Monitoring the distribution and dynamics of an alien invasive grass in tropical savanna habitats with airborne LiDAR

Shaun Levick[1], Lindsay Hutley[2], Samantha Setterfield[2], Natalie Rossiter-Rachor[2], Jorg Hacker[3]

[1]Max Planck Institute for Biogeochemistry, Germany
Email: slevick@bgc-jena.mpg.de

[2]Charles Darwin University, Australia
Email: {Lindsay.Hutley; Samantha.Setterfield; Natalie.Rossiter}@cdu.edu.au

[3]Airborne Research Australia
Email: jorg.hacker@airborneresearch.com.au

Abstract

Savannas cover 20% of the global terrestrial land surface and account for 30% of global primary production (GPP). Fire is an integral component of savanna ecology and dynamics, particularly in tropical savannas which typically burn every 1-3 years. Fire can markedly alter the structure and biomass of savanna vegetation, so understanding fire dynamics is critical for managing carbon storage and conserving biodiversity in these habitats. Global changes in land-use and climate threaten many of the ecosystem services that savannas provide, and in Northern Australia the spread of an alien invasive grass (Gamba grass - Andropogon gayanus) is presenting an additional ecological challenge. Natural fires in tropical savannas seldom kill tall and established trees, since native grass fuel-loads (and therefore char height and burn intensity) are low. Gamba grass however can reach heights of 4 m tall, and therefore has the capacity to dramatically alter fire effects in the region by increasing fuel-loads by a factor of 10. Gamba grass fires burn much more intensely and transport flames in to the canopy of tall tress, leading to higher rates of mortality and increased greenhouse gas emissions. To fully understand and better manage the spread and consequences of Gamba grass invasion, we need spatially explicit knowledge of where Gamba grass occurs and how fast it is spreading. However the savanna region of Northern Australia is the largest and most intact savanna system in the world, covering 2 million square kilometers, so mapping the extent of habitat invaded by Gamba is challenging.

We used full-waveform airborne LiDAR to map areas of known Gamba grass invasion in the Batchelor region of the Northern Territory, Australia. Our stratified sampling campaign included wooded savanna areas with differing degrees of Gamba invasion and adjacent areas of native grass and woody tree mixtures. The tall and uniform structure of Gamba grass made it readily identifiable in the high-resolution LiDAR points clouds that we collected. We used height and variance based metrics to classify returns from Gamba grass and developed spatial representations (0.5 m resolution) of Gamba grass, native grass, woody cover, and bare ground distribution. Our mapping results provide a robust benchmark for evaluating the rate and pattern of Gamba grass spread from future LiDAR campaigns. In addition, we are using our spatial representations of Gamba distribution to inform satellite image analysis for the evaluation of Gamba grass invasion over the regional scale. Our work to date on this challenge shows huge potential for airborne LiDAR to facilitate the monitoring and management of savanna habitat condition.