Synopsis of temperature data collected in the Garden Route National Park over 20 years

Text by Johan Baard
Photos by Johan Baard & Jeremy Shelton

TWENTY YEARS OF CLIMATE DATA HAS INCREASED THE UNDERSTANDING OF HOW CHANGING CLIMATES IMPACT ON THE INDIGENOUS FORESTS OF THE SOUTHERN CAPE

For the past 20 years, small data-loggers log climate data hourly at two stations in the Garden Route.

Poor availability of temperature data resulted in the deployment of temperature loggers in the Southern Afromontane Forests of the Garden Route National Park in the early 2000s. Loggers were placed at Groenkop (6 km east of George) and Harkerville forests (11 km east of Knysna) and the first data recorded in 2001. These sites, both around 240 m above mean sea level, are 6.2 km and 4.5 km from the ocean, respectively. Onset Hobo temperature and relative humidity loggers (model H08-003-02) were used until 2017, with Hobo UX100-003 loggers used thereafter.

Initially loggers were plagued by technical and logistical problems that resulted in data gaps. Problems included batteries failing, software failures, theft and damage. The newer Hobo UX100-003 loggers seem to be much more reliable and battery-efficient, which resulted in little data loss for the last ten years. Initially data were recorded three-hourly, then two-hourly and since 2017, on the hour.

Various statistics are obtained and patterns emerge from recorded relative humidity and temperature data. For example, Harkerville has both higher and lower temperatures recorded than Groenkop. One degree Celsius frequency tables show a range for Harkerville of 0.5°C – 44.9°C (n = 101 361) and for Groenkop of 1.6°C – 38.2°C (n = 99 624). Extreme temperatures are rare; for Harkerville, only 326 (0.3%) records are above 34°C and only 887 (0.9%) are below 5°C. At Groenkop, less than 0.3% of records were in the extreme ranges of <5°C or >34°C. The winter mean monthly minimum (June-July) at Harkerville over 18 years is 2.6°C but is significantly higher at 5.6°C at Groenkop. Conversely, mean monthly maximum in Harkerville is 36.2°C for December and January, while at Groenkop it is 30.1°C for the same months. The hottest winter record for Harkerville was 30.1°C in July 2019 and at Groenkop 31.1°C in June 2013, possibly due to berg wind conditions. At both sites the minimum summer temperature is just below 10°C. The five year periods of 2008-2012, 2013-2017 and 2018-2022 had average maximums recorded of 32.9°C, 33.3°C, 31.7°C at Harkerville and 27.2°C, 27.8°C, 28.5°C at Groenkop.

These long-term datasets continue to grow and add value to diverse projects and our understanding of changing climates and their impact on the indigenous forests of the southern Cape. Relative humidity and temperature data have been used in various published articles and for legal cases related to wildfires.

Possible futures for alien species under climate change

Text by Nicola van Wilgen-Bredenkamp
Art by Emma Wright

South Africa is home to an amazing diversity of indigenous species that live on land, in its rivers and oceans. Given our location, at the tip of Africa along major trade routes, introductions of alien species to the country have also been diverse. Many have been introduced intentionally and are beneficial (e.g. crops and livestock), but many others have been introduced unintentionally and have had significant negative impacts on indigenous species, ecosystems and even livelihoods. Our recent book chapter explored the various direct and indirect ways in which climate change is predicted to affect biological invasions.

Climate influences invasions directly through altering the distribution of suitable niches available to both indigenous and invasive species and by altering disturbance regimes, such as fires and floods. This also changes the way in which species interact with one another and the environment, something that is further affected by rising atmospheric CO_2 levels. Indirectly, changes in climate affect the nature, intensity and location of human activity, which may alter the predominant pathways of alien species introduction and our ability to manage them.

As climate changes, new invasions might occur in one of four ways: direct range expansion of existing invasions; addition of new invasion routes that become available

SANPARKS STAFF HAVE CONTRIBUTED TO A NEW BOOK ON HOW CLIMATE CHANGE WILL AFFECT BIOLOGICAL INVASIONS, ALSO OFFERING SOLUTIONS TO HELP NAVIGATE THIS UNCERTAIN FUTURE

Alien species under climate change cont.

because of changes in trade routes and commodities traded; because of climate action, for example planting trees for carbon sequestration; or intentionally through assisted migration (i.e. deliberate movement of species for conservation purposes).

To understand the nature of potential climate invasion interactions, we summarised the latest projected changes for rainfall and temperature using data from the 6th IPCC (Intergovernmental Panel on Climate Change) Assessment Report. This report has reduced the uncertainty around future climate projections with predicted shifts in climate being less extreme for South Africa than previous assessments. However, countries directly to the north of South Africa are expected to experience more serious temperature increases, which could have significant implications for the movement of species and people southwards.

Biological invasions in South Africa have been shown to group into four biogeographical areas (fynbos, arid, grassland and savanna), matching the broader climate and natural division in species distributions, and each region presents unique challenges.

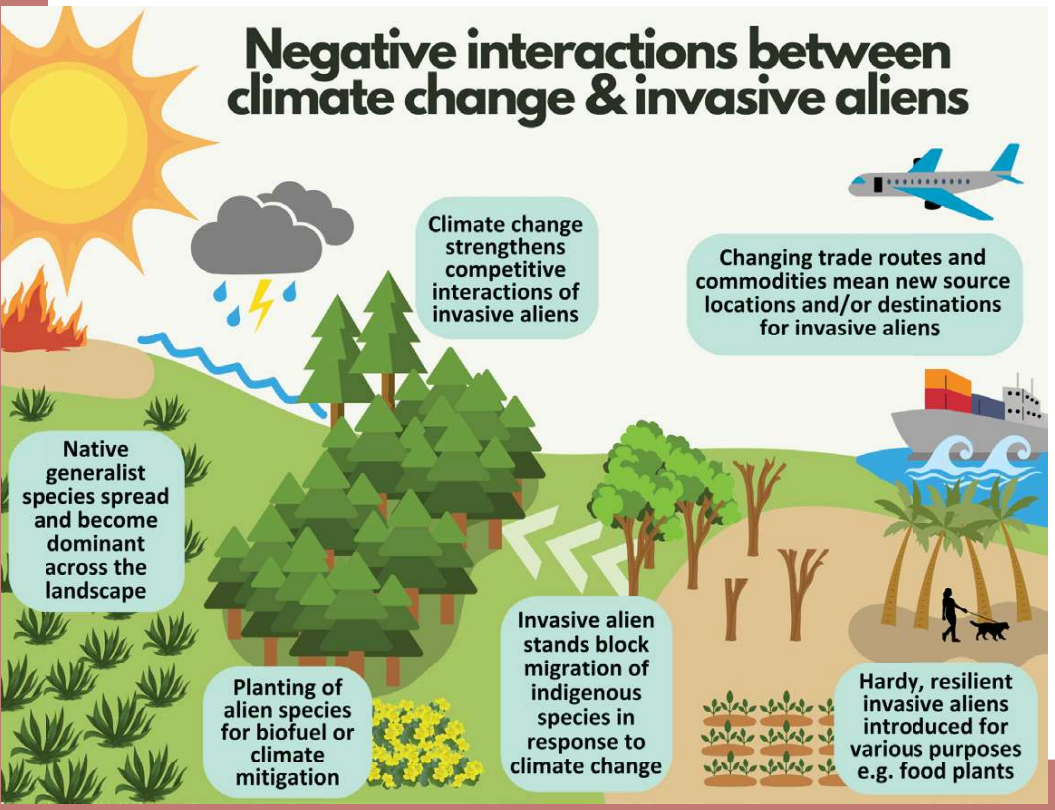
In the fynbos, invasions by woody species result in a regime shift where both the structure of vegetation and the frequency and intensity of fires are dramatically altered. Warming growing-season temperatures further facilitate the growth of grasses, building fuel loads. These changes assist to cement novel ecosystems at the expense of the slow-growing, highly diverse, indigenous vegetation. It is expected that even more intensive and consistently high management inputs will be required to reverse these shifts. On the positive side, some damaging alien species like rainbow trout are expected to fare less well under warmer conditions, with positive outcomes expected for endemic fishes.

Moving into more arid regions beyond the fynbos, invasions by grasses can introduce fire to systems where it did not occur before. The interaction between changing climate and rising CO_2 levels is also expected to increase growth of both invasive grasses and trees (e.g. mesquite), which compete for scarce water supplies. In terms of pathways, flash floods have already demonstrated they can facilitate plant invasions along river courses. In addition, there is a risk that new inter-basin water transfers brought in to alleviate drought may facilitate novel invasions, both of freshwater invasive species and species whose seeds are carried by water. In contrast to fynbos, savanna and grassland systems face somewhat opposite issues, where bush encroachment and invasion of species, such as Lantana and Chromolaena, reduce fire frequency.

In the marine environment, most invasions have been from accidental introductions relating to ship traffic and organisms that grow on ships or are found in ballast water. Climate change is already increasing the frequency of storms, which provide disturbance opportunities for invasion by damaging reefs and intertidal communities and opening opportunities for invasive species. Changing ocean currents and temperatures, along with ocean acidification are expected to shift invasions that can result in marine regime shifts with important economic implications. On a larger scale, macro-changes in trade routes are possible under climate change, which could potentially lessen ship traffic past South Africa (e.g. if more Arctic routes are opened) or introduce new ship traffic.

The most critical effects of climate change for South Africa are most likely linked to how people move in response to climate change and how conservation practitioners seek to maximise preservation of indigenous biodiversity in novel contexts. While balancing food security and livelihoods with the need to control invasion pathways is not straightforward, policy intervention can play a large role in minimising harmful introductions and ensuring a more positive interaction between climate change and invasions. The first policy focus should be around regulating carbon sequestration projects in a way that assists native species already adapted to the biome where projects are undertaken. As many of the climate change 'losers' (i.e. those that lose suitable range) are likely to be endemic, fostering mechanisms to encourage stewardship agreements, along with related planning tools, is critical for ensuring connected landscapes and retaining specialist species and functioning ecosystems. Regional collaborations to regulate introduction pathways will also be critical as countries to the north of South Africa are impacted by rising temperatures, particularly where new food sources are being considered.

Lastly, we have entered an era of managed relocations that will undoubtedly be fraught with complex trade-offs between the retention of wilderness areas, biodiversity, and novel ecosystems and the ethics around this. Legal frameworks globally are poorly prepared for the redistribution of species and land productivity and will require increased flexibility to balance biodiversity and human livelihoods. The wealth of experience that South Africa has in managing invasions will be useful in navigating these challenges.



Climate change can worsen the spread and impact of alien species in several ways, both through amplifying the dominance of alien and/or generalist species themselves, but also as a result of human climate change adaptation. As people adapt, trade landscapes are reshaped with new routes opening up as sea-ice melts, while others close as transport technologies respond to fuel availability. Hardy and resilient species are sought for food, horticultural purposes or even for climate change mitigation (e.g. biofuel), resulting in new uses, sources and opportunities for invasion. The conservation challenge will be deciding if, where and how we promote the movement of rare and endemic species in response to this change.

van Wilgen NJ, Faulkner KT, Robinson TB, South J, Beckett H, Janion-Scheepers C, Measey GJ, Midgley GF & Richardson DM. 2023. Climate change and biological invasions in South Africa. Pages 158–187 in L. H. Ziska, editor. Invasive Species and Global Climate Change, 2nd Edition. Wallingford UK, Boston USA.