11/2016 Briefing for knowledge exchange

Rangeland Management in Namibia – Scientists' and Farmers' Perspective

The OPTIMASS project

Namibian rangelands are prone to degradation associated with the loss of natural resources. The OPTIMASS project aims to develop adapted strategies and robust solutions for a sustainable management. In order to support future farming we investigate how further degradation can be stopped, rangelands can be restored and which management options support a sustainable use of the resources.

Exchange for knowledge gain

Hence, we closely cooperate with local farmers and national actors like the Namibia Agricultural Union (NAU) to understand how land use management can decrease degradation. Through interviews as well as field and greenhouse experiments we received feedbacks on rangeland farming. In a next step we need farmers' feedback on scientific results in order to develop applicable management strategies. In meetings and group discussions we focus on grazing strategies and bush encroachment.

Management in rangelands

Grazing strategies like herd rotation can have strong impacts on rangeland conditions. However, there is little and controversial evidence for or against the benefits of rotational grazing in rangelands.

Farmers' perception and action

In interviews we asked for management options and important benefits or 'services' gained from nature (ecosystem services, ESS). Figure 1 shows the connection between management and ecosystem services in the ranked answers.

Findings and questions

- Water is perceived as one of the most important service. However, water management was not mentioned as highly important. Why?
- How does de-bushing and herd rotation influence services such as vegetation and forage?
- What impact could re-seeding have?

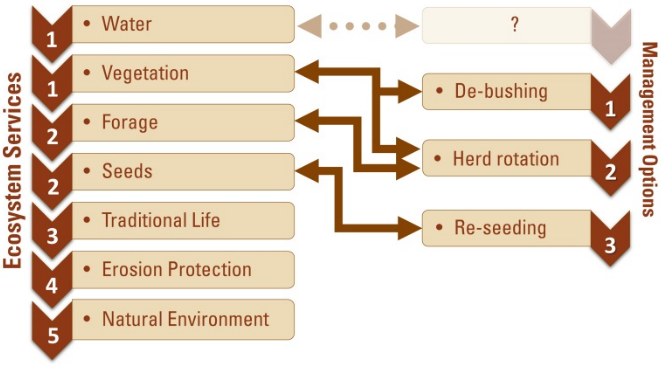

Figure 1: Ranking of ecosystem services (ESS) and management options by Namibian cattle farmers.

Herd rotation

From the interviews with farmers we learned that there are several systems of herd rotation in use, depending on farming type, farm size etc. They differ in the number of camps, design, grazing and resting periods. Reasons for moving to another camp can be the status of vegetation or of the cattle. Rotation schemes depend on the background and experience of the farmers who are more or less influenced by official and scientifically-based advice.

Findings with farmers

- Grazing period: ten days to six months
- Resting period: two weeks to four years
- Camps: 7 to 60 with an area of 45 to 330 ha
- Design of rotation system: wagon wheel, chessboard, mixed

For approaching an optimal rotational grazing scheme, our team developed the computer model EcoHyd which simulates the relationship between rainfall, grazing, grasses, shrubs, soil type and soil water availability. We based our model on a semi-arid camel thorn savanna with loamy-sandy soil and 400 mm of average annual rainfall (including drought years). Four different herd rotation scenarios (S1-4) were included. They are all based on a relatively high livestock density of 10 ha per livestock unit. Figure 2 shows the simulated long-term development of plants (200 years), based on a five camp rotation system. Values show the average biomass of all camps.

Findings with computer model

Best results were received with adaptive rotation every two weeks (bi-weekly, S3) and best camp first (S4):

- Increase of perennial grasses resulting from recovery of healthy root reserves
- Increase in soil moisture due to infiltration and shading, improved by presence of grass cover
- Maintaining healthy grass sward strongly decreases establishment of encroacher shrubs
- Higher livestock densities possible in the long run compared to continuous grazing (S1) and bi-weekly rotation (S2)
- Do you see evidence for the modelling results on your farm?

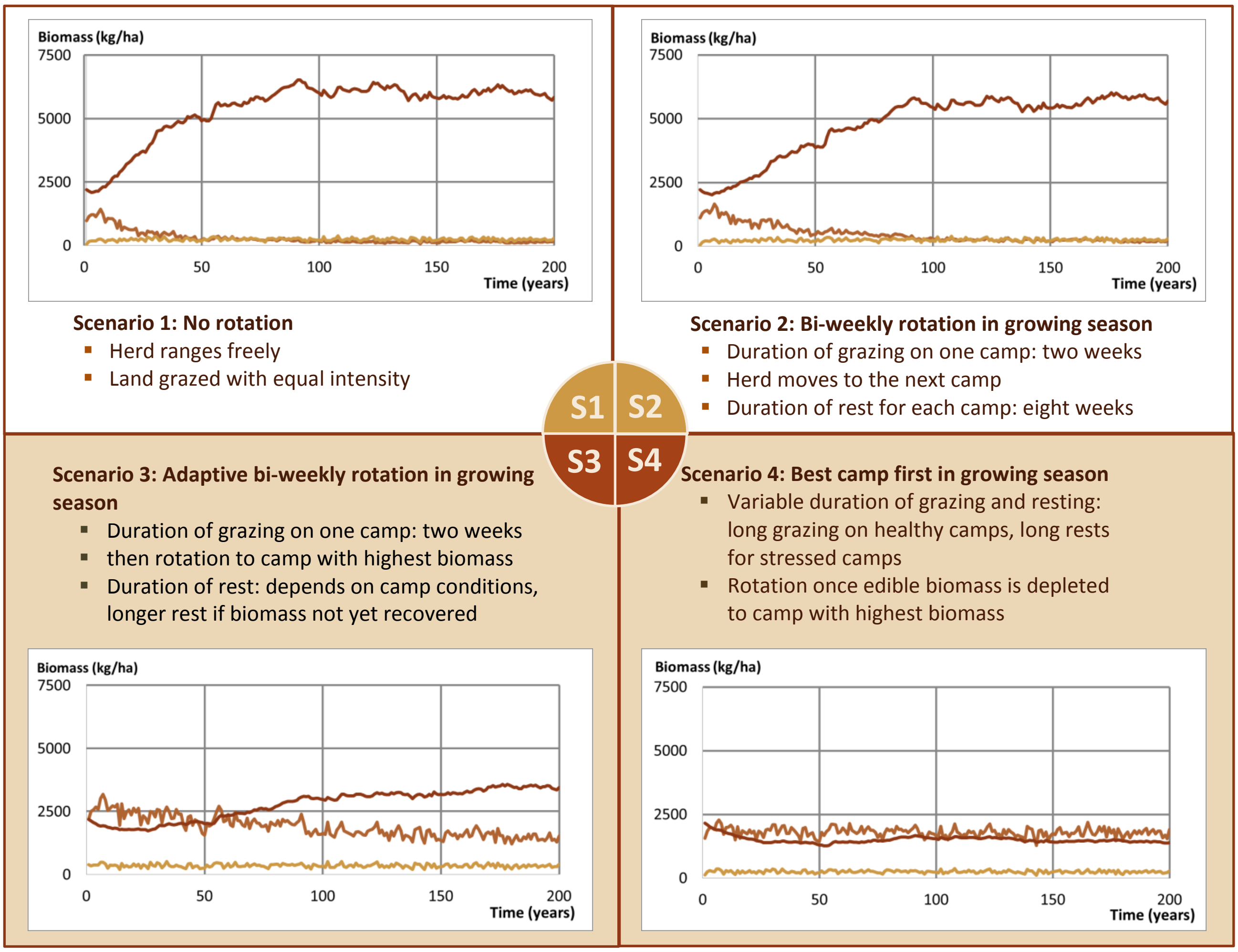

Figure 2: Results of the computer model EcoHyd for herd rotation

Annual grasses   Shrubs   Perennial grasses

Impacts of herd composition

With the computer model EcoHyd we also simulated how herds of wildlife with mixed composition of grazers and browsers affect rangeland condition. The model specifically addresses the ecology of *Senegalia* (*Acacia) mellifera* (*Black-thorn acacia*) which is known to be very sensitive to drought and fire during the first two years after seedling germination.

Findings with computer model

- A high proportion of browsers on a farm might suppress the emergence of new *Senegalia mellifera* saplings.
- As a result, grass growth is encouraged.

Management scenarios during drought

From the interviews with farmers we learned that in cases of droughts, grazing periods should decrease while resting times should be kept as long as possible. Most farmers sell cattle or buy hay during droughts while some farmers added hay production (for sale) to their farming activities which diversifies their income (Figure 3).

Questions regarding herd rotation:

- How can grass reserves be established?
- Could hay production become a major source of income in a drought year (see Figure 3)?

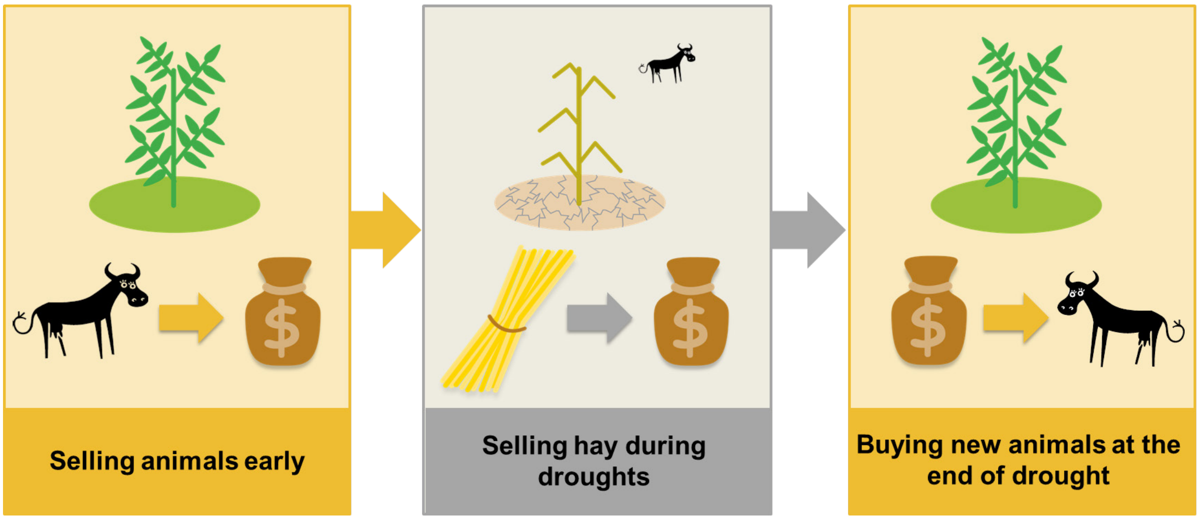

Figure 3: Management scenario on a cattle farm during drought year

Bush encroachment

With regard to bush encroachment, different counter measures are already applied, but opinions about their efficiency differ. Another question is how plants adapt to droughts, which is an important issue if one wants to understand how forage availability for browsers and grazers will be affected.

Measures for de-bushing

In the interviews with farmers we learned about the pros and cons of different measures to fight bush encroachment (and to prevent treated areas to be encroached again). Among the techniques were cutting-off, spraying pesticides, and burning. The specific pros and cons were:

- Cutting off: targeted at individual bushes, sparing trees, but labor intensive and costly
- Pesticides: by aerial spraying covering of huge areas possible at low costs, but no sparing of individual trees; by manual application individual dosage possible, but labor intensive and costly
- Burning: Low cost technique for vegetation structures above soil, but fire control is needed (risk of spreading)

According to farmers' experience, combinations and alternations of the three general techniques showed best results.

Questions:

- What is your best technique? Why and when?
- What do you do after de-bushing?

Forage quality of grasses and bushes

To understand the mechanisms of bush encroachment we analysed in what way forage quality for grazers and browsers is influenced during droughts (Figure 4). We looked at how plants respond to a lack of water. We also investigated two perennial grasses, one annual grass and one bush species to learn about their drought adaptation strategies, water use and the effects on nitrogen content of the plant (Figure 5).

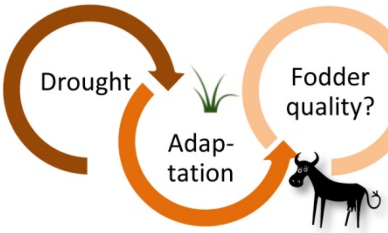

Figure 4: Research question on fodder quality

Figure 5: Grasses and shrub (left to right: Aristida stipitata - Long-awned grass, Stipagrostis uniplumis - Silky bushman grass, Senegalia mellifera - Black-thorn acacia)

Findings

- Larger shrubs suffer more after drought than smaller shrubs. They might not have active roots yet and cannot use first rains.
- Browsers suffer under reduced nitrogen content of forage during drought (assuming they mainly feed on shrubs).
- Grazers remain unaffected in terms of forage quality during drought, assuming they mainly feed on perennial grasses.

Seedling germination

Observed increases in CO_2 might allow shrubs and trees to grow faster than grasses. This could offer better fodder sources for browsers. At the same time, forage for grazers might be reduced. In a green house, we explored how the presence of grass affects the growth of shrubs. We established the experiment to investigate germination progress under different rainfall treatments (dry conditions vs. wet conditions). Seeds were collected in a dry area and an in area with more rainfall.

Figure 6: Anthephora pubescens – Wool grass

Findings

- It makes a difference whether the seeds were collected in a dry area or a more humid area.
- At the driest site, a positive effect on the germination of *S. mellifera was observed caused* by the presence of grasses. Also, a small, but significant positive effect on *Dichostachys cinerea (Sicklebush)* was observed at the dry site when there were neighboring grasses.
- *A pubescens* (grass, figure 6) and *S. mellifera* (tree) from the driest site germinated better than the same species from wetter sites, under drought conditions.
- The other two species, *S. uniplumis* (grass) and *D. cinerea* (tree), did not differ in their sensitivity to drought based on their area of origin.
- The germination of *A. pubescens (grass)* was not affected by the presence of tree seeds. It should however be noted that this species showed the most plasticity in germination, with respect to different watering level.
- What is your experience with the re-establishment of different species of grasses and shrubs?

Further research within OPTIMASS

Water infiltration in macropores

Macropores are underground structures created by soil burrowing insects (Figure 7), like ants and termites, which are related to the perennial grass cover in savanna rangelands and are mostly found in the immediate neighborhood of grass tussocks and shrubs.

- Infiltration experiments confirm that macropores are important for the infiltration of rainwater. In areas with a high number of macropores, a greater amount of water can infiltrate into the soil faster and deeper, compared to soil without insect activity.
- These enhancing effects of macropores on water infiltration seem to depend on the soil structure, the surrounding vegetation and time of the rainy season. However, it is difficult to distinguish between these three effects.

Figure 7: Macropores on a cattle farm

Modeling of water erosion

Soil erosion negatively influences productivity. We developed a computer model to disentangle the causes of soil erosion. We ask which factors favor surface runoff during heavy rainfall and lead to an enhanced risk of soil erosion and found the following:

- Depending on the sand content of the soil, more rainfall water infiltrates at the expense of surface runoff. Hence, the erosion risk is generally lower when the soils are sandy due to smaller overland flow rates.
- Vegetation structures can obstruct surface runoff and therefore reduce soil erosion. This depends on the cover density, the spatial distribution and the species composition (trees, shrubs and grass).

Vegetation Mapping

We developed different vegetation maps using satellite remote sensing to help identify effects of different commercial land use strategies on overall vegetation condition and bush encroachment. We particularly investigated vegetation greenness and derived the following variables:

- Start of the vegetation period under different management strategies (e.g. game vs. livestock)
- Environmental conditions (different sites over a range of mean annual precipitation)
- High resolution maps of land cover (vegetation types, figure 8) including percent shrub and tree cover for selected farms

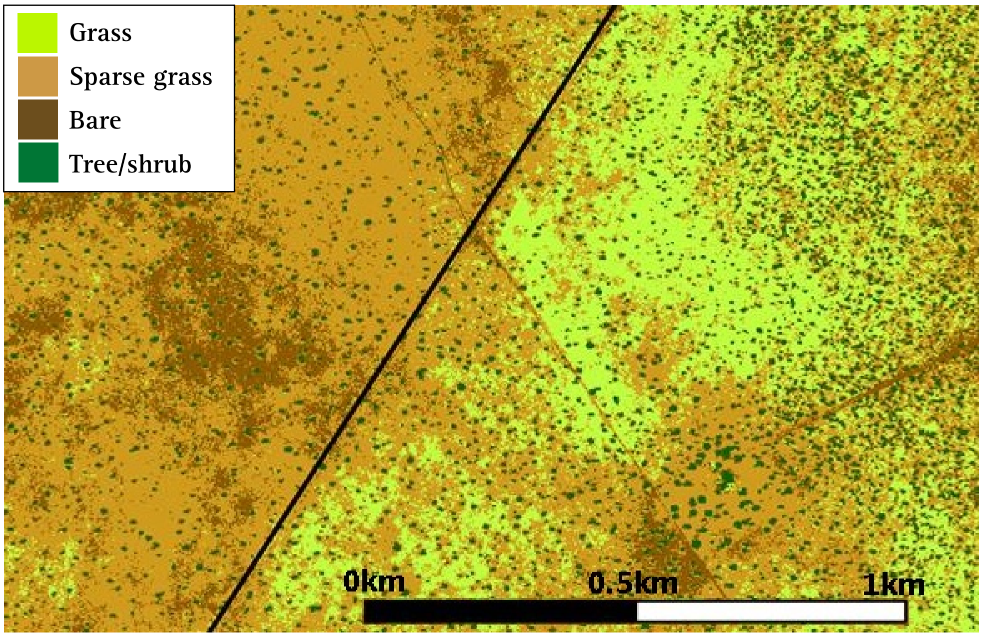

Figure 8: Land cover map derived from satellite image (left of black line/fence: game farm, right: cattle farm)

Next steps

- Incorporate farmers feedback
- Finalize the further research
- Namibian Rangeland Forum 2017

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