German Remote Sensing Data Center

Estimating grassland biomass and livestock carrying capacity using Sentinel data to strengthen grazing management on local to national scales in Armenia

Sarah Asam, Emmanuel Da Ponte Canova, Frank Thonfeld, Aiym Orynbaikyzy

MOTIVATION

- Grasslands constitute 39% of Armenia's territory and **57% of agricultural lands**.
- Grasslands provide fodder, biodiversity and other **ecosystem services** (erosion control, water purification, etc.).
- Livestock farming is important for Armenia's agricultural development, threats to livestock and pastures can significantly **impact livelihoods**
- The **condition** of grasslands is deteriorated due to anthropogenic pressure, unsustainable management, and climate change → **overgrazing and erosion**
- Support for local decision-making becomes important → need of robust and up-to-date **spatial data**.
- "GrassAM" project funded by GIZ aimed at mapping grassland **extent**, **above ground biomass** (AGB) and livestock **carrying capacities** at 10 m spatial resolution in 2020.

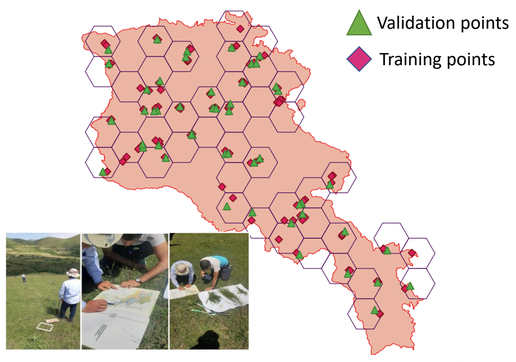

Fig. 1: Distribution of AGB samples over Armenian districts

In situ data

- Field campaigns in summer 2020
- 400 samples of 7 classes (pasture, meadow, other grassland, annual arable land, perennial arable land, bushland, bare soil)
- 147 points of wet and dry AGB on pastures & meadows, collected in 30x30 cm plot at 2 cm height
- Dry biomass weight after drying at room temperature for 48 - 72 h
- Measured wet AGB ranged from 1.733 – 27.800 kg/ha (mean: 12.367 kg/ha); dry AGB ranged from 1.011 – 14.300 kg/ha (mean: 5.416 kg/ha)

APPROACH

Grassland Mask

- Sentinel-1, Sentinel-2, and digital elevation model (DEM) data as input features for **LULC classification**
- **Random Forest** classification implemented on Google Earth Engine
- On screen sampling of rock & water
- **Urban and forest areas** masked using DLR's World Settlement Footprint (10 m resolution) and Hansen Global Forest Change map (30 m resolution).
- Classes pasture, meadow and other grassland used for **masking**

Above Ground Biomass

- **60/40** data split in training/validation
- **Random Forest regression**
- Test of 841 geospatial features using Sequential Forward Feature Selection
- Selection of **6 features** (Sentinel-2 mid-June + July NDVI, Band 12 July mean, May precip., June temp., DEM)

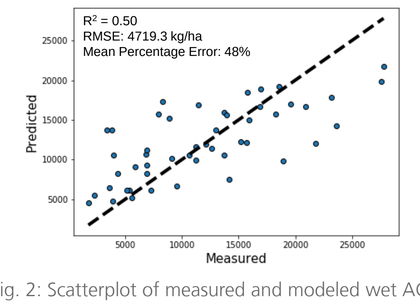

Fig. 2: Scatterplot of measured and modeled wet AGB

Carrying Capacity

Inputs to carrying capacity model:

CC = AGB / (DI × D)

- **AGB**: multiplied with proper use factor (0.65) → available fodder
- Daily **fodder** intake **(DI)** / animal unit (equivalent of 400 kg cattle weight)
- Pasture **season length (D)**

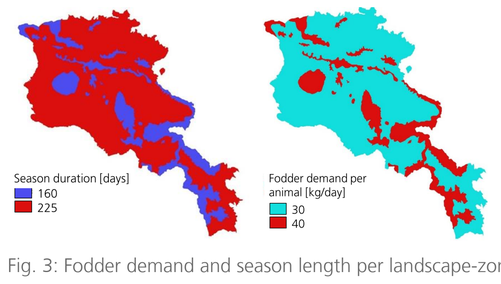

Fig. 3: Fodder demand and season length per landscape-zone

RESULTS

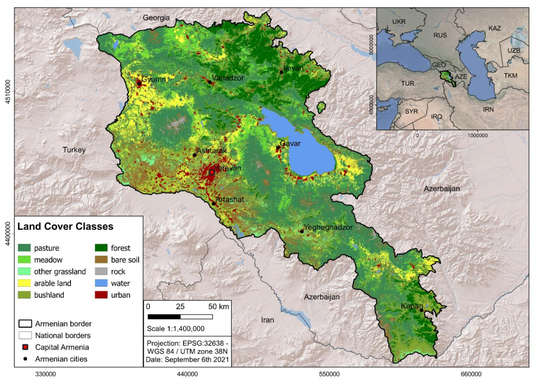

Fig. 4: LULC classification for 2020 at 10 m spatial resolution

- LULC classification achieves an **overall accuracy of 80%** (8 classes)
- Grassland area slightly overestimated with 79% UA and 92% PA

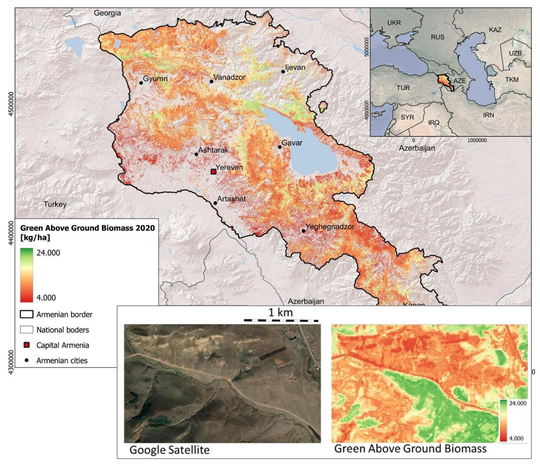

Fig. 5: Modelled wet AGB for 2020 at 10 m resolution for Armenia and zooms showing the spatial detail of the map

- Wet AGB modeled with **R^2 of 0.5**, and mean percentage **error of 48%**

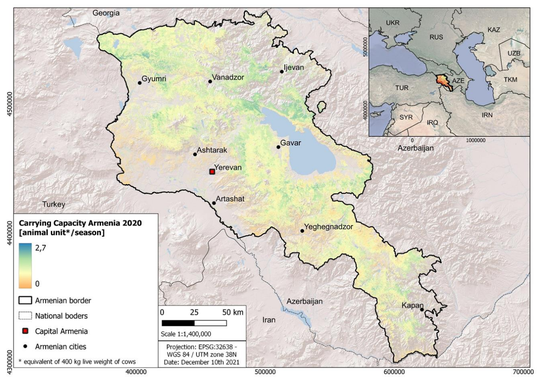

Fig. 6: Carrying Capacity for 2020 at 10 m spatial resolution

- Optimal stocking density of 1- 3 animal units per hectare
- Potential usage to improve grassland management and increase resilience

ICARE International Center for Agribusiness Research and Education · SDA Strategic Development Agency – Strategies for Development · german cooperation Deutsche Zusammenarbeit · giz · DLR Deutsches Zentrum für Luft- und Raumfahrt