How land management and water availability control ecosystem-atmosphere carbon exchange in the Karoo, South Africa

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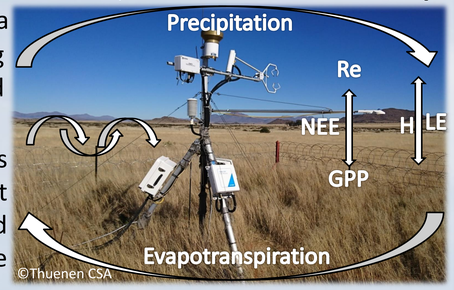
Background

- Climatic and land management factors, such as **water availability and grazing intensity**, play a a dominant role in influencing primary production and carbon fluxes
- However, not many studies have focused on the direct measurements of the land surface-atmosphere exchange



Objectives

To investigate the impacts of climatic (precipitation) and anthropogenic (livestock grazing) drivers on semi-arid Karoo ecosystem-atmosphere exchange of carbon fluxes, latent and sensible energy

- inter-annual variability of carbon exchange across the different grazing intensities
- impacts of water availability and land management on the carbon fluxes

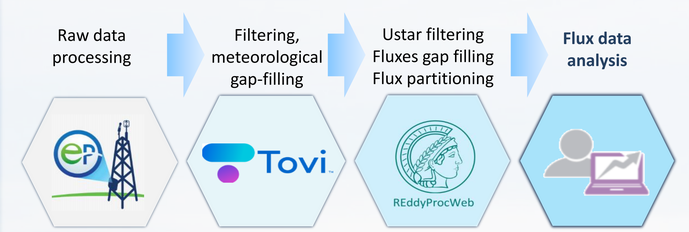
Conclusions

- 'Overgrazed in the past' but now rested site **sequestered** more CO_2 than site with the controlled grazing
- Controlled grazed site is a net **CO_2 source** after 4 years, whereas the rested site is likely to be **CO_2 neutral site**
- **Long resting period** may improve carbon sequestration

Materials and Methods

- **Livestock farming** is considered as the main land management practice
- Long-term **mean annual rainfall** (1889 – 2013) of 373 mm [1]
- **Topography** is generally flat and soils are shallow and weakly developed [2]

- **Controlled grazing** (cycle – 2 weeks grazing, approx. 24-26 weeks resting)
- **Overgrazed in the past** (density is 4 times higher than at the controlled grazing site), rested from 2007 till 2017



Results

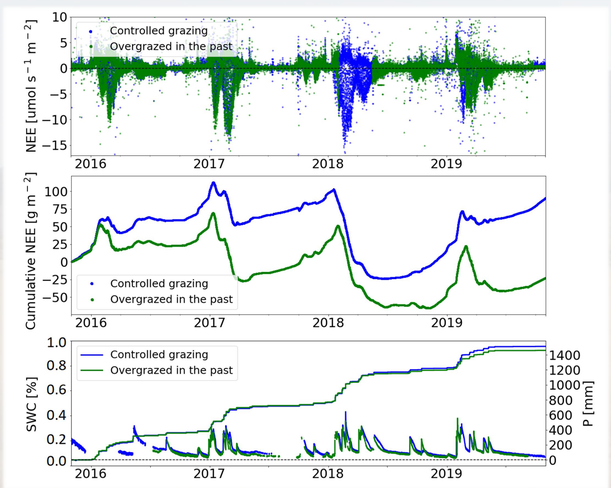


Figure 1. Half-hourly time series and corresponding cumulative Net Ecosystem Exchange (NEE) in correlation with water availability (Soil Water Content (SWC) and Precipitation (P)).

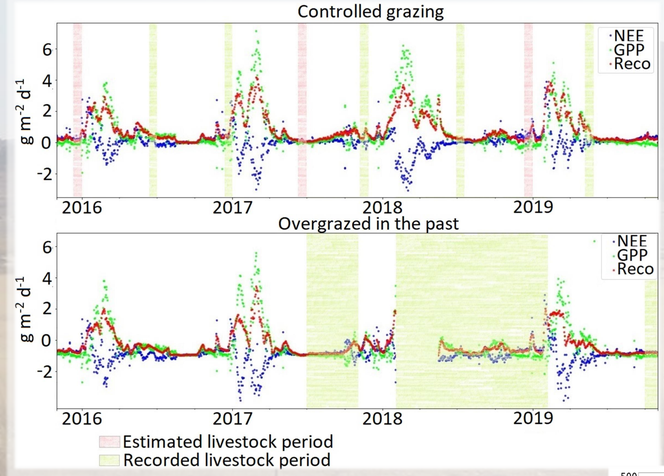


Figure 2. Directly measured Net Ecosystem Exchange (NEE) and partitioned component fluxes (i.e. Gross Primary Production (GPP), Ecosystem Respiration (Reco)) across different grazing intensities.

- Small CO_2 source during the dry season and carbon sink during the growing season
- Carbon uptake strongly correlated with water availability
- Depending on water availability sites may become CO2 sources or keeping their neutral status

$NEE = R_{eco} - GPP$

- The ecosystem is physiologically active and turning to the 'carbon sink' when GPP is higher than R_{eco}
- Third year was the most productive year (2018)

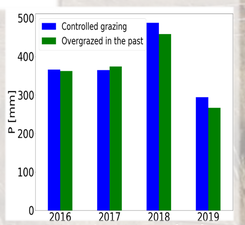


Figure 3. Annual precipitation [mm].

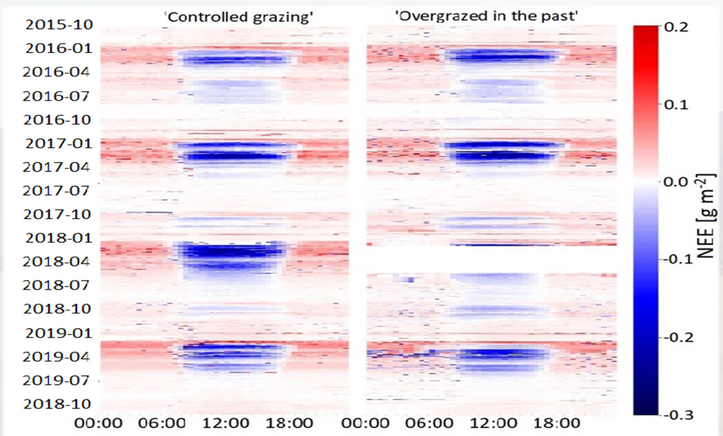
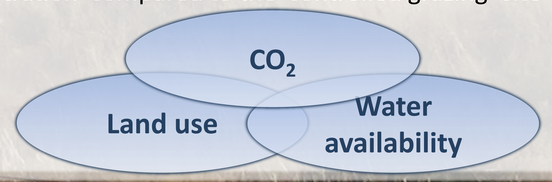


Figure 4. Temporal dynamics of the Net Ecosystem Exchange (NEE).

- 'Overgrazed in the past' site has increased carbon sequestration compared to the 'controlled grazing' site



References:

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2. Du Toit, G. vanN., Snyman, H.A., Malan, P.J., 2011. Physical impact of sheep grazing on arid Karoo subshrub/grass rangeland, South Africa. South Afr. J. Anim. Sci. 41. https://doi.org/10.4314/sajas.v41i3.11

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