



BioSCAPE: Success Stories from NASA's First Biodiversity-Focused Airborne Campaign

BioSCAPE, or the Biodiversity Survey of the Cape, is NASA's first biodiversity-focused airborne campaign led by scientists from both South African and the United States of America. The BioSCAPE domain in South Africa covers two global biodiversity hotspots, with the richest temperate flora and the third-highest marine endemism in the world. BioSCAPE is testing the limits and potential of remote sensing for biodiversity applications worldwide and will take us one step closer to measuring biodiversity variables globally from space.

BioSCAPE's Unprecedented Dataset Focuses on Accessibility for Biodiversity Science

Concurrent measurements from three imaging spectrometers and two lidar instruments were captured across the region in October and November 2023. Such a spectrally extensive dataset is unprecedented in airborne science and has immense potential to increase the impact of current and upcoming satellite missions. During the campaign, NASA's GV aircraft flew 16 science flights while the GIII flew 22 science flights, together covering ~45,000 km² and meeting the data priorities of all 19 projects in BioSCAPE. You can view the current versions of the airborne data at bioscape.io/data. Data access and analyses will be supported for both South African and U.S. data users via the "BioSCAPE Cloud" computing environment.

The airborne data are accompanied by a large amount of biodiversity field data, including: over 600 vegetation survey plots across environmental gradients, and field spectroscopy measurements from all dominant species; phytoplankton, bio-optics, and water quality data from marine and freshwater systems; eDNA surveys from rivers' source to sea; sound recordings and point counts of birds and frogs across the region; terrestrial lidar scans across a fire return time gradient; quantification of essential biodiversity variables in estuaries along the coastline; detailed biodiversity and ecosystem function measurements in plots with varying levels of invasion by alien plants; and species surveys and field spectroscopy measurements on kelp forests along the coastline.

BioSCAPE's Support for Decision-Making Needs in the Region and Globally

Since its conceptualization, BioSCAPE emphasized ensuring impact of the work, creating and maintaining deep and meaningful collaboration between researchers in the U.S. and South Africa and always emphasizing the importance of co-developing research. Early inclusion of South Africans led to a diverse Science Team of ~150 members, of which approximately half are affiliated with South African institutions and half with U.S. institutions. The U.S. participation on the team ensured global applicability, access to best-in-class technology, and bridged gaps in capacity. The strong South African presence on the team ensured that the research agenda for BioSCAPE was locally relevant and that local ecological expertise was incorporated. Many South

African collaborators are embedded within local, provincial and national public conservation and environmental management agencies. To take advantage of this, before starting data collection, we brought the science team and local stakeholders together for a five-day in-person workshop to ensure that the research was relevant for local decision-making needs for biodiversity conservation and natural resource management.

BioSCape's Support for Outreach and Capacity Building

BioSCape supported several community outreach events, including a public lecture attended by 150 local stakeholders, a school education program run by GLOBE that reached nearly 170 students from 10 schools, the development of a NASA Space Apps challenge attempted by 71 teams around the world as well as two local NASA SpaceApps events for high school students and the Graduate Student Conference for the South African Environmental Observation Network where 144 students had the opportunity to engage with BioSCape scientists. We also ran a workshop on the Nagoya Protocol (co-hosted by a U.S. and South African representative), which guided documentation of shared benefits of the research (i.e. ways in which both South African and US counterparts benefit from the research). Such a document is important for managing expectations and keeping teams focused on how South African and U.S. members benefit from working together. BioSCape also has a Code of Conduct that includes clear authorship guidelines, ran a pre-deployment Ethical Participation training course, and had zero reports of harassment or safety issues during the campaign.

To ensure equitable access to and understanding of the data that were collected, BioSCape worked with NASA's Applied Remote Sensing Training (ARSET) program to host a training webinar series that focussed on the BioSCape sensors and how they could be applied to biodiversity monitoring, and will be hosting an in-person 2-day capacity development workshop in Cape Town focussing on field spectroscopy. BioSCape also worked with NASA's ORNL DAAC to present a training webinar on the NASA DAACs, what they do, how to use them to archive your data, and data best practices. Additionally, BioSCape is supporting the ORNL DAAC to host an in-person 2-day workshop in South Africa that will focus on teaching users how to access and do basic analyses on the BioSCape data sets, as well as similar training workshops at AGU and ESA conferences in the U.S..

Quotes

"By using the BioSCape data we will be able to upscale what local scientists have been doing on the ground to what's happening at the global level. I'm hoping that in doing so we will be able to get the bigger picture and will be able to make decisions that go beyond conservation managers conserving species in one reserve."

~Muthama Muasya, Deputy Dean, Faculty of Science, University of Cape Town

"There is huge potential with these remote sensing products... as we gather more information [on the health of those ecosystems] those assessments become more reliable, they become things we can use more confidently to guide decision making."

~Andrew Skowno, South African National Biodiversity Institute

“From the South African perspective, what [international collaboration] has really done is accelerate our research... to have this opportunity, to have hands and support and people and expertise and bringing instruments and funds and enabling us to do this work and enabling us to contribute to their work as well is the most magnificent opportunity. We’ve collected more data in the last month than probably the prior six years, it really is quite extraordinary.”

~Lisl Lain, South African Council for Industrial and Scientific Research

“[Because of the sensors that have been flown in BioSCape], we are ready, we are one of the few groups in the world that is ready for this data [from PACE], ready to create these algorithms, to test our algorithms - we finally have datasets to validate all of this. I cannot understate the magnitude of this opportunity for us as South African aquatic researchers. It is huge. It is profoundly significant. I can't wait to get into analysis and writing and developing all of those exciting things.”

~Lisl Lain, South African Council for Industrial and Scientific Research



Members of the BioSCape Science, Aircraft, and Instrument teams in front of the JSC GV and the LaRC GIII in Cape Town, South Africa. Photo: O.Whitehead.



BioSCape Science Team member Andrew Turner (CapeNature) deploying an Audiomoth acoustic logger in South Africa. Photo: J. Shelton.



BioSCape PI Jinghui Wu (Columbia U.) taking radiometric measurements of coastal ocean waters in South Africa. Photo: O.Whitehead.



School students participating in NASA's GLOBE outreach program in Cape Town, South Africa (run by Brenna Briggs NASA ASP-GLOBE Engagement Coordinator). Photo: B. Biggs.



BioSCape Science Team members Jacob Nesslage (UC Merced) and Matthew Rossi (U Colorado) collecting environmental DNA samples in a river in South Africa. Photo: J. Shelton.



BioSCape Science Team member Elhadi Adam (U Pretoria) collecting spectroscopy measurements of estuarine vegetation in South Africa. Photo: J. Shelton.



School students participating in NASA's SpaceApps Hackathon event organized by BioSCape's partners at the South African Environmental Observation Network in Cape Town, South Africa. Photo: A. Wilson.