Towards sustainable livestock production systems:

Analyzing ecological constraints to grazing intensity




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LiveM 2016 Conference

Potsdam

ALPEN-ADRIA UNIVERSITÄT KLAGENFURT | WIEN GRAZ
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Analyzing ecological constraints to grazing intensity (GI)

Are we able to feed 9 billion people and at the same time avoid damage to natural resources?

Increasing food production from grasslands essential but related to ecological deteriments (e.g. carbon and biodiversity loss)

Precondition: good knowledge basis
But: data on many parameters weak or not available (forage use, storage systems, grazing intensity etc)

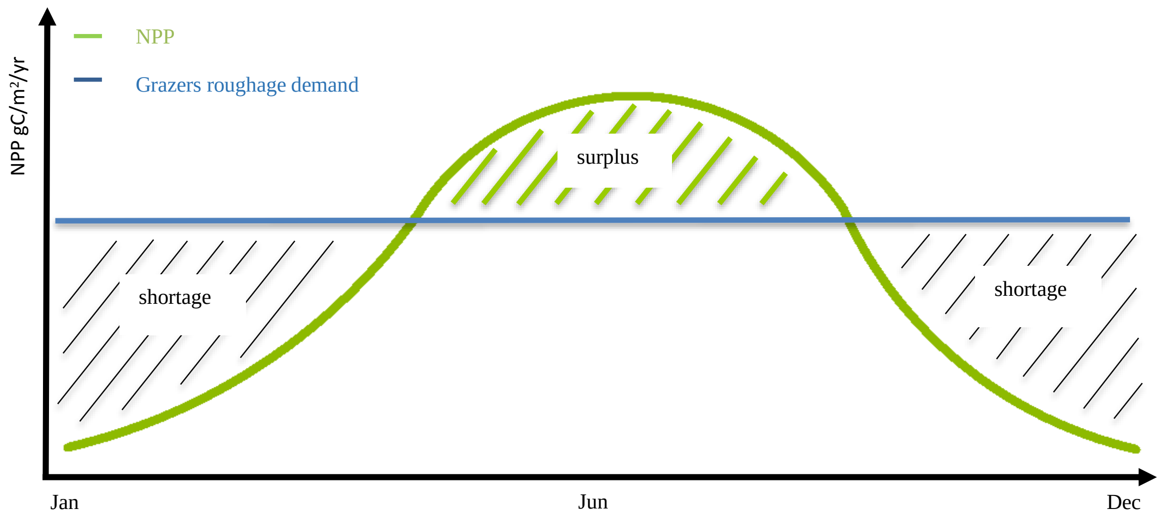
Add to current knowledge basis:

- ✓ System level perspective: Grazing intenstiy (GI) integrates edaphic and bioclimatic factors by focusing on NPP
- ✓ Major constraint to grazing intensity: seasonality of biomass provision

How seasonal patterns of biomass provision influence grazing intensity

- Seasonal patterns of biomass provision result in shortage and surplus periods:

NPP provision as determinant of grassland management patterns and GI?



→ During shortage period: less animals supported

→ Without supplementation and/or management: livestock numbers limited by seasonal constraints

Why grazing intensity matters – research questions

What are the limits to grazing intensity considering seasonal limitations?

Does the observed grazing intensity exceed the seasonal potential in some regions?

How much more biomass could be used if we were able to utilize this surplus potential?

Data

Delineation of ecosystems subject to grazing:

- Natural grassland biomes (FAO 2000 ecofloristic zones; Olson 2001; Ramankutty et al. 2010)
- Current grazing area from Erb et al. 2007
- Utilizable and accessible fraction of NPP:
  - Accessibility: trees (Hansen et al. 2013), steep slopes, protected areas
  - Utilization: average observed from local case studies (Milchunas and Lauenroth 1993) and others within Köppen-Geiger climatic zones
- Animal densities for Cattle, Sheep, Goat and Buffaloes (Gridded Livestock of the World; FAO 2007, Robinson et al. 2014)
- Monthly Net Primary Productivity data for the years 1994-2004 from ISI-MIP Fast Track (ESGF 2014) for JULES and ORCHIDEE models
- Grazing feed-demand/total feed-demand (Herrero et al. 2013)

Methods: Observed and potential grazing intensity (Gi_{season})

Observed GI:

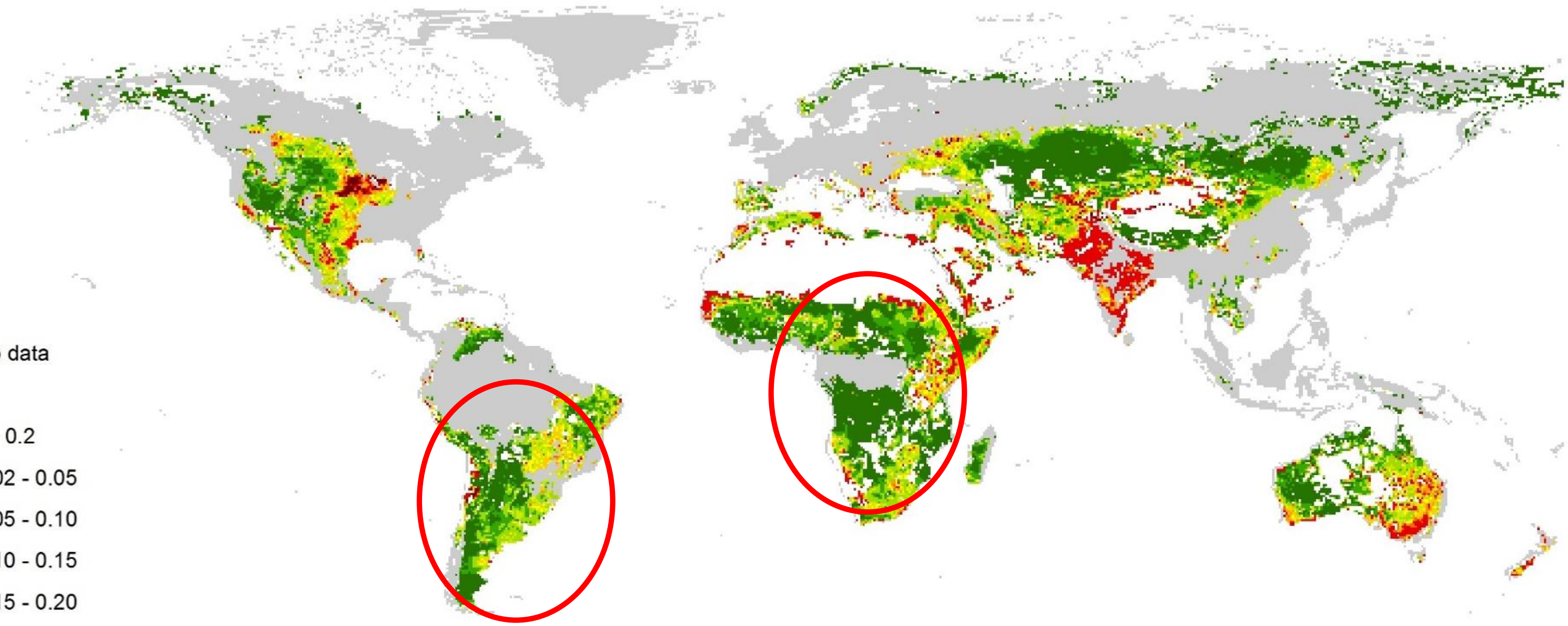
Defined as grazing feed-demand related to the available NPP per grid-cell

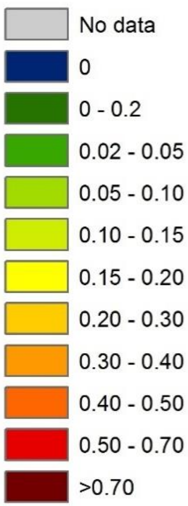
GI_{season}:

- ✓ Defined as grazing intensity that could be sustained in the month with minimum biomass supply
- ✓ Animals can feed on old standing biomass for a certain time
- ✓ Conservative assumption:
  - 1-5 months can be bridged according to the length of growing period
  - 3% decay per week
  - Range of years: 1994-2004 to capture inter-annual variations

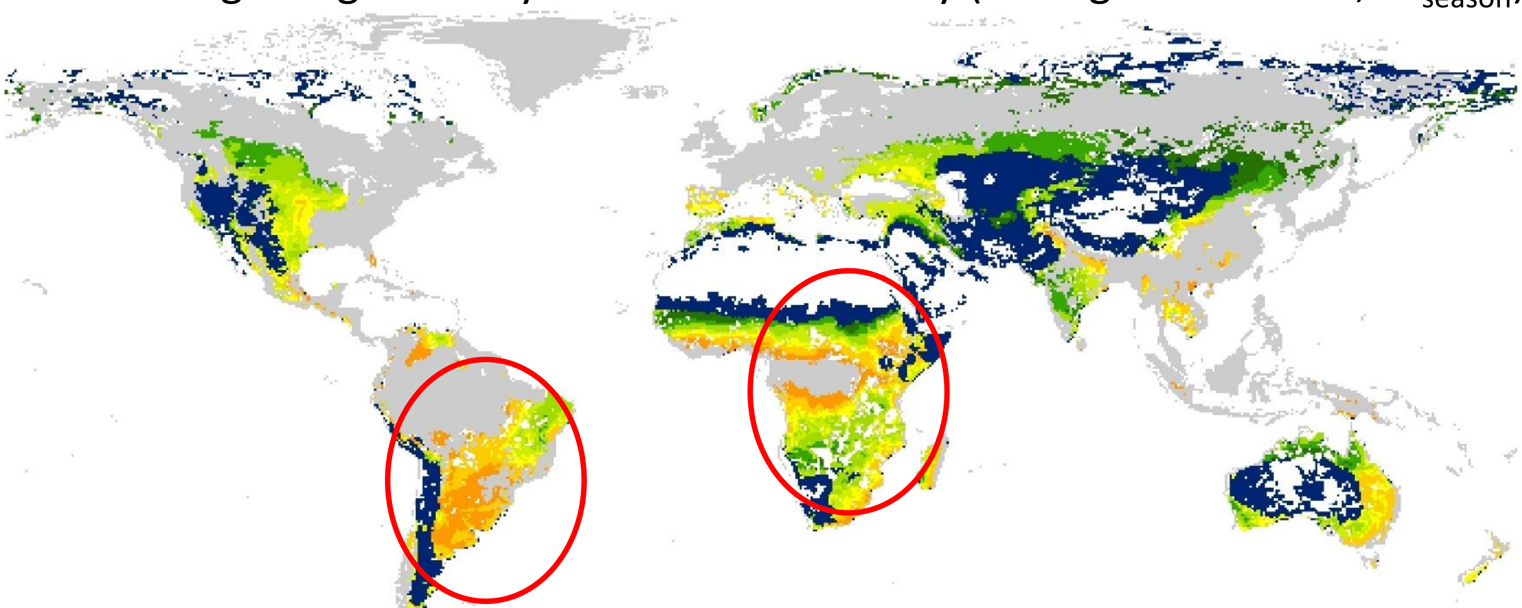
Potential for further biomass extraction: GI_{season} higher than current GI

Global pattern of observed grazing intensity (average 1994-2004)

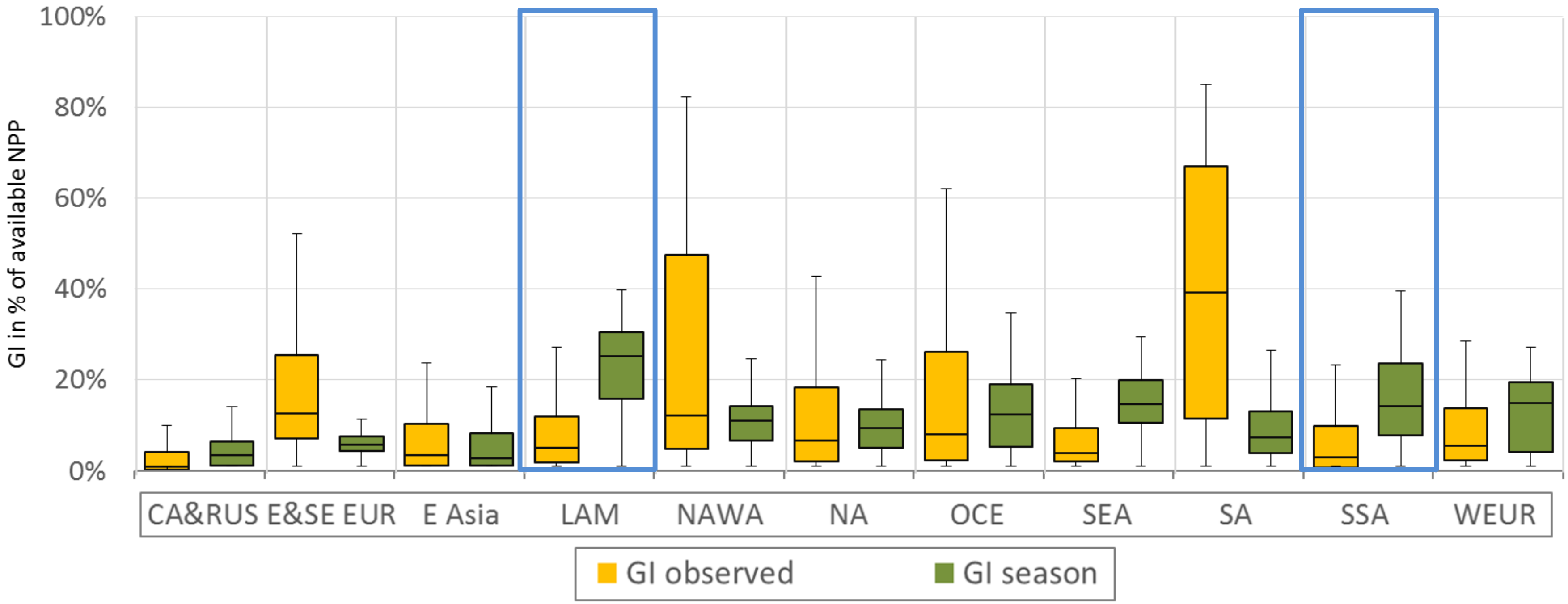




Potential grazing intensity based on seasonality (average 1994-2004; GI_{season})



Patterns of current GI versus Gi_{season}



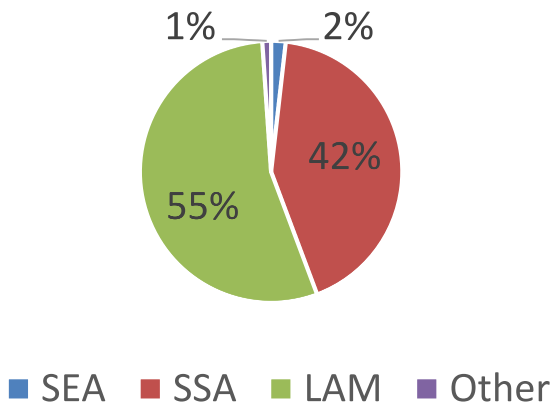
- In most regions, GI observed is much higher than GI season
- Latin America (LAM) and Sub-Saharan Africa (SSA): GI observed BELOW GI season

→Potential surplus biomass: 181 – 997 Mio tC/yr

Distribution of supplementary feed and potentials of using surplus biomass

LAM and SSA:

- 97% of potential surplus biomass
- 35% of total supplementary feed
- LAM: 73% of supplementary feed in areas with no seasonal feed-deficiency



Potential to:

✓ Reduce the fraction of supplementary feed and hence negative impacts of crop production like deforstation, degradation or nitrogen pollution

✓ Increase milk and meat production (milk +5% and meat +4% compared to 2000)

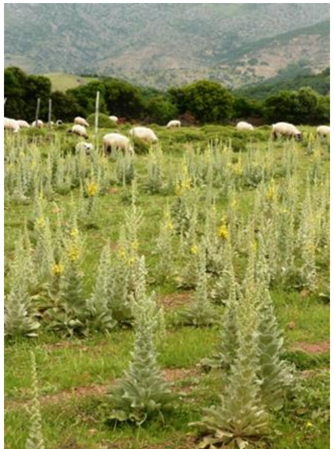
✓ Release area from production for carbon storage: 2.8 Mio km²

Conclusion: Potential barriers to using surplus biomass

Barriers and Trade-Offs:

- ✓ Socio-economic barriers: lack or inefficiency of marketing chains, market and captial access, labor constraints, storage facilities, land tenure, competition among stakeholders, or transport systems
- ✓ Ecological impacts of grazing on species diversity, composition, primary productivity and hydrology causing bush encroachment, weed invasion, decreasing soil cover, degradation

> - ✓ Sustainability thresholds depend on local socio-ecological circumstances
> - ✓ Potential for increasing GI must be determined at the local/regional level to avoid detrimental environmental effects of overgrazing




Thank you for your attention!

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