Biomass production from grassland - Supply

General description

The approach presented here is comprised of two main parts. The first part (steps 1 and 2) assesses the **optimal yield** (ES potential) according to the length of the growing season, the respective growth functions and the specific land use types. The second part refines the biomass productivity according to region-specific precipitation patterns (steps 3 to 7) and local small-scale topographic conditions (steps 8 to 10), in order to provide more reliable **local yield estimates** (ES status). **Flowchart below** describes in detail the calculation procedure to derive the Supply (DM kg/ha) for each local administrative units (LAU2) of the Alpine Space.

Input data

- DEM (slope, aspect)
- Precipitation (in mm)
- Climate Data (number of Vegetation days, start of growing season)
- Land use types (intensively used, moderately used and extensively used grassland, Natural Grassland (CLC)…)

Calculation processes

(1) Calculate Vegetation Days (days with *T*_{mean}≥ 5 C)

The approach is based on the assumption that biomass production does not start if the daily average temperature is below 5°C, hence the year is divided into a growing season and a dormant season.

(2) Calculate Optimal Yield

This is done according to the productivity type of the grassland types of your study area. In the table below you find the factors we used for the Alpine-wide approach according to the dataset we had at our disposal.

Land use type	**Productivity type**
Permanent Grassland	4
Natural Grassland (CLC)	3
Natural Grassland (HRL)	3

Bogs	2
Dwarf bushes	2
Larch meadows	1
Alpine grasses	1

The **optimal yield** is then derived using the following functions, where x is the number of vegetation days.

Forage type	Yield function (dt/ha)
4	y=(0.0021*(x²))-(0.419*x)+93.774
3	y=(0.0007*(x²))-(0.1513*x)+26.585
2	y=(0.0006*(x²))-(0.1613*x)+25.321
1	y=(-0.00007*(x²))+(0.1084*x)-4.7726

(Yield calculations Source: Egger, G., et al. (2004). GIS-gestützte Ertragsmodellierung zur Optimierung des Weidemanagements auf Almweiden. Irdning, Irdning: BAL. Modified by Jaeger and Tasser)

(5) Indicate Growing SeasonStart and End in days of the year (DOY)If no specific data is available for your test region, you can use a DEM-based method (i.e. Krautzer et. al. 2012) to approximate the start of the growing-season.

- **(3) Calculate start of growing season based on DEM** (DOY). Here the example function we used for the entire Alpine space:[(0.0689*DEM)+0.4444]
- **(4) Calculate end of growing season.** Start of Growing Season + Vegetation Days (in DOY).

(6) Calculate average precipitation needed during growing season

- Sum the average precipitation data for the growing season (in mm).

(7) Optimizing (reducing) regional yield by applying a

correction factor if precipitation during the growing season is below a certain threshold

- precipitation sums (in mm) in vegetation season are lower than (Vegetation days * 3.33) **then** the regional yield (unit: dt) ⇒ regional yield =[(Precipitation in growing season (in mm) / Vegetation days * 3.33) * optimal yield]
- **else** use optimal yield.

(8) Calculate slope yield

- Calculate the yield reduction caused by slope because of radiation reduction* the slope is > 10, **then** use the following formula [(1- (Slope/ 100)) * regional yield], **else** keep the regional yield value.

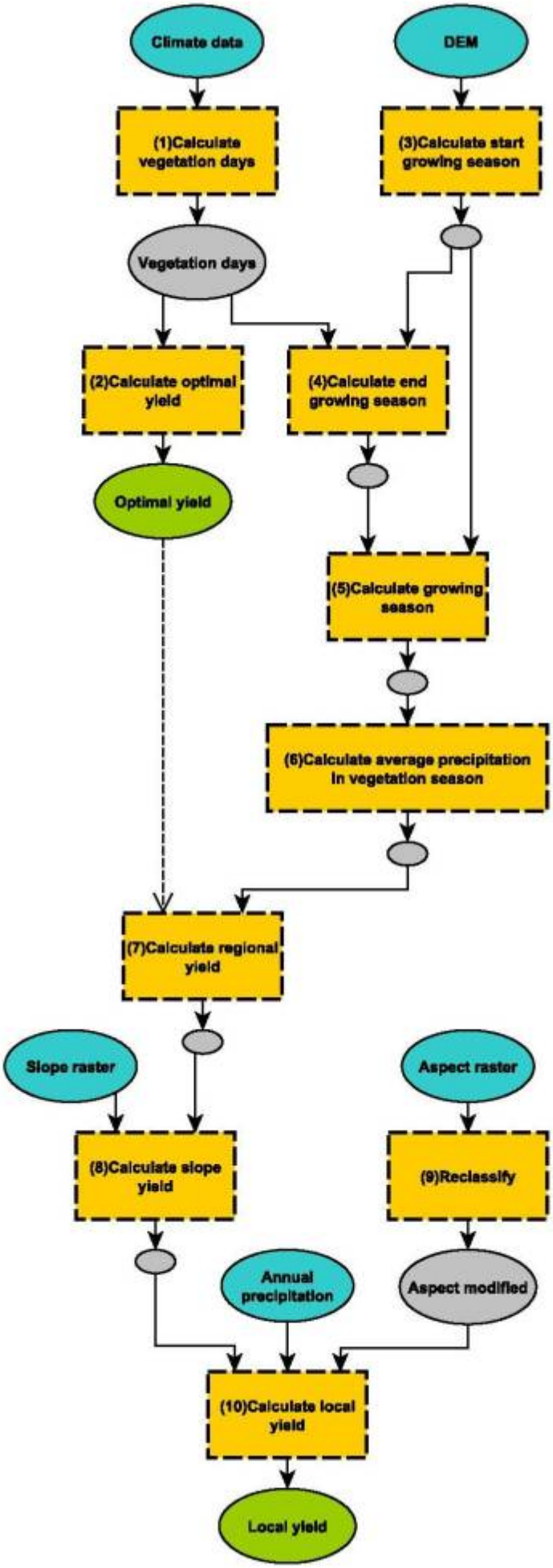
(9) Reclassify the “Aspect raster” to “Aspect modified” in preparation of step (10)

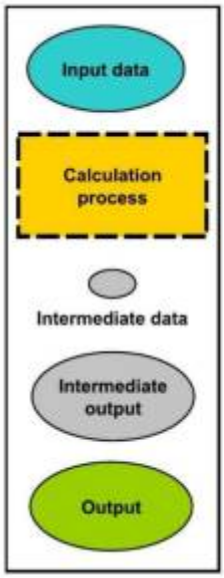
- For the purposes of the model, simplified aspect values are required that account for losses caused by radiation decrease due to unfavorable exposition. Only values between 0° (north) – 180° (south) are valid inputs, where 90° refers to both east and west exposition. The reduction factors range between 0% and 20%, respectively for southerly and northerly facing slopes. We applied a linear distribution of the **reduction factor** from south to north.* Hence, first aspect values have to be reclassified and inverted using the following formula: ***aspect_recl =******180 - (180 - (Aspect - 180)***
- And second, this raster has to be multiplied with its specific **reduction factor**. ***Aspect modified = aspect_recl * reduction factor***

The result is the layer **„Aspect modified“** with cell values ranging from 0 (for southern faced slopes) up to 20 (for northern faced slopes).

(10) Calculate local yield

- In the final step local yield is calculated without the losses caused by exposition:* the Annual Precipitation ⇐ 1500 mm **then** use the following formula: [(100 - (Aspect modified / 2)) / 100) * Slope Yield] **else** this other formula [((100 – Aspect modified) / 100) * Slope Yield)].


Climate data
DEM
(1)Calculate vegetation days
(3)Calculate start growing season
Vegetation days
(2)Calculate optimal yield
(4)Calculate end growing season
Optimal yield
(5)Calculate growing season
(6)Calculate average precipitation in vegetation season
(7)Calculate regional yield
Slope raster
Aspect raster
(8)Calculate slope yield
(9)Reclassify
Annual precipitation
Aspect modified
(10)Calculate local yield
Local yield



Input data→elements that hold a value or a reference to data stored on disk. It is usually a spatial explicit information coming from official sources.

Calculation process→ the actual operation performed on the data. The number preceding the item refers to the number in the model description.

Intermediate data→ for each calculation process intermediate data is generated. This data, however, is usually not significant itself, but is used as an input for the next calculation step.

Intermediate output→ is intermediate data that has a significance for the ES evaluation.

Output→ is the result of the calculation process. It is typically one of the ES indicators, either Supply, Demand or Flow.

References:

Krautzer, Bernhard, Christian Uhlig, and Helmut Wittmann. “Restoration of Arctic–Alpine Ecosystems.”Restoration Ecology: The New Frontier 189 (2012)

Egger, G., et al. (2004). GIS-gestützte Ertragsmodellierung zur Optimierung des Weidemanagements auf Almweiden.Irdning, Irdning: BAL. modified by Jaeger and Tasser et al.

Urthaler, K. (2016). Modellierung und Validierung des landwirtschaftlichen Ertrages der Grünlandflächen Südtirols. Institut für Ökologie. Innsbruck, Leopold Franzens Universität. Master of Science