry up wells and springs. Its preference for watercourses results in widespread damage to natural hydrology. Dense infestations together with water-carried plant debris create barriers in watercourses which can divert the normal flow into the surrounding veld alongside drainages resulting in accelerated soil erosion. The *Prosopis* invasions result in the loss of wetland-adapted plants like grasses, sedges and reeds which naturally line and protect river banks from erosion during flooding.

Dense *Prosopis* lining watercourses can prevent livestock and game from accessing the water or watercourse grazing and shade. These plants sometimes form an impenetrable "wall of thorns" that can prevent the movement of all larger animals through it.

A prime concern with *Prosopis* is the cost of control. It has been found that farmers in the Northern Cape spend approximately R20 000.00 per farm per year. With the ever-increasing spread of the invasion, and the rising costs of herbicide, transport and labour, this expenditure will probably increase substantially in the near future. This will unfortunately dampen the enthusiasm of landowners to do any effective *Prosopis* control.

Description and adaptation

Prosopis glandulosa var. *torreyana* (honey mesquite) is the primary invasive *Prosopis* species in Southern Africa but it can also hybridize with *Prosopis velutina* making accurate identification somewhat difficult. Both species, and the hybrids, however, are equally invasive.

Prosopis is a multi-stemmed shrub or small tree that closely resembles an *Acacia*. It can grow up to 10 m high and forms dense impenetrable thickets. It has straight paired thorns and the younger branches are a reddish-brown colour. The tiny yellow flowers occur in spikes, looking somewhat like a small yellow bottlebrush. The feathery compound leaves are dark green and each tiny leaflet is 10 to 20 mm long. The fruits are narrow yellowish or purplish woody pods which are highly favoured by both livestock and game.

The *Prosopis* tree is phreatophytic which means that it can obtain its water needs from the saturated zone in the soil, just above the water table. It is able to survive extreme water stress as its taproot can reach deep groundwater, penetrating more than 50 m deep and its roots can spread up to 40 m laterally enabling very efficient use of both upper soil moisture as well as much deeper groundwater. *Prosopis* is reputed to have the deepest roots of any tree in the world.

Prosopis can thus tolerate a wide range of rainfall patterns ranging from a mean of 100 mm to 1500 mm per annum. This extremely wide ecological flexibility enables *Prosopis* to adapt to a wide range of soil types including stony substrates, terrace gravels, alluvial dune sand, clay soils, lime-rich soils and saline soils.

Despite the arid environments to which *Prosopis* is very well adapted, it can live for 100 years or more and can grow at a rate of up to 30 to 60 cm per year, an impressive growth rate by any standard.

How *Prosopis* invasions affect the environment

Ecosystem services like water supply and grazing potential are unavoidably affected by *Prosopis* invasions. The invasions also have a negative impact on bird and invertebrate diversity and biology and this is certain to have a knock-on effect on pollination services in the affected areas.

Prosopis invasions have been known to cause the death of keystone tree species like *Acacia erioloba*. The invasions are known to reduce the density, species richness and diversity of indigenous woody plants and also reduce the cover of indigenous herbaceous plants, particularly grasses and herbs as a result of the allelopathy characteristic of *Prosopis*.

The general loss of the protective ground cover under the *Prosopis* canopy results in accelerated soil erosion because the now unprotected soil surfaces are more easily carried away by runoff water. Soil erosion is thus typical of *Prosopis* infestations because of the loss of the natural indigenous vegetation soil cover.

The general loss of biodiversity as a result of the invasions also has implications for the livelihoods of rural communities. The loss of *Vachellia karroo* and *Acacia erioloba*, both important keystone plants in arid systems for farming and the loss of grazing and browsing for livestock irreversibly changes the fortunes of the people who traditionally depended on these natural resources.

The primary negative impact of *Prosopis* invasion, however, is certainly the general loss of soil moisture, making conditions more arid for the indigenous vegetation and making water less available for livestock and game.

Controlling the *Prosopis* invasion

The first step towards the effective control of the *Prosopis* invasion is undoubted to improve awareness about the problem and then the following step must be to instil a desire in landowners to control new infestations and sparsely invaded areas before they too become hopelessly invaded and too expensive to eradicate.

Prosopis is notoriously difficult to control because if it is merely damaged through inadequate removal, it will simply resprout from the base again to form a dense multi-stemmed tree with twice or three times as many flowers producing seeds for further invasion.

Mechanical control

The basic mechanical control method is to clear-cut the trees, as close to the ground as possible, and then treat the cut stumps with a suitable herbicide to kill off the stumps and roots to prevent resprouting. The herbicide should be applied with a paintbrush to prevent overspill onto other plants.

The basic principle to use as a guide is to cut out the light infestations (occasional plants) and small patches before tackling the areas of denser infestation. In this way, the partially invaded areas can be cleared and then kept clear of *Prosopis*. The denser areas will then become isolated patches in the otherwise uninvaded veld. One can then clear around the edges of the patches, shrinking them and, hopefully, eventually clearing them away completely. Then follows what is known as the maintenance level of control during which the cleared areas are followed up, repeatedly, to cut and treat what resprouts or germinates from the seed. The initial control of the denser mature *Prosopis* is labour intensive and expensive but the maintenance level of control will reduce in cost with every follow-up action.

The key to success here is the follow-up clearing, if this is not done properly then the initial investment in clearing the trees will have been money down the drain.

Biological control

Goats have been found to consume more *Prosopis* seeds than other livestock and game and few of the seeds eaten survive through the goat's digestive system. Goats have been effectively used in Texas to help control the spread of *Prosopis*.

Alien plants become naturalized and invasive because they flourish in the absence of their natural enemies in their new host region. The biological control of invasive plants involves the deliberate use of these natural plant enemies

Figure 3. The leaves, flowers and red stems of *Prosopis glandulosa*.

Figure 4. *Prosopis glandulosa* seed pods.

which are specially collected from the area of origin of the invasive plant. By introducing these natural plant enemies, which are also without their own natural controls, it is sometimes possible to decrease and even completely eradicate invasive alien plants. A good example of the successful use of biocontrol in South Africa is the Cochineal insect (*Dactylopius austrinus*) which was introduced from Central America to help control the spread of prickly pear (*Opuntia ficus indica*). The introduction has been so successful that the cactus has been completely eradicated in some areas.

Great care, however, must be taken to ensure that the selected biocontrol agent is completely host-specific and that it will not attack closely related indigenous plants of the host region and, thereby, itself becoming a new invasive problem organism. Potential biocontrol agents must thus be carefully screened in quarantine while conducting exhaustive trials that will ultimately ensure that the agent is completely host-specific and therefore "safe" to use. The Plant Protection Research Institute of South Africa is the agency tasked with this long-term and extremely important research.

When a suitable biocontrol agent is declared "safe" it can be released onto the invasive plants to multiply and prey on their host plant. The procedure of screening a potential biocontrol agent is, unfortunately, a time-consuming and lengthy process and therefore also rather expensive.

Once cleared and declared safe for introduction, successful biocontrol agents can become the most cost-effective method of alien vegetation control and, in some cases, may result in the complete eradication of the problem plant. This ideal situation, however, takes considerable time to develop and biocontrol should not completely replace mechanical and chemical control methods, but should rather be introduced simultaneously to assist with the overall control strategy. Biocontrol is thus not a miracle "quick-fix" option.

The advantages of biocontrol are numerous:

- There is no pollution, as no chemicals are used.
- The biocontrol agents are only released if completely host-specific – there is thus no danger of introducing a new alien problem organism.
- Biocontrol agents are self-dispersing.
- Once successfully introduced, biocontrol is permanent – there is thus no need to regularly reinfest, as is the case with a chemical application which has to be continuously followed up.

It is important to appreciate that the aim of biocontrol is not to eradicate the invasive alien plant, but to reduce its competitiveness with the indigenous plant species, this reduces the density of the infestation and thus its overall impact on the environment.

The main disadvantage of biocontrol is that the level of control that the biocontrol agent will achieve is not known beforehand and there is a delay before biocontrol agents achieve their full impact. There is, however, a very positive benefit to cost ratio - the benefits of biocontrol normally outweigh the drawbacks and it still represents a comparatively cheap and safe option for the control of alien plant invasions.

Biocontrol agents for alien trees come in a variety of forms and operate in a variety of ways. It is thus often the best

strategy to release a variety of control agents for one particular alien plant species. Most agents are either insects, mites or fungi. Insects (often beetles, moths and flies) are usually flower head or flower bud feeders, seed feeders, leaf miners or stem borers. It is most often the larvae of the insects that do the damage. Flower, fruit or seed-feeding insects will not destroy the plant, but will reduce its reproductive potential. To really damage an alien plant, flower and seed feeders, stem borers, leaf miners and fungal agents should be simultaneously introduced for maximum effect.

Some insect agents (certain wasps and midges) attack the growing tips of the host plant and manipulate the host to divert valuable resources into gall production rather than the production of flowers, seeds, stems and leaves. A gall is a globular, woody swelling, sometimes used by the insect agent as a site for egg-laying or as a food source for larvae. Some fungi also cause growing tips to gall. Irrespective of how the galls are formed, the result is the same – the reproduction of the host plant is severely disrupted.

Some insect bio-control agents can complete their life cycle in as little as 10 days from egg to new adult, while others may take as long as 10 months to complete their cycle.

The Plant Protection Research Institute (PPRI) of the Agricultural Research Council of South Africa can be contacted regarding the acquisition of approved biocontrol agents for release on invasive alien plants.

The two biocontrol agents that have been released in South Africa are both seed-feeding beetles *Algorobius prosopis and Neltumius arizonensis*.

Biocontrol of *Prosopis* has been restricted to introduced seed-feeding insects due to the perceived value of *Prosopis* as animal feed and as a source of wood, and as a result, the biocontrols released have not been aggressive enough to be effective for the widespread eradication of *Prosopis*. The introduction of other more effective biocontrol agents has been frustrated by the potential that these bio-controls may affect non-invasive, indigenous and useful *Prosopis* in North African regions. In South Africa the perceived value of *Prosopis* hampers the "stepping up" of effective biological control, of which there are an additional 9 beetles, 4 moths and a gall midge, all known to be highly effective in the control of *Prosopis* elsewhere.

An extensive study in South Africa revealed that local rural communities preferred indigenous firewood sources to *Prosopis* even though *Prosopis* was freely available. *Prosopis* coals do not last as long as those of indigenous wood, the thorns make it more difficult to harvest, wet *Prosopis* gives off unpleasantly smelly smoke and dried Prosopis is more quickly reduced to powder by wood-boring beetles. The solution to the Prosopis problem is clearly not firewood.

The use of *Prosopis* for timber in South Africa is relatively low-key compared to its use elsewhere, such as in India, so silviculture with *Prosopis* does not appear to be a solution to the problem in South Africa either.

So, in a nutshell, a more effective biocontrol solution to the rampant spread of *Prosopis* is really urgent.

Summary

Clearly, the rapid spread of *Prosopis* in South Africa is a major catastrophe. Equally clear is that the problem is not being effectively addressed, as it should be, and that many millions of hectares of grazing rangelands, rivers, wetlands and groundwaters are at risk.

A fresh, new awareness is needed, landowners need to be advised, helped and encouraged to take action with new and spreading *Prosopis* invasions. Farmers' associations, farmers' unions and the formal agricultural sector all have a great responsibility here for creating greater awareness about the *Prosopis* invasion threat. We need videos about the problem, the threat and the control actions required.

The future implications of doing nothing must be clearly and visually expressed in the media and to those that have the responsibility of guiding agriculture, nature conservation and running the country.

Research and implementation of additional, more aggressive biocontrol agents are urgently required as this is probably the most practical way in which to effectively address the areas that are already densely invaded.

The use of *Prosopis* for the manufacture of charcoal, biochar, dry animal feed and activated charcoal should be investigated, researched and implemented. Attaching a value to the *Prosopis* product will certainly help with the control of the invasion.

The above are some of the options that could be explored because without any dedicated human intervention, much of our valuable rangelands will be forever transformed into useless, environmentally damaged *Prosopis* monocultures.

References

Bromilow, C. 2018. *Problem plants and alien weeds of Southern Africa*. 4th Edition. Briza Publications, Pretoria.

Coetzee, K. 2005. *Caring for natural rangelands*. University of Kwa-Zulu Natal Press, Scottsville.

Henderson, L. 2001. *Alien weeds and invasive plants*. Plant Protection Research Institute, Handbook No.12, Agricultural Research Council.

Shackleton, R.T. , Le Maitre, D.C., van Wilgen, B.W. & Richardson, D.M. 2015. *The impact of invasive alien Prosopis species (mesquite) on native plants in different environments in South Africa*. S. African J. Botany, Vol.97 (25-31).

Shackleton, R.T., Le Maitre, D.C. & Richardson, D.M. 2015. *Use of non-timber forest products from invasive alien Prosopis sp. (mesquite) and native trees in South Africa: Implications for Management*. Forest Ecosystems, Open Access, Springer Nature.

Strohbach, B.J., Ntesa, C., Kabajani, M.W., Shidolo, E.K. & DÁlton, C.D. 2015. *Prosopis encroachment along the Fish River at Gibeon, Namibia*. Dinteria, No. 35(53-73).

Van Wilgen, B.W. & Richardson, D.M. 2014. *Challenges and tradeoffs in the management of invasive alien trees*. Biol. Invasions. 16 (721-734). Springer Nature, Forest Ecosystems, open-access online.

Zachariades, C. Hoffman, J.H. & Roberts, A.P. 2011. *Biological control of mesquite (Prosopis species) (Fabaceae) in South Africa*. African Entomology, 19 (2): 402 -415).

Removing alien plants can save water: we measured how much

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Humans' relationship with nature is broken. We're transforming the Earth so dramatically that almost one million plant and animals species face extinction. Losing species unravels the tapestry of nature, changing how ecosystems function and, ultimately, damaging society too.

Nature brings huge benefits to people. Some are tangible. In South Africa alone, the value of these benefits to people is estimated at R275 billion annually (about 7% of the country's gross domestic product). That value includes providing the country with crops, wood, water and fuel.

There are other, less immediately tangible benefits, too: air purification, water regulation, water purification, recreation, tourism, and cultural and heritage value.

One of the things that contribute to ecosystem degradation in South Africa is the invasion by alien plants. This is estimated to cost the nation R6.5 billion annually in damages and the government spends over R400 million annually clearing alien trees. Despite this investment, alien tree invasions continue to increase across the country.

Alien trees threaten biodiversity, increase the risk of more intense and frequent wildfires and also guzzle water. This is an important factor in water-scarce regions, like South Africa, that experience drought.

Alien trees are invading mountainous areas across South Africa. These are important water generating regions and the trees threaten water supplies in several cities, among them Cape Town and Gqeberha. Both have experienced water shortages in recent years.

To find out just how much alien trees threaten the water supply, we conducted a hydrological study. The research set up the most fine-scale, detailed models possible to try and estimate how alien trees affect streamflow in four small mountain catchments above some of Cape Town's major dams. This study also used satellite imagery to input accurate information on the types of alien trees and where they are.

Key findings

The models predicted that clearing catchment areas fully infested with mature invasive alien trees can increase streamflow by between 15.1% and 29.5%. Although the catchments modelled are currently not fully invaded, this presents a strong argument for preventing full invasion.

The study also found that streamflow gains from clearing alien trees from rivers were almost twice as high as clearing the alien trees from the surrounding land. That's because alien trees in rivers have access to an almost endless water supply and so use more.

Another interesting finding was that clearing alien trees seemed to have a greater impact on the mid to low flows – in other words during the dry season when the river flow is low, rather than the high flows – during rainfall events in the wet season when the rivers are full.

This makes sense: during rainfall events, there is so much water that the negative effects of alien vegetation become less evident.

But it is important because it implies that clearing alien trees makes more water available in between rain events, especially in the dry season. This is useful to improve water security during droughts.

The positive effect of clearing alien trees was also predicted to be higher in dry years compared to wet years. This suggests that clearing alien trees is a viable measure to ensure there will be more water when it is most needed.

It is useful to explain what the savings predicted by our models mean to Cape Town's overall water supply – and to consumers. For instance, we found that clearing the current levels of invasion in the catchments above the Berg River Dam (currently 9% invaded) could increase streamflow by over 1%.

This doesn't sound like a lot, but it could mean an increase in the mean annual volume of as much as 1.5 million m^3 or 4.1 million litres per day.

According to the 1:50 year yield model for the Berg River Dam, this equates to a 0.2% increase in yield. Putting this into perspective with a quick first-order calculation, from the City of Cape Town's Water Strategy, we have a value of R9 per kilolitre for the operating costs of desalination. If we multiply this by the

Figure 1. Alien trees threaten biodiversity, increase the risk of wildfires and also guzzle water. Photo courtesy Cape Winelands Biosphere Reserve

0.2% increase in yield each year from clearing alien trees above the Berg River Dam, we get to an estimated annual equivalent value of that water of around R2 million.

However should the Berg River Dam catchment become fully invaded with alien trees, this would reduce the 1:50 year yield by 4.3%, costing us about R38 million each year if we had to source this water elsewhere.

Reversing the damage

Our findings are important for several reasons. First, they can be used to encourage society to redouble its work by clearing alien vegetation. Second, they confirm that improved water security is possible for South African cities during their dry seasons or droughts.

It is critical that more work be done to halt and reverse the degradation of ecosystems. This is especially urgent in what the United Nations has dubbed the Decade on Ecosystem Restoration.

We all have a chance to undo some of the damage we have wrought – and, as our research shows, clearing alien trees must be part of these efforts.

Jason Hallowes contributed to this article. We thank Dr James Cullis for his help with the yield calculations and cost estimations.

How to make Africa's 'Great Green Wall' a success

One of the world's most ambitious plans to restore degraded land needs a more meaningful way to measure its achievements

Nature.com

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It's now 15 years since the African Union gave its blessing to Africa's Great Green Wall, one of the world's most ambitious ecological-restoration schemes. The project is intended to combat desertification across the width of Africa, and spans some 8,000 kilometres, from Senegal to Djibouti. Its ambition is staggering: it aims to restore 100 million hectares of degraded land by 2030, capturing 250 million tonnes of carbon dioxide and creating 10 million jobs in the process. But it continues to struggle.

An assessment two years ago by independent experts commissioned by the United Nations stated that somewhere between 4% and 20% of the restoration target had been achieved (go.nature.com/39zqgkr). That figure has not changed, according to the latest edition of Global Land Outlook (go.nature.com/3kdjtw5) from the UN Convention to Combat Desertification (UNCCD), out last week. Equally concerning is the fact that funding for the project continues to lag. Africa's governments and international donors need to find around US$30 billion to reach the 100-million-hectare target. So far, $19 billion has been raised.

A pandemic — and now a cost-of-living crisis — has placed demands on all governments, and that means countries might be expected to reduce their green-wall commitments. But the project continues to be weighed down by other difficulties, including the complex system through which it is funded and governed, as well as how its success is measured. These problems can and must be fixed, otherwise, it will struggle to achieve its goals.

One potential solution — improved metrics — comes from an analysis published last year by Matthew Turner at the University of Wisconsin–Madison and his colleagues (M. D. Turner *et al. Land Use Policy* 111, 105750; 2021). The researchers explored limitations in the Great Green Wall project metrics by assessing the impact of World Bank funding from 2006 to 2020. As their work indicates, definitions of success depend on which measure is used.

In Niger, for example, green-wall projects could be said to be succeeding if measured by the area of eroded soil that has been recovered or by the number of trees that have been planted. But the authors report that these gains were not necessarily benefiting the most vulnerable people. In places, women were being excluded from employment in green-wall projects, and in some cases, local administrations looked to privatize restored land that might instead have been owned by everyone in a community.

Broader problems with metrics are highlighted in the UN's latest land-degradation report. This estimates that nearly half of the land that has been pledged for restoration worldwide will be planted predominantly with fast-growing trees and plants. This will provide only a fraction of the ecosystem services produced by forests that are allowed to naturally regenerate, including significantly less carbon storage, groundwater recharge and wildlife habitat.

The Great Green Wall project also needs more predictable funding and more transparent governance. The project was conceived by Africa's leaders for the benefit of the continent's people, on the basis of warnings from scientists about the risks of desertification and land degradation. The original idea was not brought to Africa by international donors, as is often the case in international science-based development projects. But it still relies on donor financing, and lots of it — and that brings other problems, among them coordination challenges.

The project is the responsibility of an organization set up by the African Union called the Pan African Agency of the Great Green Wall, based in Nouakchott, Mauritania. But some donors, such as the European Union and the World Bank, are not providing most of their Great Green Wall funding through this agency. Instead, they often deal directly with individual governments, because this gives them more control over how their money is spent. It is unfair to expect the Pan African Agency to coordinate a raft of donors doing one-on-one deals with individual countries. Bypassing the Pan African Agency also creates a problem for transparency, because it makes it harder for the African Union to determine precisely who is funding what.

In January 2021, at an international biodiversity summit hosted by France, Emmanuel Macron, the French president, announced that the Great Green Wall would receive an extra $14 billion in funding for 5 years. He also said that a new body, called the Great Green Wall Accelerator, based in Bonn, Germany, would be responsible for pulling together funding pledges and tracking progress against targets. This is well-intentioned, but the accelerator needs to coordinate its work with the Pan African Agency. It is not yet clear how this will happen.

A potentially more transformative solu-

tion was proposed two years ago by a group of UN-appointed experts. They recommended that a single trust fund be set up that all donors could contribute to and through which they could decide funding priorities together. Regrettably, this has not happened, and observers say it is not likely to happen in the current climate.

This month, the international community will come together in Abidjan, Côte d'Ivoire, for the 15th conference of the parties to the UNCCD. The green wall's funders and participating countries will all be there. If a single trust fund is off the table, they must work together to find a better way to coordinate their green-wall project activities. It is also essential that they study the findings of Turner and colleagues' review. Along with a focus on existing metrics, the Great Green Wall needs evaluation criteria that take better account of the needs of all people in participating countries, particularly the most vulnerable.

Figure 1. Farmers at a Great Green Wall site in Niger. Researchers have found that the project does not always benefit the most vulnerable people. Credit: Boureima Hama/AFP/Getty

Jersey cows happily grazing on the mixed pastures at the Outeniqua Research Farm near George. Photo: Malissa Murphy

Managing grasslands for biodiversity

Richard Lechmere-Oertel

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South Africa's grasslands cover approximately a third of the country from the eastern seaboard into the interior. They provide ecological infrastructure and economic benefits to a range of users, from families to municipalities and metropolitan centres. There are five Ramsar wetlands and three world heritage sites in South Africa's grasslands.

Although grasses make up the dominant layer of the grassland, only one in six plants are actually grass species. Other plant types include bulbs and soft-leaved herbaceous plants (collectively called forbs), ferns, subterranean trees, shrubs and scattered trees or bush clumps. The non-grass component of this plant community has high conservation value, but is vulnerable to land use pressure.

Grasslands support diversity in all the major animal groups: mammals, birds, reptiles, amphibians and invertebrates. Stock farmers depend on the grassland biome for grazing and most of the country's sheep and cattle are found here. Beef production has increased by almost 10% during the past decade, yet the area under grazing has declined because of expanding human settlement, alien plant invasion, veld degradation, mining, crop farming and forestry.

Figure 1. South Africa's grasslands cover approximately a third of the country.

Converting land use to cropping, mining or forestry significantly modifies an ecosystem. Livestock grazing also affects grasslands over time, but the changes are more subtle. As grazing and burning regimes change, grasslands can lose productivity and ecosystem function.

The resilience of grasslands

The deterioration of the grasslands deprives future generations of the benefits associated with this biome. However, it is not feasible for the state to purchase the land needed to meet grassland conservation targets. Alternative low-cost mechanisms to protect valuable grassland biodiversity include biodiversity-friendly grazing and burning programmes. These can improve livestock productivity and preserve grassland integrity.

Most unmodified grasslands are used for extensive livestock production, with fire and grazing the primary management tools. Any change in fire and grazing that supports more resilient grassland will better sustain livestock production and biodiversity, even in the face of climate change. Integrating biodiversity objectives with extensive livestock grazing management principles has a positive impact on the biome.

Burning and grazing guidelines

The South African Biodiversity Institute (Sanbi) has compiled best-practice guidelines for burning and grazing. These can be used by farmers with some technical understanding of grazing and burning. The information available covers agriculture and conservation issues and can help land managers and extension officers understand the principles of grassland ecology as they relate to grazing and burning management.

The guidelines give practical advice that can be applied at farm level to improve plant and animal conservation and maintain livestock production. The guidelines were developed from discussions with grassland ecologists, farmers, and biodiversity and grazing specialists. They represent the current best understanding of how to achieve the mutually beneficial objectives of sustainable livestock production, improved or stable veld and soil condition, and conservation of the grassland and its plant and animal species.

Grassland ecosystems

South Africa's grasslands are resilient and stable ecosystems dominated by perennial plants that can withstand repeated defoliation or disturbance by fire, drought, frost and grazing. However, they are not invincible. Changes in plant vigour, species composition, vegetation structure and productivity occur in response to various management pressures, particularly inappropriate grazing and burning. These changes are highly undesirable in terms of biodiversity, livestock productivity and ecosystem functioning. But they are avoidable if the grassland is well managed.

Grasslands are found at a range of altitudes, from sea level to an altitude of above 3 000 m. They occur across various environments — from the sandy coastal plains and rolling hills of the eastern seaboard to the steep slopes, valleys and ridges of the sub-escarpment, up onto the plateaux of the high escarpment and the plains of the central Highveld. Across this landscape, 72 grassland vegetation types are recognised. They are differentiated from one another by shifts in species composition resulting from a complex interplay of environmental variables such as climate, topography, geology and soil.

Environmental patterns influence other ecological forces such as grazing and fire, which give rise to finer differen-

tiation of the grassland types. The 72 grassland vegetation types have been arranged into three broad groups based on their species composition, community structure, ecological characteristics and response to management.

- Dry Highveld Grassland
- Mesic Grassland
- Mesic Highveld Grassland
- High-Altitude Grassland
- Sub-Escarpment Grassland
- Coastal Grasslands
- Maputaland Coastal and Wooded Grassland
- Pondoland-Ugu Sandstone Coastal Grassland
- KwaZulu-Natal Coastal Belt
- Transkei Coastal Belt

Although the grassland ecosystems have similarities, each is unique in its sensitivity and response to grazing and burning, and requires a slightly different management approach. Within the ecosystems, the vegetation types share similar structure and species composition, are maintained by similar ecological processes and have similar management requirements.

Grassland management involves integrating the two primary tools of grazing and burning, particularly in the more mesic grasslands.As the principles of biodiversity-friendly grazing and burning are applied across increasing areas of grasslands, there is a better chance for the persistence of biodiversity across the large portions of the grassland biome used for extensive animal production.

Rangeland management

These biodiversity-friendly management guidelines build on an extensive body of agricultural principles, such as moderate stocking rate and rest, that complement biodiversity conservation. Indeed, a minimum starting point for biodiversity-friendly rangeland management is to correctly apply the agricultural best practices that emphasise healthy veld and soil. There is a correlation between veld condition and biodiversity values.

Several methods of grazing, differing significantly from one another in theory and practice, have been published. Indeed, grazing and burning management in South Africa is a hotly debated topic. This series does not attempt to review the strengths and weaknesses of these regimes, but rather focuses on the principles of biodiversity-friendly grazing that managers can apply.

At the end of the series, a model for grazing and burning is presented as an example on which a land manager can develop his or her own model. This should by no means be seen as the only model. Relatively little research has been done on biodiversity-friendly grazing and burning. This allows the debate to be dominated by anecdotal evidence and speculation rather than by sound science. Considering that grasslands are complex systems about which there is insufficient knowledge, the focus of the guidelines will be on management principles. Conservative practices are applied to guard against damage through ignorance.

Action based on observation

There will never be a single recipe for successful management in all grassland ecosystems and socio-economic contexts. It is thus better to avoid a strict rules-based approach in favour of a principled, adaptive management approach that recognises the saying, slightly modified for this context:

- "The eye of the owner makes for healthy veld and fat cattle".

In short, the manager should observe the grassland and so acquire knowledge of how it responds to various management and climatic regimes. Management decisions can then be based on these observations and the principles presented in the guidelines.

Phone Tsumbedzo Mudalahothe on 012 843 5000 or e-mail t.mudalahothe@sanbi.org.za, or email Dr Richard Lechmere-Oertel at richard.bpm@gmail.com. Visit www.grasslands.org.za.

Irrigated mixed pasture systems on the Outeniqua Research Farm near George.

Through Thicket and Thin: Protecting This Incredible Biome

Zoë Chapman Poulsen

Current Address: Botanical Society of South Africa

Reprinted from: https://bit.ly/3OqLjlW

South Africa's thicket vegetation is characterised by a dense tangle of multistemmed and often prickly shrubs. Despite its initially unwelcoming appearance, it is in fact home to the highest diversity of different plant growth forms compared with the country's other biomes.

Thicket comprises evergreen and deciduous trees, a rich succulent diversity from towering Euphorbias to creeping vygies, shrubs, vines, bulbs and grasses. Historically, thickets have received little attention from scientists in comparison with other biomes such as the fynbos, but this is changing.

Where is thicket found?

Thicket is found in semi-arid areas of the Western Cape and the Eastern Cape. It forms part of the thicket biome and is present as a key vegetation type in three different biodiversity hotspots in South Africa, namely the Maputaland-Pondoland-Albany, Succulent Karoo and Cape Floristic Region.

It is distributed in South Africa from the Gouritz River eastwards to the Kei River, with the largest areas of thicket being found in the Gamtoos, Sundays and Fish River valleys.

Thicket biodiversity

There are estimated to be around more than 1 500 plant species that are found in thicket, of which about 20% are endemic to this extraordinary vegetation and found nowhere else on earth. Thicket is also home to the second largest succulent flora in the world, with 344 species and an extraordinary level of endemism of 50%.

It comprises a total of 206 species across 66 genera. But thicket vegetation is highly understudied and it's likely that there are in fact more species waiting to be discovered. Either way, the proportion of bulbs in the total thicket flora is one of the highest in the world, only short of the fynbos biome and Namaqualand in the Succulent Karoo.

Thicket is also home to many different animals and birds, as well as a substantial reptile fauna including four tortoise species and many endemic lizards. Large mammals play an important ecosystem engineering role,

Figure 1. Top: Dune Thicket along the Eastern Cape coast, with African Aloe (*Aloe africana*) emerging above the thicket canopy. Left: Grassridge Bontveld, a mosaic-type thicket restricted to calcareous soils derived from limestone. Right: Many shrubs typical of karoo shrublands also occur in arid forms of thicket, such as this Perdekaroo (*Oedera humilis*) found in noorsveld around Jansenville. Dunes along the Cape south coast house dune fynbos–thicket mosaic vegetation, with dune thicket patches restricted to deep, fire-protected swales. Photos by Adriaan Grobler.

Figure 2. Succulent-rich Valley Thicket on shallow soils of the Zuurberg Mountains near Kirkwood. Photo by Adriaan Grobler.

Figure 3. Top left: Greater Kudu (*Tragelaphus strepsiceros*) are a common sight in Thicket vegetation of the Eastern Cape. Top right: The succulent shrub *Crassula perfoliata* var. *falcata* grows on open rocky slopes in Thicket vegetation. Bottom left: Club Spurge (*Euphorbia clava*), a stem-succulent frequently seen along the fringes of thicket clumps. Bottom right: The dwarf succulent *Aloe bowiea* is an unusual and threatened aloe species found only in open patches between Thicket in Nelson Mandela Bay. Photos by Adriaan Grobler.

Figure 4. Top left: Shepherds Tree (*Boscia oleoides*) in arid thicket that has been degraded by livestock overbrowsing. Top right: Above: Noorsveld, a form of Arid Thicket, with karroid elements like soetnoors (*Euphorbia radyeri*) and Cape Aloe (*Aloe ferox*). Photos supplied by Adriaan Grobler.

including elephants, black rhinos and even buffalo, creating open spaces that allow other wildlife to move through the vegetation.

Formed by the climate

Subtropical thicket vegetation is found in areas that receive an average annual rainfall of 200–950 mm per year.

This rainfall is distributed throughout the year due to the convergence of two different climatic systems. The region to the southwest receives year-round rainfall, whereas the area to the northeast receives most of its rainfall during the summer months.

In the northeast of the thicket biome, as the climate moves toward summer rainfall, the vegetation gradually transitions to grassland and thorn tree savanna. As the climate changes to the southwest, there is a gradual transition to fynbos.

Geology and soils: A rich history

The thicket biome is dominated by the mountains of the Cape Fold Belt, which comprises sandstone and quartzite geology of the Table Mountain and Witteberg groups.

These date from the Ordovician Period (starting 485 million years ago) to the Silurian Period (from 443 million years ago) and the Devonian Period (between 419 to 358 million years ago).

This geology is of biogeographical importance because it supports outliers of fynbos and renosterveld vegetation within the thicket biome.

Most of these fine-scale variations in vegetation are because of the interaction between climate and soils, the latter of which are derived from the underlying geology.

Origins of the thicket biome

Most lineages of the flora and associated insects of the thicket biome have their origins in the Eocene (56–33.9 million years BP) when the climate became much colder and drier. This timing is supported by evidence derived from fossil pollen.

Some taxa have their origins in the supercontinent of Gondwanaland, dating back more than 280 million years. This includes cycads in the genus *Encephalartos*, the cabbage tree *Cussonia* in the *Araliaceae* family, as well as the bird of paradise plants (Strelitzia).

Many of the trees that grow in thicket are tropical in affinity, with extensive distribution ranges extending northwards

Figure 5. Mountain Cabbage Tree (*Cussonia paniculata*) commonly occurs in temperate forms of Thicket found along mountain ranges of the Great Escarpment. Photo by Adriaan Grobler.

Figure 6. Valley Thicket occurring in a single landscape with three other biomes – fynbos, forest and grassland – in the Zuurberg Mountains north of Kirkwood. Photo by Adriaan Grobler.

into the African subtropics and tropics.

Threats to thicket: Losses continue

Like many of South Africa's highly biodiverse ecosystems, thicket faces a range of different threats. In fact, around 70% of thicket has been transformed or removed. Threats include crop cultivation, livestock grazing and urban development.

Much of the thicket that remains intact and in good condition is conserved within national parks, including Addo National Park in the Eastern Cape.

However, there is concern among conservationists regarding the thicket outside of the protected area estate, with more work needed to protect this biome.

At the same time, more research is needed to better understand thicket. Several of our BotSoc Algoa Branch members are now involved with thicket research, which will also assist in conserving the thicket biome.

The Botanical Society of South Africa is committed to the strategic conservation of South Africa's extraordinary flora and biodiversity. Learn more about our work on our website and by following our social media channels.

Further reading

Cowling, R.M. Pierce, S. (2009) *East of the Cape: Conserving Eden*, Fernwood Press, Simonstown, South Africa.

Mucina, L. Rutherford, M.C. (2006) *The Vegetation of South Africa, Lesotho, and Swaziland*, Strelizia 19, South African National Biodiversity Institute, Pretoria, South Africa.

Figure 7. Arid Thicket with spekboom (*Portulacaria afa*) dominant on upper slopes and soetnoors (*Euphorbia radyeri*) dominant in lowlands. Photo by Adriaan Grobler.

‘Human factors’, not just the climate crisis, aggravated KZN floods - top hydrology researcher

Professor Emeritus of Hydrology at the University of KwaZulu-Natal’s Centre for Water Resources Research argues that not just heavy rain and climate change were responsible for the devastation in Durban and other provincial areas.

Tony Carnie

Current Address: Daily Maverick
Reprinted from: https://bit.ly/3cDgsoL

Given the devastating impact of the “rainbombs” that struck Durban and other parts of the KwaZulu-Natal coast in April and May, it’s no surprise that several commentators have described the recent floods as the worst in living memory — and also linked them to the global climate crisis.

Yet, contrary to popular perception, detailed historical analysis suggests that the KZN coastline has experienced many similar events over the past 170 years — some of them significantly worse in terms of the volume or intensity of rainfall (see historical details further below).

While the jury is still out on the extent to which the April/May 2022 weather events were driven by human-induced climate change, one of South Africa’s most senior hydrology researchers suggests that it is equally important to interrogate and address the wide variety of “human factors” that aggravated the severity and human death toll of the most recent floods.

Roland Schulze, Professor Emeritus of Hydrology at the University of KwaZulu-Natal’s Centre for Water Resources Research, says the rapid and widespread expansion of human settlement and industrial development around Durban has created vast new areas of hard, impervious surfaces which exacerbate the erosive power of floodwaters.

Figure 1. Cars are seen semi-submerged on the road during severe floods on 10 October 2017 in Durban, South Africa. (Photo: Gallo Images / The Times / Thuli Dlamini)

Whereas larger areas of grasslands, gardens and undisturbed natural vegetation once helped to absorb or disperse floodwaters, the almost wall-to-wall covering of concrete, brick paving or tarred roads in some parts of the city has promoted faster and more intense water channelling and scouring.

Due to the lack of strict planning controls on where to build or how to build, several informal homes had been built in vulnerable floodplains. In other places, homes were built on steep slopes (often with unstable soils) or without adequate foundations.

Schulze also suggests that the proliferation of shallow-rooted alien plants along river courses was a further contributing factor. Quoting research by eThekwini

Figure 2. Roland Schulze, Professor Emeritus of Hydrology at the University of KwaZulu-Natal's Centre for Water Resources Research. (Photo: Supplied)

municipality civil engineer Geoff Tooley, he noted that these shallower-rooted plants were washed away more easily than slower-growing and deeper-rooted indigenous vegetation.

As these plants were uprooted, the exposed soils were washed away rapidly, with alien plant debris and growing volumes of litter adding to the blockage of stormwater culverts.

How did the 2022 floods compare with previous storms in KZN?

Between 9 and 12 April, Durban and other parts of the KZN coastline were hit by three days of very heavy rain due to a cut-off low-pressure system.

The heaviest rain (more than 300 mm) fell on 12 April onto already saturated soils due to the preceding two days of rainfall between. By the fourth day, Virginia Beach in Durban had measured an accumulation of 411 mm while Pennington measured 464 mm.

Just six weeks later, there was a "double-blow", when the coast was struck by further heavy falls of between 160 mm and 240 mm over consecutive days (21 to 22 May).

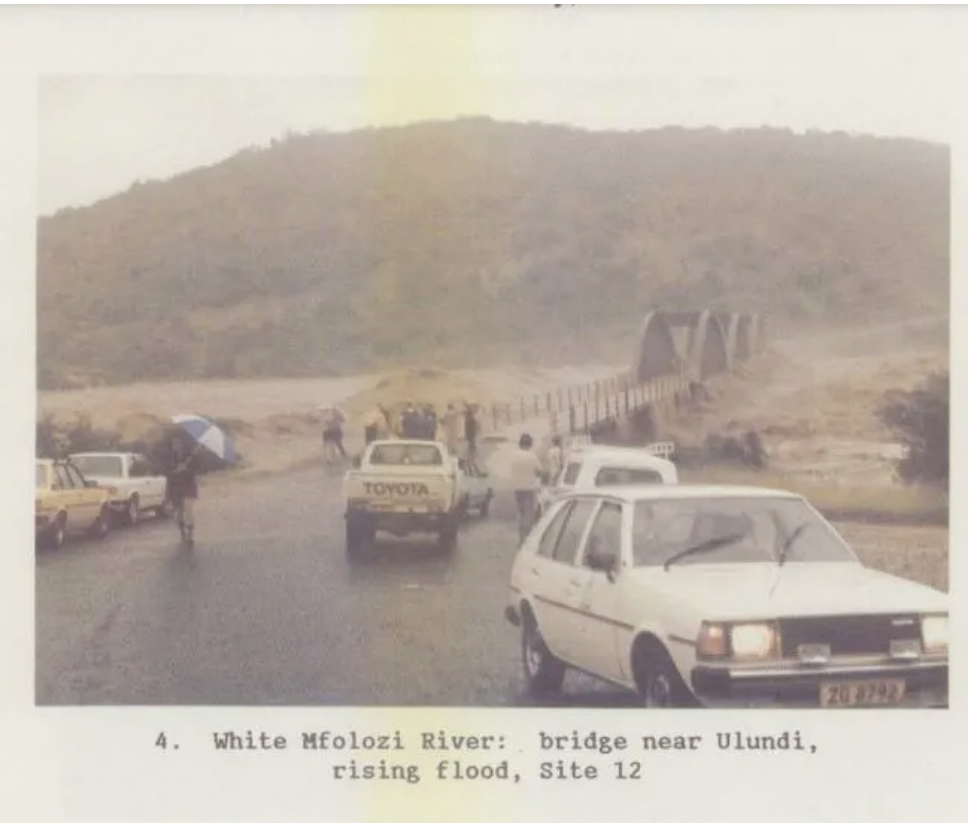

Figure 4. Vehicles were stranded next to the Umfolozi River bridge which was severely damaged. (Photo: Department of Water Affairs)

Dramatic as they are, these falls have been exceeded several times since rainfall collection records began from the 1850s onwards.

To compare the severity of the recent floods, Schulze extracted data from a variety of sources, including a South African Weather Bureau document titled "A History of Exceptional Weather Occurrences in South Africa: 1500-1990" (which Schulze translated from Afrikaans to English).

Schulze also notes that similar heavy rains fell over the KZN coast in May 2017, November 2019 and November 2020, but does not elaborate on the rainfall volumes recorded during these events.

Why are comparisons important?

Schulze says that — devastating as it was — April 2022 had to be seen in the context of previous similar floods and storms.

The scale of devastation had prompted the senior government and state-linked officials (including President Cyril Ramaphosa) to suggest "unequivocally" that climate change was behind these floods.

"A key question is whether such statements and sentiments related to climate change are backed up with certainty by science, especially when scientific experts at the South African Weather Service, commenting on this particular April 2022 cut-off low-pressure system, could not with any 'quantifiable precision', attribute it to climate change."

Further questions that arose were "whether rainfalls and associated floods of the magnitude of the ones in April 2022 are necessarily related directly to climate change, or whether statements such as those above are signs of conveniently jumping on to the climate change bandwagon by blaming climate change for possibly unrelated naturally

Table 4 One-day as well as 2-consecutive day, 3- and 4-consecutive day accumulated rainfall values, with antecedent rainfall amounts in square brackets, at the four stations with the highest precipitation during the April 2022 floods across KwaZulu-Natal

Location	1-Day Rainfall 12 April 2022	2-Day Accumulated [& Antecedent] Rain 11-12 April	3-Day Accumulated [& Antecedent] Rain 10-12 April	4-Day Accumulated [& Antecedent] Rain 9-12 April
Margate	311	368 [57 mm]	410 [42 mm]	427 [17 mm]
Mt Edgecombe	307	354 [47 mm]	385 [31 mm]	411 [26 mm]
Pennington South	307	370 [63 mm]	438 [68 mm]	464 [26 mm]
Virginia Airport	304	344 [40 mm]	370 [26 mm]	404 [34 mm]
Average	**307 mm**	**359 mm**	**401 mm**	**427 mm**

Figure 3. Rainfall data for the 2022 Durban floods showing the total volumes after four days – (Source: Roland Schulze)

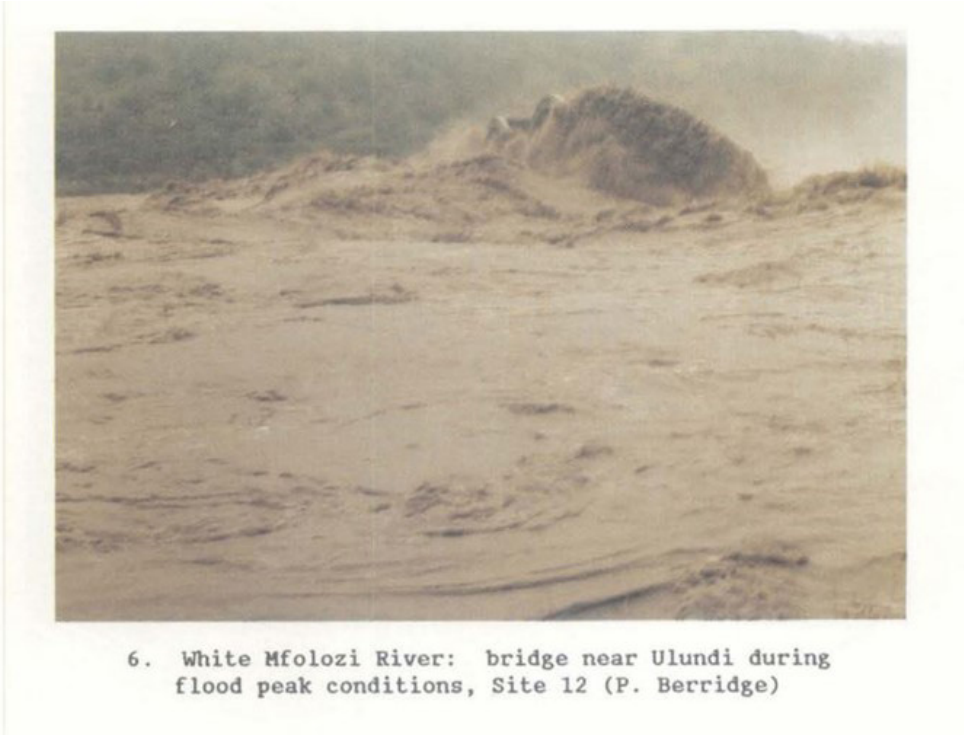

Figure 5. The top of the Umfolozi River bridge is just visible above the raging waves of river water. (Photo: Department of Water Affairs)

occurring disasters, or by using climate change for either political expediency, point-scoring, or to hide shortcomings of own governance, or possibly out of sheer ignorance of KwaZulu-Natal's flooding history?"

It is worth stressing at this point that Schulze is by no means a climate change sceptic.

In fact, Schulze has been researching climate change since the early 1990s and was a lead author or contributor for two United Nations Intergovernmental Panel on Climate Change (IPCC) expert reports.

He was the recipient of the SA Institute of Agricultural Engineers Gold Medal for "outstanding contributions to hydrology in SA"; he has advised the Dutch government on how to adapt to climate change and also served on the International Commission on Irrigation and Drainage working group on global climate change and irrigation.

The search term "climate change" pops up more than 600 times in his CV, which lists the research projects he, his colleagues and students have been involved in.

As real as climate change is, and as severe as the recent Durban floods were, Schulze says historical records kept since the 1850s show that "there have been many rainfall events far exceeding the magnitudes of the 2022 flood" for single and for multiday accumulated rainfalls. Compared with some past events, rainfall intensities in the April 2022 rains were "generally quite low, and by anecdotal accounts much higher rainfall intensities have been experienced many times in the past".

For example, some of the highest rainfall intensities recorded in Durban in 2022 were 51 mm/h at Shongweni and 31mm/h at Cato Ridge, whereas extrapolation from historic records suggested Durban rainfall intensities as high as 260 mm/h in 1984 and 135 mm/h in 1985. This suggested that most of the damage in 2022 was due to the overall amount of rainfall rather than the intensity.

To learn lessons from the 2022 floods and to prepare for the more frequent and severe weather events predicted by global climate modelling, he suggests that solutions should include:

- A review of disaster management strategies;

Figure 6. Northridge Park complex was affected by mudslides after severe storms hit the area on 11 October 2017 in Durban, South Africa. (Photo: Gallo Images / The Times / Jackie Clausen)

- Better catchment management to clear alien vegetation;
- A review of human settlement planning, including preventing settlement in floodplains and below recommended floodlines;
- Better maintenance and upgrades of drainage systems;
- Construction of new engineered structures to intercept debris before it blocks culverts or bridges; and
- An update of methods of reliable and consistent flood estimation with easy access to up-to-date climate information from the SA Weather Service.

In a paper to be submitted to the Transactions of the Royal Society of South Africa, he says: "Given the above findings from the history of flood producing rainfalls in KZN, this writer — although a proponent of dire consequences which climate change may have on hydrological events because of the non-linear responses of runoff to changes in rainfall, and with a long list of publications since the 1990s on potential climate change impacts — at this point in time urges caution to place the cause of the 2022 KZN flood producing rainfalls unhesitatingly on climate change." DM/OBP

Figure 7. Residents cross a flooded road during severe floods on 10 October 2017 in Durban, South Africa. (Photo: Gallo Images / Daily Sun / Jabulani Langa)

Figure 8. A damaged car after a mudslide on 27 April 2019 in Durban, South Africa. (Photo: Gallo Images / Netwerk24 / Edrea du Toit)

New near-real-time tool reveals Earth's land cover in more detail than ever before

Carolyn Cowan

Current Address: Mongabay news & inspiration from nature's frontline
Reprinted from: https://bit.ly/3PHT08s

- *A new tool co-developed by Google Earth Engine and the World Resources Institute is being billed as the planet's most up-to-date and high-resolution global land cover mapping data set, giving unprecedented levels of detail about how land is being used around the world.*
- *The launch of the tool this week marks a big step forward in enabling organizations and governments to make better science-based, data-informed decisions about urgent planetary challenges, the developers say.*
- *Named Dynamic World, it merges cloud-based artificial intelligence with satellite imagery to give near-real-time global visualizations of nine types of land use and land cover.*
- *The tool is likely to be important for a variety of purposes, the developers say, such as monitoring the progress of ecosystem restoration goals, assessing the effectiveness of protected areas, creating sustainable food systems, and alerting land managers to unforeseen land changes like deforestation and fires.*

Google and the World Resources Institute (WRI) this week announced the launch of a new mapping tool touted as providing an unprecedented level of detail about how land is being used around the world. Called Dynamic World, it's said to be the first global land cover data set available in near-real-time at high resolution.

"It's a new frontier in global, high-resolution, near-real-time environmental monitoring," Rebecca Moore, director of Google Earth, said at an online press launch on June 6.

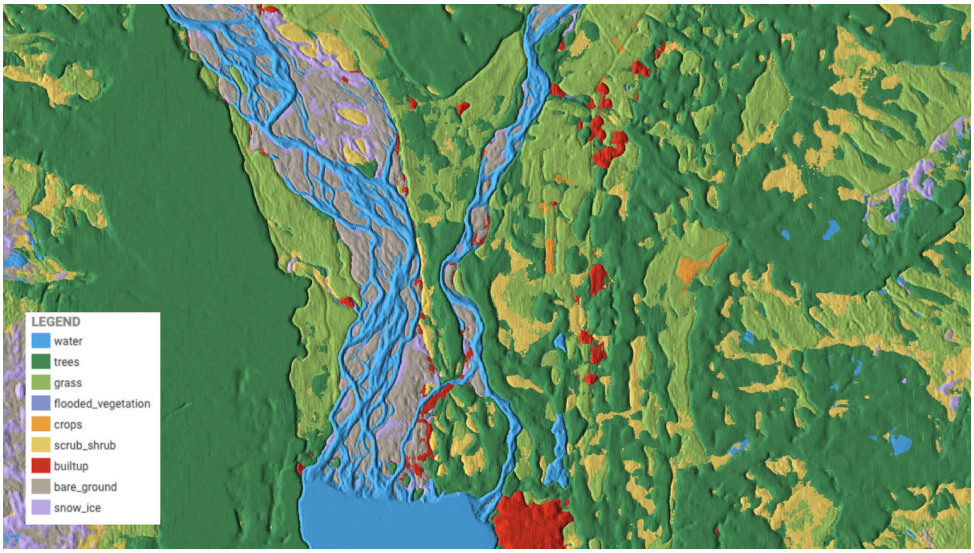

Figure 1. A Dynamic World land use land cover map showing the distinct classification of different land cover types. Image courtesy of Google / WRI.

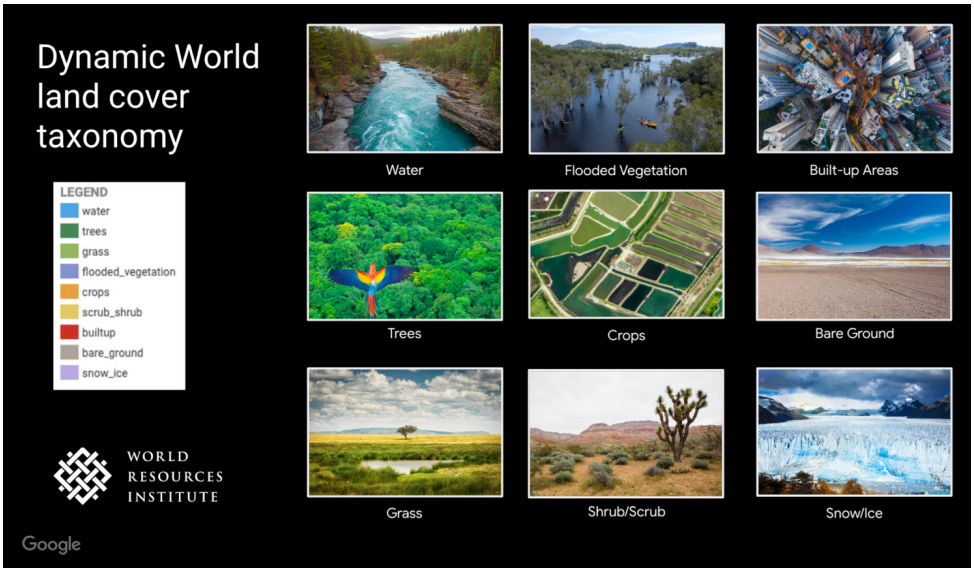

Figure 2. The nine land cover types Google Earth Engine's cloud-based artificial intelligence classifies to generate the land use land cover mapping in Dynamic World. Image courtesy of Googe / WRI.

Powered by Google Earth Engine's cloud-based artificial intelligence, Dynamic World uses satellite imagery with a resolution of 10 by 10 meters (33 by 33 feet) from the European Space Agency's Sentinel-2 satellites to reveal up-to-date coverage of a suite of different land and water types, including urban development, wetlands, forests, crops and trees.

While satellite images are typically processed as soon as they become available, up until now, global land cover maps often take months to produce and are updated only on a monthly or annual basis. As a result, decision-makers at times lack timely data that could lead to rapid actions to address environmental disturbances, such as unprecedented changes to seasonal ecosystem cycles, the impacts of storms, floods and fires, or human disturbances like illegal logging.

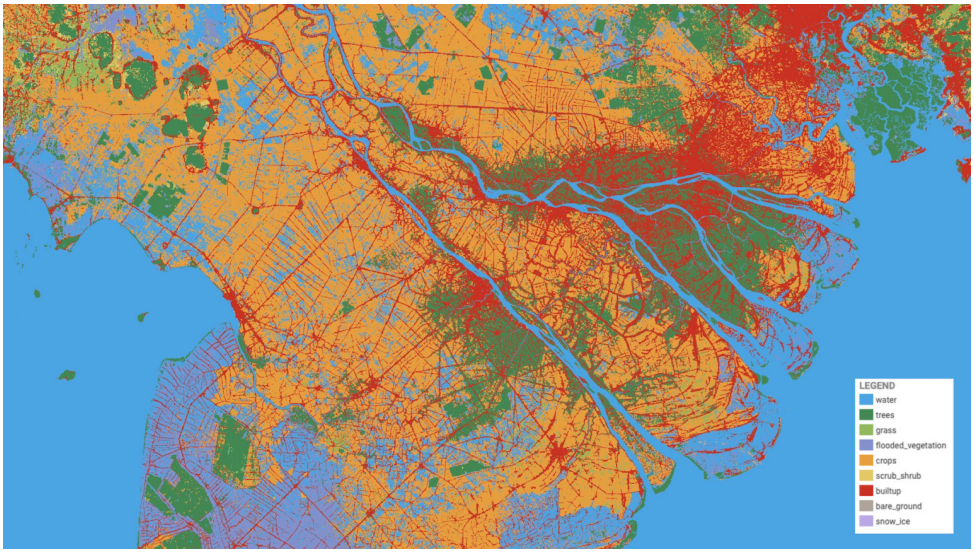

Figure 3. A Dynamic World land use land cover map of the Mekong River delta, showing classification of different land cover types like urbanized Ho Chi Minh (red pixels). Image courtesy of Google / WRI.

"We've heard from a number of governments and researchers that they're committed to taking action … but they're lacking critical environmental monitoring information that they need [in order] to understand what's happening on the ground," Moore said. She added that the level of detail available through Dynamic World will now enable scientists and policymakers to rapidly detect and quantify the extent of environmental change anywhere on Earth.

A new study about the tool, published June 9 in Scientific Data, says Dynamic World's features will "enable unprecedented flexibility for a diverse community of users across a variety of disciplines."

The Dynamic World tool leverages the systematic orbit of the ESA's Sentinel-2

Figure 4. Land use mapping via the new tool can enable monitoring groups to hold oil palm companies accountable for the clearing of natural forests. Image by Rhett A. Butler for Mongabay.

satellites, which collect imagery of the entire globe every five days at the equator and every two to three days at mid-latitudes, amounting to more than 5,000 images per day. These are streamed into the Google Earth Engine's AI platform for analysis.

As new satellite images become available, the AI system classifies land cover types in near-real-time by detecting combinations of nine different land cover types — water, flooded vegetation, built-up areas, trees, crops, bare ground, grass, shrub/scrub, and snow/ice — in the images and calculating which types are most representative within each 10-by-10-meter pixel.

The continual updates mean the data set is extremely up-to-date, and users can also compare land-use maps for specific areas across chosen time periods between 2015 and two days ago. The data set is open-access and freely available on monitoring platforms Google Earth Engine and Resource Watch.

Speaking at the launch event, Craig Hanson, vice president of food, forests, water and the ocean at the World Resources Institute, said the new tool will enable public, private and nonprofit groups to make wiser decisions to protect, manage and restore our forests, nature and ecosystems, as well as create sustainable food systems and alert people to unforeseen changes to land.

"This is particularly important because we live in a world facing great land squeeze," Hanson said. "The world is experiencing growing demand for food, for timber, for bioenergy, for urban expansion. All the while, we need to be conserving land for nature, biodiversity and climate."

Unlike most land cover platforms, which typically display a static view of locations, Dynamic World displays "the pulsation of life" throughout the year, Hanson said, making it useful for understanding longer-term trends of seasonal ecosystem change.

For example, as landscapes are seasonally flooded, the land cover can switch from grassland or trees to wetland and water. In agricultural landscapes, Dynamic World is able to detect the presence and proliferation of agroforestry systems, which would have once been classified simply as cropland.

"Given the importance of restoration for the global agenda, such monitoring abilities are increasingly important and valuable, and will empower government, NGO and village efforts to advance restoration of their landscapes," Hanson said.

The African Forest Landscape Restoration Initiative (AFR100), which aims to restore 100 million hectares (247 million acres) of land in Africa by 2030, is applying Dynamic World to keep track of progress toward its restoration goals, according to Mamadou Diakhité, leader of the initiative. Speaking at the online launch event, he said AFR100 is aiming to establish a credible monitoring platform that leverages satellite land cover data sets "to bring in more investment from the private sector, from non-state actors, from the government to really embrace land restoration."

For Wanjira Mathai, vice president and regional director for Africa at WRI, the new tool essentially brings landscapes to life. "To understand the vulnerability of this precious planet is to understand how dynamic and how fragile it truly, truly is," Mathai said at the online launch. By showing the complex details of how land on Earth is used in a continually updating manner, she said, Dynamic World "activates an emotional connection" that has the potential to "trigger a level of action that we have never seen before."

Citation

Brown, C. F., Brumby, S. P., Guzder-Williams, B., Birch, T., Brooks Hyde, S., Mazzariello, J., Tait, A. M. (2022). Dynamic World, Near real-time global 10 m land use land cover mapping. *Scientific Data*, 9(1), 251. doi: 10.1038/s41597-022-01307-4

Figure 5. Forest clearing for soy in Parecis in the state of Rondonia, Brazil. Image by Microsoft Zoom Earth

In one of earth's driest countries, smart maps help protect water supplies

David Gadsden

Current Address: Esri Blog
Reprinted from: https://bit.ly/3zozcRX

Conservationists in the Kruger to Canyons Biosphere Region are using geographic information system technology for education and collaboration among diverse stakeholders.

Key Takeaways

- Researchers use GIS technology as a visually dynamic tool for understanding the diverse ecosystems within the Kruger to Canyons Biosphere Region.
- Analysts rely on smart maps to document, enhance, and monitor critical water sources that sustain rural villages, wildlife, tourism, and commercial agriculture.
- Location intelligence supports an integrative approach to conservation focused on equity and sustainable social and economic development.

Ninety-one percent of South Africa's land is at risk of becoming desert. The sense of urgency is palpable among conservationists working to improve water management practices in the diverse and majestic Kruger to Canyons Biosphere Region. The biosphere comprises 10 percent of the republic's land yet provides more than half of its water.

Rivers, streams, wetlands, and other catchments in this 6.1-million-acre ecosystem are under pressure. Worsening droughts, pollution from human activity, and encroachment of invasive plants have diminished water quality and volume. A nonprofit company, Kruger to Canyons (K2C), is rallying residents and businesses to work together to protect the nation's waterways.

Using geographic information system (GIS) technology—including digital maps that mark the location of resources—K2C has created a library of scien-

Figure 1. Protecting water supplies from pollution is important for the survival of wildlife in the Kruger.

Figure 2. Many species, including elephants, are already threatened by the loss of habitat and other factors.

Figure 3. South Africa's Kruger to Canyons Biosphere Region is known for biodiversity, including the greater kudu pictured here.

Figure 4. Kruger National Park, in the biosphere's eastern region, is considered the world's premiere wildlife viewing area—home to 147 species of mammals, 507 species of birds, 114 species of reptiles, 49 species of amphibians, and 34 species of fish in the park's seven rivers.

Figure 5. A pride of lions drinking water is a beautiful sight to see in the Kruger National Park.

tific data as evidence of changing conditions in this ecosystem. The maps and data also serve as a compelling source of truth as the nonprofit works to build consensus among residents and businesses around the need for better resource management, more sustainable practices, and disaster risk reduction.

"If we don't act now, we're all really going to feel it 20 years down the line," said Romy Antrobus Wuth, stewardship ecologist with K2C. "For this landscape to stay as beautiful as it is, where we all love to live, we all need to work together."

A Landscape Experiences Transition

Climate change in the South African drought belt is occurring more rapidly and bringing impacts that are more severe than the global average, according to a report from the Intergovernmental Panel on Climate Change. These conditions rank the republic among the 30 driest countries on earth. Rainfall accumulates at a rate roughly 40 percent lower than the annual world average.

Heat waves, rising temperatures, prolonged droughts, and intense floods are evidence of the changes occurring here. These conditions further degrade deforested and excessively grazed rangelands where family-owned livestock roam. Climate shifts also diminish the waterways that run through the rangelands.

Unlike some regions of South Africa, rainfall in the Kruger to Canyons Biosphere Region's escarpments remains ample, ranging from 39 to 78 inches (1,000–2,000 mm) per year. The water runoff helps sustain natural systems and people in the Lowveld region, where rainfall averages just 15 to 25 inches per year. K2C has used GIS technology to monitor conditions and document polluted waterways in residential areas and locations where sand mining operations exist. The data makes it clear that stakeholders must act now to protect water availability and purity to sustain life in the biosphere in the decades ahead.

In the biosphere, water flows from breathtaking escarpments that reach into the clouds in the western region and then moves through vulnerable rural villages and commercial agriculture operations at lower elevations. Biomes of forest, grassland, and savannah also exist in this biodiversity hot spot.

The eastern reaches of the biosphere include protected nature parks. The flagship is Kruger National Park, a renowned tourist destination. The park is considered the world's premiere wildlife viewing area - home to 147 species of mammals, 507 species of birds, 114 spe-

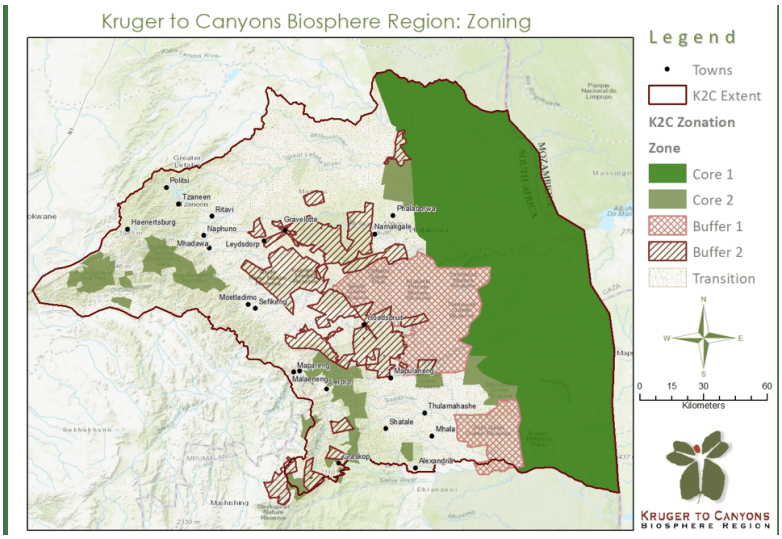

Figure 6. Maps such as this are useful for strategic planning and outreach to stakeholders. Goals include reducing conflicts between humans and wildlife, especially in communities adjacent to protected areas. Kruger to Canyons nonprofit's work includes data capturing, proper reporting, awareness and research, and communication with relevant agencies.

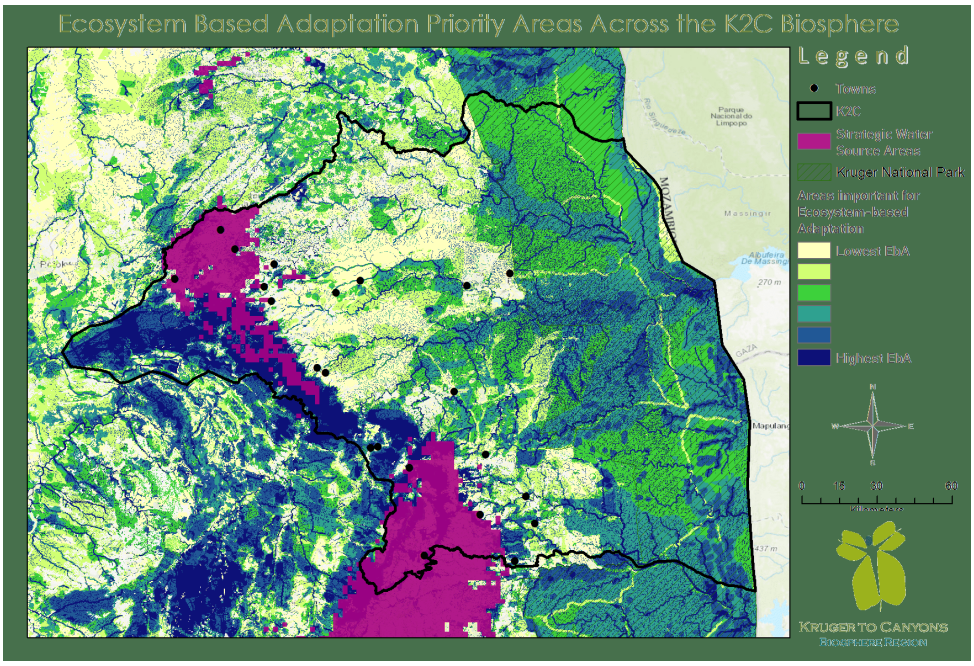

Figure 7. This map shows communities located within or near Strategic Water Source Areas. Keeping pollution from human settlements out of the biosphere's waterways is among the goals of conservationists.

cies of reptiles, 49 species of amphibians, and 34 species of fish in the park's seven rivers. However, extreme drought in the biosphere's subtropical Lowveld region caused a shortage of food for the park's wildlife in 2015 and 2016. Rangers had to put down 350 hippos and buffaloes to reduce the competition for resources.

Technology Aids Communication and Outreach

The K2C team takes a modern, inclusive approach to outreach that makes stakeholders with disparate interests a force for action and equity. GIS technology supports K2C's monitoring in the field; collecting and analyzing data; and, ultimately, providing environmental education for community groups, conservation partners, and stakeholders in the industry. The resultant smart maps help stakeholders and partners see where to focus their efforts and set priorities.

"A map always tells an amazing story," said Nick Theron, K2C senior program manager. "If you're sitting together with a group of people and you need to explain what's going on or get everyone onto the same page—or better understand our work and strategically how we plan—then we need maps."

Interventions Address Diverse, Widespread Needs

With such an expansive territory, the nonprofit is selective in activating or supporting projects as a partner. K2C's projects must be manageable yet produce significant results. Priorities include protection of land around waterways, environmental education, clearance of invasive plants, and sustainable land management.

The Blyde River catchment, just west of Kruger National Park, has been designated a strategic water source for the country; this set in motion a notable restoration project where K2C was a partner with AWARD in combating invasive plant species that have degraded the ecosystem.

Through other initiatives, the K2C team has undertaken spatial analysis to mark the location and spread of alien plants that choke wetlands. By targeting and removing these plants, and documenting illegal dumping and sand mining, the K2C team expects to see long-term improvement in water quality.

To help address high unemployment in the region, K2C has a program that employs residents as environmental monitors. The workers post daily updates, sending GPS coordinates and photographs from mobile devices when they find hazardous or improved conditions and enrich the GIS database with up-to-date information. These efforts also help preserve water corridors that serve as breeding grounds and migration routes for threatened wildlife.

K2C is helping villagers and farmers improve water access while safeguarding biodiversity; the recent cycle of flood and drought has hit 1.5 million people in the region, creating food insecurity. K2C conservationists have been working with small-scale farmers on sustainable land-use practices, responsible water management, and equitable access to water. Larger-scale commercial farmers have started to become involved, and K2C hopes to pilot projects with them soon.

Here, too, digital maps are valuable for identifying project locations and broadening awareness of conditions. Research data compiled with GIS technology can help stakeholders align with project priorities:

- Working with smallholder farmers, K2C's team revitalized irrigation systems and improved farming techniques in the Sabie River catchment adjacent to Kruger National Park to foster water security.
- Assisting cattle owners on the Dinkwanyane Water Smart Project enhanced sustainable land-

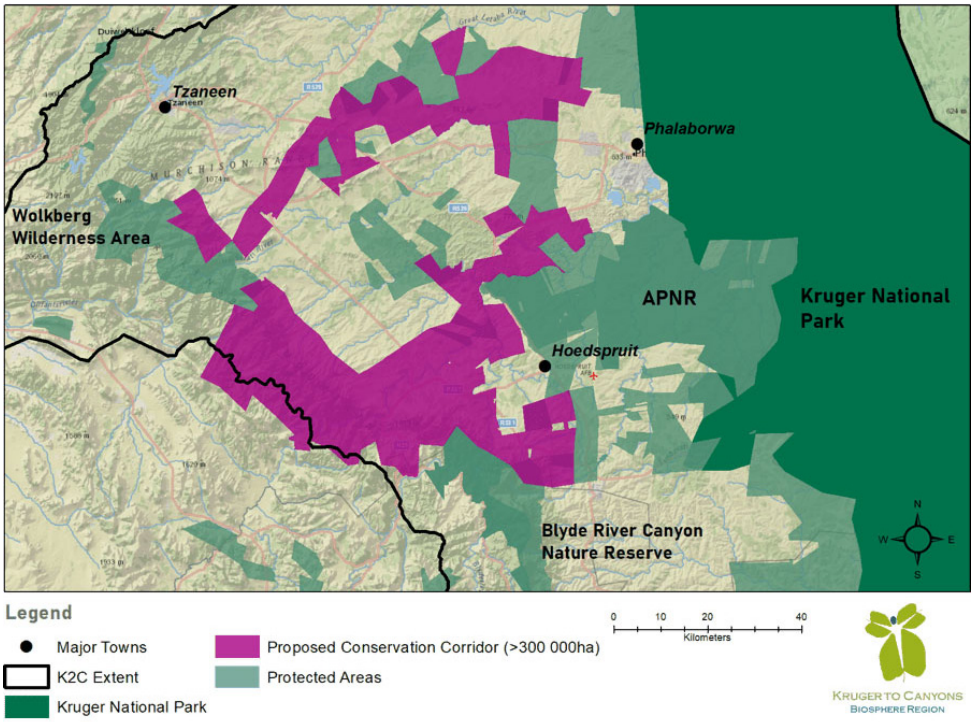

Figure 8. The area in pink shows corridors that researchers want to see protected, to ensure pure water can continue to flow from those territories. Territories in green are among existing protected land.

Figure 9. The K2C Biosphere Region is a diverse territory that includes more than 6 million acres of land. In the biosphere's western region, escarpments are common at these higher altitudes. Environmental monitors are out daily to document conditions that threaten water purity and availability.

use practices on rangelands and strengthened long-term social and ecological benefits.

- Educating the public on better sanitation practices in the Blyde River catchment provides safer drinking water for people and wildlife.

More recently, a methodology called Climate Risk Informed Decision Analysis (CRIDA) has taken K2C's work in a new direction. Through the K2C Catchment Investment Program, the team encourages businesses to invest in nature-based solutions for water resource management and disaster risk reduction.

Natural solutions have the added benefit of reducing the need for implementing water purification or pumping water through pipelines. Instead, nature does this work as humans focus on restoring ecosystems. Partners in this effort include The Nature Conservancy, Pegasys, Conservation International, and Conservation South Africa.

"From a business perspective, if you invest a certain amount of money into the catchments, you are going to be saving money in the longer term, which builds additional levels of sustainability," Theron said. "Projects that we are building benefit the whole landscape and the local economy."

Figure 10. Unlike some regions of South Africa, rainfall in the Kruger to Canyons Biosphere Region is still ample, ranging from 39 to 78 inches (1,000–2,000 mm) per year.

Figure 11. Rangelands east of the escarpments sustain wildlife and human settlements.

Figure 12. Exotic plants decorate an escarpment in the Kruger to Canyons Biosphere Region.

The K2C team members will tell you their work—whether in research and data science, outreach and education, or on-the-ground intervention—is far from glamorous. Yet they are committed to supporting and promoting balanced and sustainable social and economic development. In the process, they are also working to address inequality, poverty, and climate change.

"It's grinding work," said Wehncke van der Merwe, K2C's buffer zone coordinator. "It takes years and years to get it right because you're working with people and setting up governance systems and changing perspectives and understanding. And it's working within fields with a lot of nuances. People aren't always that keen on this nonsexy stuff. They love to hear about saving a wild dog from a snare, but the more important thing is to have more habitat for the wild dog to roam in."

Team develops new method of hunting for carbon in soil without digging or taking soil samples

Lawrence Berkeley National Laboratory

Current Address: Lawrence Berkeley National Laboratory
Reprinted from: https://bit.ly/3z9hDEm

Physicists and soil scientists at the Department of Energy's Lawrence Berkeley National Laboratory (Berkeley Lab) have teamed up to develop a new method for finding carbon stored in the soil by plants and microbes. Unlike all previous methods, this new technique makes it possible to see the carbon in the dirt without digging holes or taking soil samples, like an X-ray for the soil. This new method for measuring carbon pulled out of the air promises to be an important tool for fighting climate change and developing more ecologically friendly forms of agriculture.

"What this instrument really enables is repeated measurements over time," said Arun Persaud, a Berkeley Lab physicist and one of the leaders of the team. "With our instrument, you can get a very accurate and fast measurement of the total carbon in an acre of land, without disturbing the soil or harming the organisms that live there."

A plant transfers carbon into the soil as a natural part of its life cycle. Plants breathe in carbon dioxide and breathe out oxygen (which we animals then breathe in). The carbon remains in the plant, used to build molecules and cells it needs to live. A large fraction of that carbon ultimately enters the soil through the plant's roots. Microbes in the soil then take this carbon and turn it into organic matter that can persist for decades, centuries, or longer.

Plants and soil microbes play a key role in the Earth's carbon cycle—a cycle that humans have drastically altered. Burning fossil fuels heats up the planet quickly. Human land use for agriculture has depleted organic matter in the soil, resulting in an enormous soil carbon deficit that also contributes to climate change.

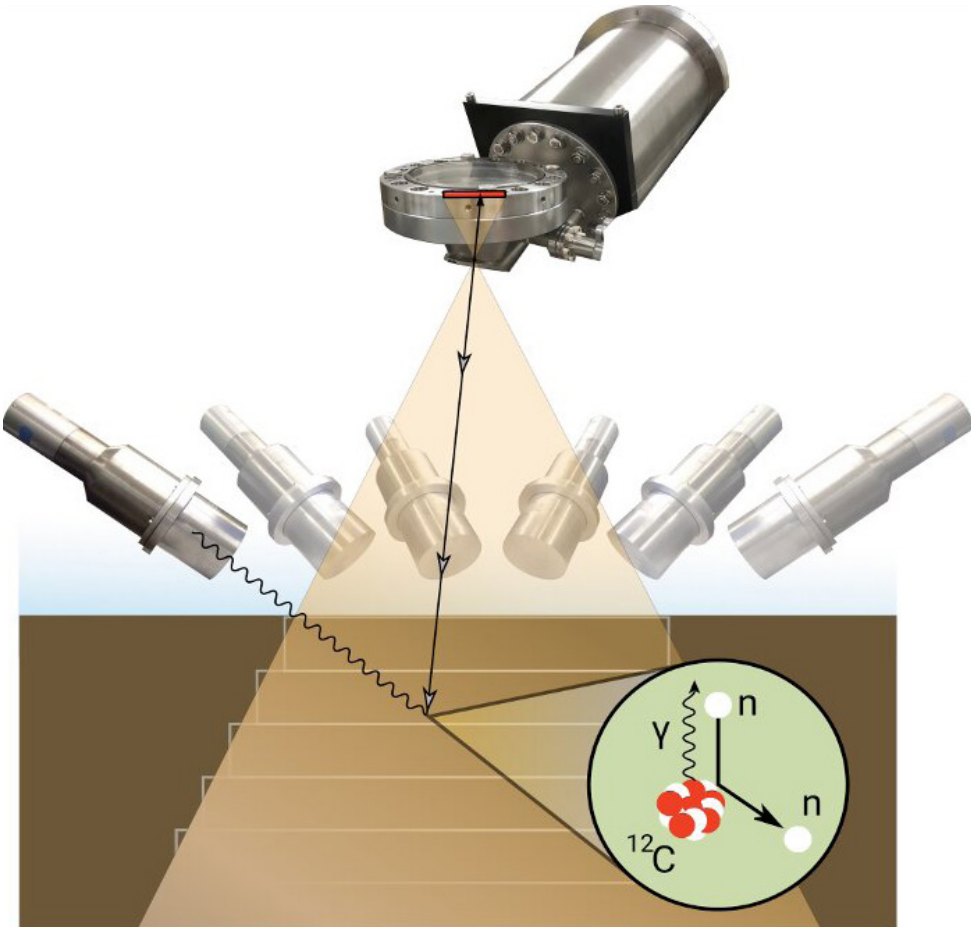

Figure 1. Soil imaging with neutrons can give a quick, detailed look at the amount and distribution of carbon (and certain other important elements) in soil without disturbing the soil or plant roots. Credit: Berkeley Lab

Pulling large amounts of carbon out of the atmosphere is a vital component in virtually all plans to limit global warming to 2 degrees Celsius or less. This need is the impetus behind Berkeley Lab's

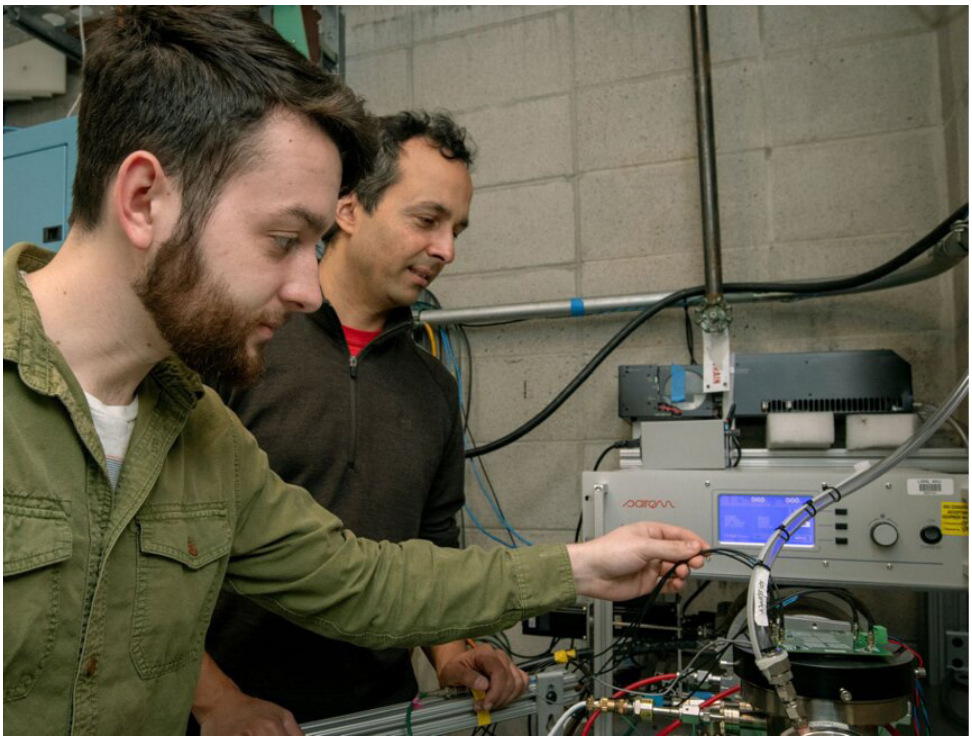

Figure 2. Will Larsen and Arun Persaud at the neutron test facility of the Fusion Science and Ion Beam Technology Program in the Accelerator Technology & Applied Physics Division, configuring the alpha particle detector. The alpha detector allows the measurement of the distribution of carbon atoms in soil. Credit: Berkeley Lab

Carbon Negative Initiative, which aims to develop technologies to capture, sequester, and use carbon dioxide. Plants and microbes are experts at pulling carbon out of the atmosphere—they've been doing it for billions of years. But before we can harness them to help manage atmospheric carbon, we need to accurately measure how much carbon is already locked in the soil through plant-microbial interactions, or other management strategies. Unfortunately, existing techniques for testing the carbon content of the soil are quite destructive, and error-prone at large scales.

"We have a major limitation in understanding and quantifying how carbon enters and persists in soil because of the way that we measure it," said Eoin Brodie, a Berkeley Lab scientist. "Typically we would take a soil core sample from a position in a field and bring it back to the lab. Then we'd basically burn it and measure the carbon that's released. It's extremely laborious and costly to do that, and you don't even know how representative those cores are."

Brodie is Deputy Director of Berkeley Lab's Climate and Ecosystem Sciences Division and one of the leaders of the EcoSENSE Program, a component of the Biological & Environmental Program Integration Center (BioEPIC) currently in development. EcoSENSE aims to create suites of sensors to monitor the impacts of climate and weather on ecosystem function, and Brodie and his colleagues wanted to find a better way to measure carbon in the soil. The broad scientific expertise available at Berkeley Lab, and a timely call for proposals on below-ground sensor technologies from DOE's Advanced Research Projects Agency-Energy (ARPA-E), led Brodie, Persaud, and their colleagues to team up on this project. "What it really took was communication across very different programs at Berkeley Lab," said Brodie. "We became aware of this potentially useful technology in the Accelerator Technology & Applied Physics (ATAP) Division, and we joined forces." Ultimately the cross-disciplinary team was awarded a grant from ARPA-E's Rhizosphere Observations Optimizing Terrestrial Sequestration (ROOTS) program, which enabled this work.

The new method of measurement developed by the Berkeley Lab team eliminates the need to dig anything out of the ground at all. Instead, the as-yet-unnamed device scans the soil with a beam of neutrons. Then a detector senses the faint response of the carbon and other elements in the soil to the neutrons, allowing it to map the distribution of different elements within the soil to a resolution of about five centimeters. All this happens above the ground, with no holes, no cores, and no burning. "It's like giving the soil an MRI," said Persaud, who is a staff scientist in ATAP. "We get a three-dimensional picture of the soil and the carbon distribution in it, along with other elements like iron, silicon, oxygen, and aluminium, which are all important to understand the persistence of carbon in the soil."

"What really excites me about this neutron imaging approach is that it lets us effectively and accurately image the carbon distributions in soils at the scales that carbon accounting needs to happen at," added Brodie. "And we can do it repeatedly over growing seasons, to see how it's changing with different climates and land management practices. Eventually, you could use this to identify what specific land management practices are more effectively drawing carbon down from the atmosphere and storing it in soil."

"This new carbon sensing method is an example of thinking outside the box and bringing together researchers from diverse backgrounds—here physical sciences and earth science—to create new technology addressing the challenges of climate change," said Cameron Geddes, director of ATAP.

Right now the project is just emerging from the lab, and Persaud, Brodie, and their colleagues are about to test it in real soils in an outdoor system soon. "We're really excited to test this on the soil here at Berkeley Lab after the rainy season," Persaud said.

"The next step is making this process field deployable and more automated so that it can be incorporated onto things like combine harvesters and tractors, so that this becomes part of the sensing capabilities that you find in farms and across forests," Brodie added. "There's really huge, huge potential in this."

More information

Mauricio Ayllon Unzueta et al, An all-digital associated particle imaging system for the 3D determination of isotopic distributions, *Review of Scientific Instruments* (2021). DOI: 10.1063/5.0030499

Journal information: Review of Scientific Instruments

How to Respond to Reviewer's Comments

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Peer-review system was established to scrutinize and validate scientific findings before they are released for public consumption through publication. Navigating the established system involves communication between authors, editors, and peer-reviewers.

Your response to the reviewer's comments is an important part of the peer-review process because it summarizes your answers to reviewers' critiques. Below are some Do's and Don'ts when responding to reviewers' comments.

- Appreciate the editor and reviewers, stating how their critiques have helped improve your article. See the example below:

Dear Editors and Reviewers:

Special thanks to you for your letter and the scholarly comments on our manuscript entitled "ARTICLE TITLE" (ARTICLE ID). The explanations provided are all invaluable and very helpful for revising and improving the quality of our paper. They provided insights for future research as well. We have studied the comments carefully and have made the necessary corrections.

The revised portions are marked in yellow in the revised article or we have used the review pane in MS word to show the corrections made. The primary corrections in the paper and the response to the editor and reviewer's comments are as follows:

- Show politeness and respect in the tone of your responses.

Politeness is important. The reviewers have invested their time to evaluate your article. Recognize any misunderstandings on your part, for example, a poor presentation that may have confused the reviewer. In your responses, do not imply incompetence or a lack of expertise on the part of the reviewer but make everything clear enough to understand. If you feel the reviewer lacks understanding of your work, attacking the reviewer is not the next step.

Remember that the reviewer's failure to understand your work may be because you did not explain it well. Besides, the reviewer may also be discourteous. Nevertheless, a rude comment should not be met with a rude response. Moreso, your interest is to get your scientific findings out there to make an impact.

- Keep your responses short.

Copy and paste the reviewer's comments on your MS. Then provide your response beneath. Always keep your answers succinct and direct. See the example below:

Should you also include a glossary of the terms used in the survey form in the appendix?

A glossary of terms used in the survey questionnaire has been included in Appendix B.

- Employ the use of typography to make your revision clear

You can use different colours, typeface, bold, or indenting to differentiate between the reviewer's comments, your response, and the changes you made in your article.

- Respond to each comment and make it clear.

Respond to each comment separately, referring to the corresponding line numbers. If the line number(s) change due to the revision, point the reviewer to the new line number(s). This will help save time when reassessing your work.

- Don't be apologetic in all your responses.

Peer review is an intellectual engagement. If you are the cause of a misunderstanding, apologize reasonably, revise it, and quote the revised text in your response. However, do not apologize in your response to every comment. It sends a negative signal about you and the credibility of your research.

- Where possible, follow the reviewers' instructions.

Generally, don't give the impression that you can't do additional work (e.g., review, experiment, discussion) to improve the quality of your article.

However, where such additional effort will not add value to your work or is out of your study's scope, you can politely inform the reviewer about this, providing grounded justification(s).

If the reviewer asks for 10 stuff, and you claim 9 is out of scope, there may be a counter-response. In such situations, you may need to do some of those things and show why and how they are out of synch with your work.

- Finally, revise your response to the reviewer's comments for clarity and conciseness.

When you finish responding to the comments. Take a short break, then come back to revise it again to be sure everything is in order.

A New Fynbos Lily Discovered on The Agulhas Plain

The discovery of a new Fynbos Lily is a great story which highlights how special the Overberg is in terms of plant diversity.

Brent Lindeque

Current Address: Good Things Guy

Reprinted from: https://bit.ly/3b3VBe3

A beautiful plant species discovered in a conservation area on the Agulhas Plain – that had the botanical experts bemused – has been confirmed to be a new fynbos species. And it has now been named too: It's a *Cyrtanthus Novus-Annus* (Latin for Nuwejaars).

The pretty pink and white-flowered plants have only been found in two locations – both on the Nuwejaars Wetlands Special Management Area (NWSMA) in the Overberg, close to the most southerly tip of Africa. With fewer than 250 plants in total, covering an area of less than 5 km², it's likely that the new *Cyrtanthus* will be classified as Endangered by the South African National Biodiversity Institute (SANBI) Red List once assessed.

According to *Cyrtanthus* expert Dr Dee Snijman, who described the new species, "The species epithet honours the recent restoration of biodiversity in the Nuwejaars Wetlands area." This conservation area covers 47,000 hectares and includes Critically Endangered fynbos and irreplaceable wetlands and rivers crisscrossing the landscape. The farmers who are members of the NWSMA have appointed a team of conservationists to help restore and manage these land- and waterscapes.

A new sister for the Bredasdorp Lily

In a botanical twist, the *Cyrtanthus Novus-Annus* is seen as a sister species to the Critically Endangered *Cyrtanthus guthrieae* (the Bredasdorp Lily), given their resemblance and their reasonably close proximity to each other. The Bredasdorp Lily only occurs in the mountains above the Overberg town. There's only one other example of a sister pair in the *Amaryllidaceae* family in the Western Cape, near Wellington.

Figure 1. *Cyrtanthus Novus-Annus* Photo: Dr Dee Snijman

This most unexpected discovery took place in 2019 when during an exploratory NWSMA trip, a small population of soft pink and white flowering plants were spotted. A series of events, including Covid and the subsequent lockdowns, put the discovery on hold. But in late 2021, the NWSMA conservation team came across another flowering population.

The experts are called in!

With the help of the Botanical Society of South Africa's Rupert Koopman, the experts were brought in to undertake a complete assessment earlier this year, including Dr Snijman and Dr John Manning.

Snijman has just released her scientific paper, "A new species of *Cyrtanthus* (*Amaryllidaceae: Cyrtantheae*) from the Agulhas Plain, Western Cape, South Africa". She says in the paper, "The unexpected discovery in 2019 of a small population of *Cyrtanthus* on the Agulhas Plain that could not be matched with any known taxon prompted the description of one further species."

According to Koopman, "This is a great story which highlights how special the Overberg is in terms of plant diversity. And in fact, how special the fynbos biome is in general, considering that we are still picking up new species even in areas that are well known."

The new species occurs on low, open vegetation, which includes elements of both Central Rûens Shale Renosterveld and Elim Ferricrete Fynbos. Both of these are Critically Endangered.

Koopman adds, "It also shows the importance of the integration of the botanical community. This species went from the Nuwejaars conservation team through a series of botanical experts; I acted as a courier to SANBI's taxonomist to ultimately describe the species. This outcome – that the species is now formally described and can be assessed to receive a red list status – is essential."

A unique conservation model!

NWSMA Project Manager Ross Kettles says the discovery highlights the importance of understanding and protecting natural landscapes, also on private land.

"This 'Nuwejaars Lily' as it's being called, would never have been recognised as a new species were it not for the conservation work taking place here in partnership with our farmer-members. This model is unique: farmers continue to farm, but at the same time, we can't lose what's left of our biodiversity here. Farmers here have therefore made the ultimate commitment to this protection, signing title deed restrictions to protect our natural world in perpetuity."

Kettles says, "Aside from our landowners, this would also not have been possible without those incredible funders who see the value of this biodiversity-rich area, and the importance of this model. That includes the Mapula Trust, Hans Hoheisen Charitable Trust, WWF South Africa, the National Lotteries Commission and the Overberg District Municipality."

Figure 2. Measuring the height of the *Cyrtanthus*. Photo: Dr Dee Snijman

Amateur botanist uncovers rare plant species

Karen Watkins

Current Address: Constantiaberg Bulletin
Reprinted from: https://bit.ly/3lYiP1K

A plant, possibly only last seen many decades ago in Cape Town, has been identified in the Kirstenhof greenbelt.

The plant, found and photographed by amateur botanist and Friends of Kirstenhof Wetland member Tim Kirsten, was identified as the longleaf fountain bush (*Psoralea filifolia*) on Wednesday, March 23.

However, concern has been raised about the wholesale clearing of the river vegetation in the greenbelt near Oranje Road in Kirstenhof where the plant was found.

Psoralea filifolia is in flower between November and March and grows along riverbanks and seepages.

Mr Kirsten, who has lived in Kirstenhof all his life and walks the local greenbelts most days, first noticed the plant in 2020 and took photos of it in flower in November 2021.

It was originally misidentified as *Psoralea pinnata* on the iNaturalist app.

Last month, he took better photos that were positively identified on iNaturalist by professors Charles Stirton and Tony Rebelo.

Figure 1. Friends of Kirstenhof Wetland members, from left, Tim Kirsten, Louise Kinrade and Jean Fillis.

On Thursday, March 31, researchers working for the SA National Biodiversity Institute (SANBI) and Custodians of Rare and Endangered Wildflowers (CREW) – a citizen-science initiative that involves members of the public in the surveying, monitoring and conservation of plants – collected a small cutting for the Compton Herbarium at Kirstenbosch and for Sanbi and UCT. Professor Muthama Muasya, of UCT's department of biological sciences, performed the molecular/genetic analysis on the plant.

Professor Stirton said *Psoralea filifolia* was thought to be locally extinct on the greater Cape Flats. "The last time this species was officially recorded on the Cape Flats, including Kirstenhof, was in the 1830s, despite botanists having searched extensively for it since. There are still small populations elsewhere in the Western Cape, but these are also threatened as the species is confined to riverbanks and seepages."

Louise Kinrade, who has the "green" portfolio on the Kirstenhof and Environs Ratepayers' Association, fears that the *Psoraleas* are at risk of being pulled out and sent to the compost dump by the City's alien invasive removal team, which, along with a contractor, is working in sections of the Keyser and Westlake rivers clearing aliens and *typha* reeds as part of the annual winter preparedness and anti-flooding programme.

"Last year, we had contractors further downstream in the reed bed supposedly only removing bramble and Madeira vine and who, for whatever reason, hacked our indigenous Salix willow and left the Australian cherry standing right next to it intact," she said.

However, ward councillor Carolynne Franklin said she had made sure that the clearing teams had been "sensitised to the necessity of retaining the indigenous plants alongside the banks".

Mr Kirsten said he was very excited about the find. "How amazing that this species could have survived in the seed bank for decades or as seedlings that no one who knew them well enough to identify managed to see. And that my hobby of taking photos and recording biodiversity on the greenbelt might lead to conservation action for an endangered species," he said.

Figure 2. Longleaf fountainbush (*Psoralea filifolia*) was thought to be locally extinct on the Cape Flats.

Regenesis: Feeding the world without devouring the planet

George Monbiot

Reprinted from: https://bit.ly/3b7Yc6y

"This remarkable book, staring curiously down at the soil beneath our feet, points us convincingly in one of the directions we must travel. I learned something on every page." - Bill McKibben

For the first time since the Neolithic, we have the opportunity to transform not only our food system but our entire relationship to the living world.

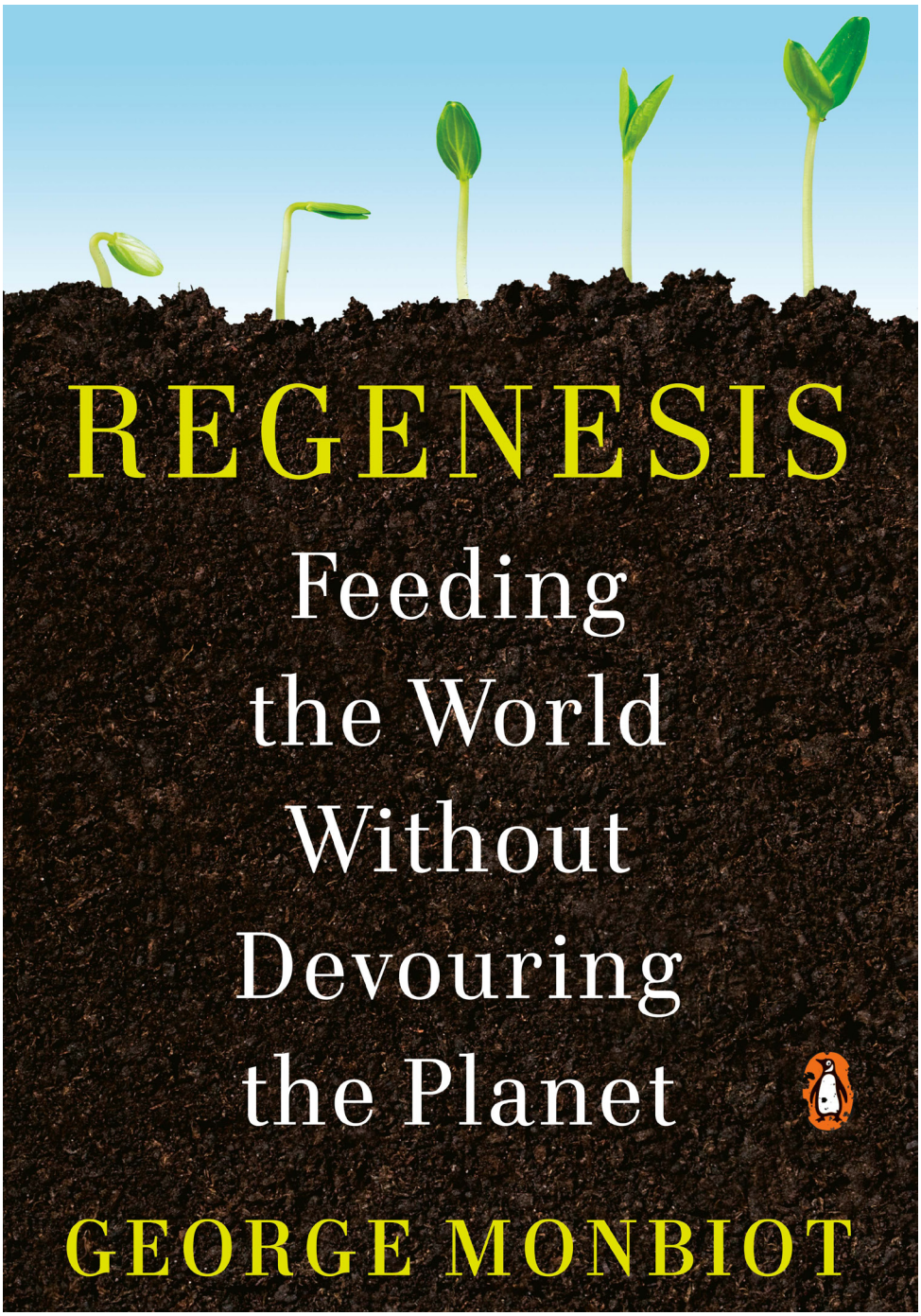
Farming is the world's greatest cause of environmental destruction – and the one we are least prepared to talk about. We criticise urban sprawl, butfarming sprawls across thirty times as much land. We have ploughed, fenced and grazed great tracts of the planet, felling forests, killing wildlife, and poisoning rivers and oceans to feed ourselves. Yet millions still go hungry.

Now the food system itself is beginning to falter. But, as George Monbiot shows us in this brilliant, bracingly original new book, we can resolve the biggest of our dilemmas and feed the world without devouring the planet.

Regenesis is a breathtaking vision of a new future for food and for humanity. Drawing on astonishing advances in soil ecology, Monbiot reveals how our changing understanding of the world beneath our feet could allow us to grow more food with less farming.

He meets the people who are unlocking these methods, from the fruit and vegetable grower revolutionising our understanding of fertility; through breeders of perennial grains, liberating the land from ploughs and poisons; to the scientists pioneering new ways to grow protein and fat.

Together, they show how the tiniest life forms could help us make peace with the planet, restore its living systems, and replace the age of extinction with an age of regenesis.



Go check out the following

Websites, Webinars & Podcasts

Jan Emming: *Aloe ramosissima* and other Richtersveld aloes in South Africa

Jan Emming have procured and planted three different 15-gallon pots of *Aloe ramosissima* at D. F Ranch, and decided to craft a post on them in habitat using photos he took in September 2009 trip to South Africa. Visit: https://bit.ly/3Pz6nIc

Common names of South African Grasses

Frits van Oudtshoorn has compiled a list of common names of grasses of South Africa in one document. Visit the Grassland Society of South Africa at: https://grassland.org.za/ to view this list.

Rangelands in the World

Vast natural landscapes in the form of grasslands, shrublands, woodlands, and deserts: rangelands are the wild open spaces that cover about half of the earth's land. Rangelands are known by many names across the globe including prairies, shrublands, deserts, woodlands, savannas, chaparral, steppe, and tundra. Explore the world's rangelands on Wrangle.

Search the Rangelands Gateway database of more than 25,000 resources https://rangelandsgateway.org/topics/rangelands-world?

Conservation Conversations with BirdLife South Africa

These weekly webinars hosted through Zoom will hopefully bring some entertainment and education to your household as we embrace the new virtual reality that we all find ourselves in thanks to the restrictions brought on by the recent COVID-19 pandemic. Each talk will last approximately 45 minutes to an hour with a 15-30 minute Q&A session with our presenters afterwards. These sessions will give you a chance to learn about the incredible conservation work taking place across South Africa and beyond while also sharing some of the conservation success stories which BirdLife South Africa has been privileged to drive.

Visit: www.birdlife.org.za/blsa-conversations/

The Art of Range

The Art of Range is a podcast about rangelands for people who manage rangelands. The goal is education and conservation through conversation.

Find us online at www.artofrange.com

THE ART OF RANGE PODCAST

Go check out the following

Websites, Webinars & Podcasts

BBC: The Life Scientific - Pete Smith on why soil matters

Pete Smith is very down to earth. Not least because he's interested in soil and the vital role it plays in helping us to feed the world, mitigate climate change and maintain a rich diversity of species on planet earth. He was born in a pub and failed the 11+ exam (designed to identify bright children just like him) but he became a distinguished professor nonetheless. Tackling climate change in isolation is a mistake, he says. We need to consider all the challenges facing humanity and identify strategies that deliver benefits on all fronts: food security, bio-diversity and human development goals. He tells Jim Al-Khalili about his life and work and the urgent need for our degraded peat bogs to be restored. Peat bogs that have been drained (for grazing or to plant trees) add to our carbon emissions. Healthy peat bogs, however, are carbon sinks. Producer: Anna Buckley.

Visit: www.bbc.co.uk/programmes/m0017tgl

African Wildflowers of KwaZulu-Natal, South Africa, Part 1 (Species 1 – 50)

A brief description of 50 species of wildflowers that can be found in the bushveld of KwaZulu-Natal in South Africa. Each flower featured is classified by Family name and is listed with both the species name and the common name.

Visit: https://youtu.be/JmEU70MXIEY

The need for seed: Sue Milton-Dean at TEDxPrincePrinceAlbert

Ecological restoration addresses the twin problems of increasing environmental damage and social stress. Using the Karoo as the context, Sue speaks about human estrangement from the land, the need for seed in the rehabilitation of damaged landscapes, and opportunities for job creation and mainstreaming the value of natural capital through veld rehabilitation activities.

Visit: https://youtu.be/aGQi6bLkxhk

Growing local guardians

Sissie and Nicky's 20-year friendship has been instrumental in helping restore the South African wetland of Matatiele. Bringing community knowledge, energy and enthusiasm to their conservation efforts, they have equipped local residents with the tools and desire to help repair their home's ecosystems.

Visit: www.bbc.com/storyworks/age-of-change/growing-local-guardians

Lessons and surprises from a drought in the Kruger National Park

A drought in the Kruger National Park: Dr Izak Smit discusses lessons learned and surprises encountered. You can join these live talks by e-mailing lca.webinar@lcafrica.org and subscribe to our channel for more!

Visit: https://youtu.be/XuYroYWlY5c

Upcoming events

1 - 4 August 2022

Veld Management Course

This 4-day accredited course aims to train the learner on the important principles and practices needed for sustainable veld and natural resource management. It includes the most important legislation, the natural resources we utilise, important ecological principles and processes related to veld management as well as management practices such as farm planning, grazing management, veld assessment, fire management, control of unwanted plants and veld restoration. The course includes theoretical and practical training. All people directly or indirectly involved in veld management or related advisory services will benefit from this course. Learners who complete the course receive credit-bearing certificates under the jurisdiction of AgriSETA.

Note: This course can also be presented to groups on invitation in you're area.
Please send us an e-mail to courses@alut.co.za for more info on arrangements, or visit:
https://mailchi.mp/139e669789c2/veld-management-course-aug-2022

30 - 31 August 2022, Kuala Lumpur, Malaysia (Virtual)

ICRER 2022: 16. International Conference on Rangeland Ecology and Research

Prospective authors are kindly encouraged to contribute to and help shape the conference through submissions of their research abstracts, papers and e-posters. Also, high quality research contributions describing original and unpublished results of conceptual, constructive, empirical, experimental, or theoretical work in all areas of Rangeland Ecology and Research are cordially invited for presentation at the conference. The conference solicits contributions of abstracts, papers and e-posters that address themes and topics of the conference, including figures, tables and references of novel research materials. Visit https://waset.org/rangeland-ecology-and-research-conference-in-august-2022-in-kuala-lumpur for more information.

4 - 9 September 2022 (hybrid event)

SAWMA Conference 2022

The conference will be streamed live from Bonamanzi Private Nature Reserve, KwaZulu Natal Province. Presenters will have the option of presenting either in person or virtually. Similarly, prospective delegates may choose to attend in person or virtually. Deadline for abstracts are 29 April 2022. For more information, please visit https://sawma.co.za/conference-2022-2/

If you would like to advertise your upcoming event, please contact us and we will include it in our next edition.

Upcoming events

5-9 September 2022 (Hybrid event)

MEDECOS Conference XV 2022

Fynbos Forum 2022 will be accepting abstracts soon again for the postponed 15th Coference on Mediterranean-type ecosystems to be held at Club Mykonos Resort, Langebaan, Western Cape. Visit www.fynbosforum.org.za for more information.

11-13 October 2022 (Hybrid event)

AZEF Conference

AZEF 2022 will be held in Vredendal, WC! We've opted for a hybrid conference this year, so an on-line registration option via Zoom will be available. There will also be an optional one-day in-person workshop for those able to attend. For more details, please visit http://azef.co.za.

31 Oct – 4 Nov 2022 (Hybrid event)

The Conservation Symposium

The Conservation Symposium serves as a bridge between conservation practitioners, scientists and policymakers in a conducive environment to solve real-world problems. It integrates a broad range of disciplines in a meaningful way, creating and strengthening connections both within and between disciplines. It provides an effective platform for researchers to demonstrate the relevance of their work in addressing real-world conservation problems, and to identify new applied research opportunities and directions. It also provides a platform for training and skills development for conservation science and monitoring.

Emerging or ongoing issues identified by the conservation sector will be tackled through careful construction of the programme, including providing a selection of leading international keynote speakers, presentation of synthesis papers, and facilitated discussions. It also provides a platform for horizon scanning and exploration of new policy directions.

Visit: https://conservationsym2022.dryfta.com

If you would like to advertise your upcoming event, please contact us and we will include it in our next edition.

GSSA Congress 57 KEYNOTE PRESENTERS

NKABENG MZILENI

SANParks

Adaptive change for climate adaptation

MICHIEL SCHOLTZ

Agricultural Research Council API
University of the Free State

An updated perspective on the contribution of extensive ruminant production to greenhouse gas emissions in SA

CAROLYN PALMER

Institute for Water Research, Rhodes University

Why is transdisciplinarity relevant for the future of grassland ecosystems?

SIGRUN AMMANN

Western Cape Department of Agriculture

How pasture production in South Africa has evolved; and has a new era started? Lessons from practice and research

PAUL AVENANT

Department of Agriculture, Land Reform & Rural Development

Rangeland Science - back to the future

ANTHONY EGERU

Makerere University
RUFORUM

Wished out: revisiting why pastoralists are invisible

57TH ANNUAL CONGRESS OF THE GRASSLAND SOCIETY OF SOUTHERN AFRICA

PRELIMINARY PROGRAMME OUTLINE

TUESDAY, 26 JULY 2022		WEDNESDAY, 27 JULY 2022		THURSDAY, 28 JULY 2022	
8h00	Climate change Keynotes: Nkabeng Mzileni & Michiel Scholtz	8h00	Planted pastures I Keynote: Sigrun Ammann	8h00	Rangeland ecology & management I Keynote: Paul Avenant
10H15-10h45	TEA BREAK	10h00-10h30	TEA BREAK	10h15-10h45	TEA BREAK
10H15-10h45	Poster Session 01: Climate change; Bush encroachment & alien invasive plants; Communal rangelands, land tenure and land transformation	10h00-10h30	Poster Session 03: Planted pastures	10h15-10h45	Poster Session 05: Rangeland ecology & management; Livestock & game management
10h45-12H15	Bush encroachment & alien invasive plants Advances in methodology	10h30-11h45	Planted pastures II Special Session: Unlocking regenerative grazing DISCUSSION	10h45-11h45	Rangeland ecology & management II Special Session: Delineation of high potential rangeland - methodologies and philosophies DISCUSSION
13h00-14h00	LUNCH	13h00-14h00	LUNCH	13h00-14h00	LUNCH
14h00	Conservation & restoration Keynote: Carolyn Palmer	14h00	Feed & nutrition	14h00	Livestock & game management Keynote: Anthony Egeru
16h00-16h30	TEA BREAK	15h45-16h15	TEA BREAK	15h30-16h30	TEA BREAK
16h00-16h30	Poster Session 02: Conservation & restoration	15h45-16h15	Poster Session 04: Feed & nutrition; Fire Ecology	15h30-16h30	Poster Session 06: Research Proposal Posters
16h30	Special Session: Rangelands & locusts DISCUSSION	16h15	Fire ecology		
	DINNER		DINNER		GALA DINNER
	GSSA ANNUAL GENERAL MEETING		BINGO!		AWARD CEREMONY

AJRFS: Impact Score

The journal Impact Factors have been released today. The scores for the African journal of Range and Forage Science are:

Journal Impact Factor	5 Year Impact Factor
1.966	2.184

These are both record scores for the journal.

Deadlines for

Newsletter of the Grassland Society of Southern Africa

GRASSroots

submissions 2022:

~~Issue 1: 01 February 2022~~

~~Issue 2: 01 May 2022~~

Issue 3: 15 August 2022

Issue 4: 01 November 2022

Please visit
www.grassland.org.za/publications/grassroots/submit-to-grassroots-now
for submission guidelines.

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