Species composition, productivity, and functionality of grassland in the Greater Caucasus

-a remote sensing based assessment-

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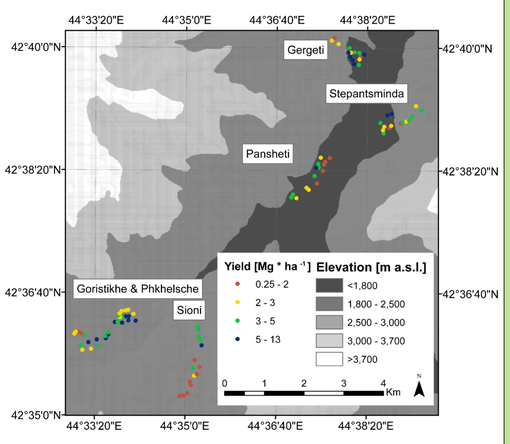
1. Background and research aims

High mountain grassland is prone to global change, i.e. land abandonment, which strongly affects high mountain **ecosystem functioning** through reduced species richness and erosion control. Mapping of grassland properties, such as **species composition, productivity and functionality** aids in sustainable land-use planning and thus sustaining ecosystem functioning.



Our main aims were:

- to analyse the **species composition** and main **environmental gradients**
- to test the predictability of **species composition, aboveground biomass and plant functional groups** by remotely sensed data, and
- to test the possibility of identifying **encroaching shrub species** in remotely sensed data.

2. Methods

2.1 Analysis of species composition and environmental gradients

- Multivariate statistics (isomap, NMDS)
- Clustering and identification of typical species (isopam)
- Significance testing for differences in environmental and structural factors

2.2 Modelling species composition, aboveground biomass and plant functional groups

- Satellite imagery, vegetation indices, topographic parameters
- Random Forest modelling
- Simulation of sensor bands

2.3 Separation of encroaching shrub species

- Birch, Rhododendron, Buckthorn, Veratrum
- Simulation of sensor bands
- Jeffries-Matusita distance

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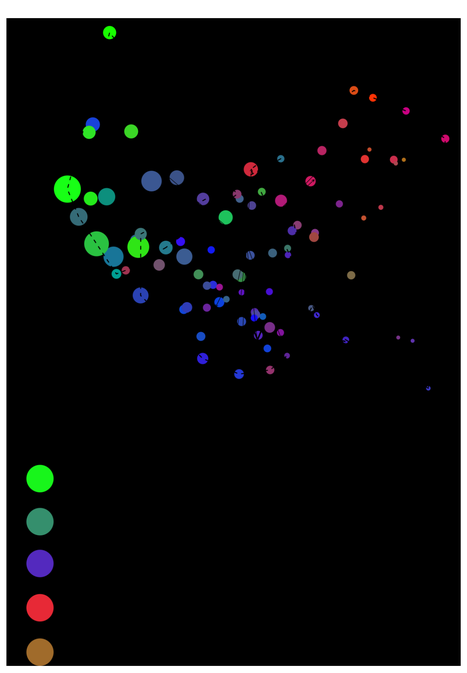
3. Results

3.1 Species composition and environmental gradients



***Hordeum brevisubulatum* meadow (HB)**

- Productive: ∅ 6t*ha^{-1}
- Grass-rich: ∅ 40%

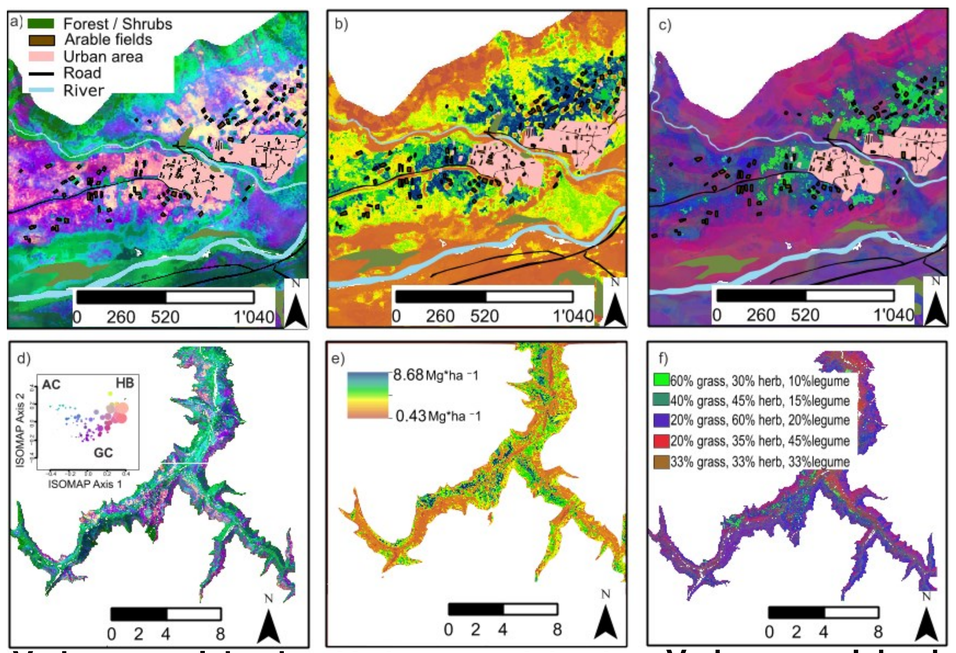
***Gentianella caucasea* grassland (GC)**

- Low-productivity: ∅ 2.6 t*ha^{-1}
- Herb-rich: ∅ 60%
- Species-rich: ∅ 31 species per 5 m²

***Astragalus captiosus* grassland (AC)**

- Low-productivity: ∅ 2.6t*ha^{-1}
- Legume-rich: ∅ 35 %

3.2 Mapping species composition, aboveground biomass and plant functional groups

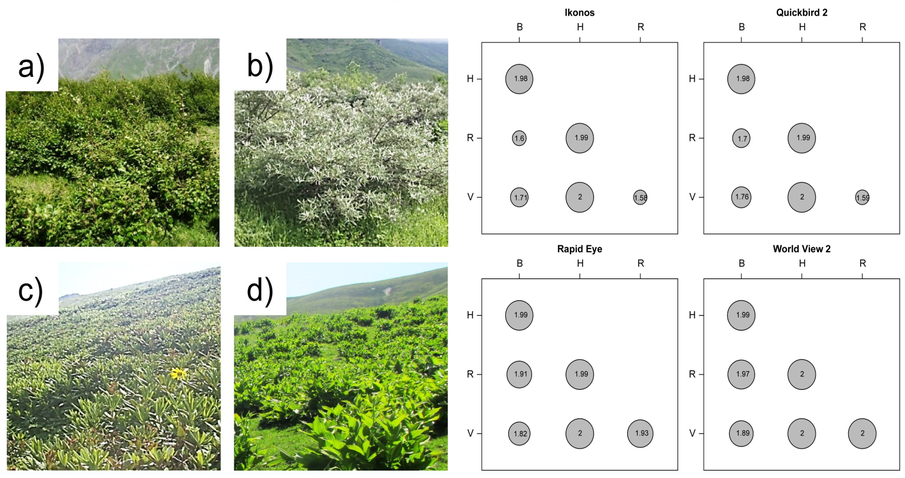


Variance explained:
Axis one = 64 %
Axis two = 33 %
Axis three = 46 %

Variance explained:
Yield = 62 %

Variance explained:
Grass cov. = 32 %
Herb cov. = 25 %
Legume cov. = 37 %

3.3 Identification of encroaching shrub species



- ***B**etula litwinowii* (a) and ***H**ippophae rhamnoides* (b), show a good seperability.
- ***R**hododendron caucasicum* (c), as well as ***V**eratrum lobelianum* (d) are difficult to seperate from *Betula litwinowii.*

4. Discussion

- The species-rich *Gentianella caucasea* grassland resembles the semi-natural dry grassland in central Europe, which is mainly threatened by **abandonment** and **succession**. Maintaining the local practice of spring pasturing is thus essential for **sustaining phytodiversity**.
- **Species composition** and **biomass** allow for a remote sensing based, periodic, and **standardized monitoring system.**
- **Further encroachment of shrubs** can be expected and its impacts of on species composition, productivity and functionality of high mountain grassland are **widely unknown**. **Mapping and monitoring** of shrub encroachment in a cost-effective manner is thus urgently needed.

Sources: Magiera, A., Feilhauer, H., Tephnadze, N., Waldhardt, R., Otte, A. 2016: Separating reflectance signatures of shrub species – A case study in the Central Greater Caucasus. - Applied Vegetation Science 19: 304–315.

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