Degradation in lowland areas of Akhmeta.

Remote Sensing as a Tool for LDN Monitoring (Georgia)

DESCRIPTION

Land degradation contributes to climate change, biodiversity loss and the impoverishment of rural livelihoods in Tusheti. The concept of Land Degradation Neutrality (LDN) and the method of using remote sensing for monitoring are tools to identify the need for action of local planning processes. This showcase describes the LDN monitoring concept, national targets and the technology to assess indicators, mechanism and incentives for LDN.

Purpose
The continuing global degradation of land resources threatens food security and the functioning of ecosystem services by reducing or losing their biological or economic productivity. Unsustainable land-use practices such as deforestation, overgrazing and inappropriate agricultural management systems trigger the loss and degradation of valuable land resources in Georgia. These effects are visible in all countries of the South Caucasus. About 35% of the agricultural land in Georgia is severely degraded, 60% is of low to middle production quality.

Land Degradation Neutrality (LDN)
LDN is a new international concept to combat the ongoing degradation of valuable soil resources. The LDN concept was developed by the UNCCD to encourage countries to take measures to prevent, reduce or reverse land degradation, with the vision of achieving a zero net loss of productive land. LDN activities must be designed on the basis of the causes of degradation, the development targets, and the needs and initiatives of local communities.
To combat land degradation in Georgia, in 2015, the national LDN Working Group set voluntary national targets to address specific aspects of LDN, and submitted them to the UNCCD Secretariat. These include:
•Integrate LDN principles into national policies, strategies and planning documentations and legislations
•By 2030 about 1,500 ha of degraded forests will be reforested, about 7,500 ha will be afforested, and 60% of forests will be managed sustainably
•By 2030, protected areas coverage should reach 12%
•Degraded land will be rehabilitated
•Irrigation and drainage system will be improved.

Sensitivity Model
IBIS (GIZ and partners) in cooperation with national experts in Georgia, applied the remote sensing tool – the Erosion Sensitivity Model. It helps to assess the current state and the general erosion risk. The sensitivity model is based on the RUSLE – Revised Universal Soil Loss Equation. The approach allows the calculation of erosion caused by rainfall and surface runoff. The RUSLE equation incorporates a combination of different input factors such as precipitation (R), soil type (K), slope (LS), vegetation cover (C) and protection measures (P). In this way, the estimated average soil loss in tonnes per acre per year (A) can be calculated as follows: $A = R * K * LS * C * P$.

The rainfall factor (R) results from a quotient from the monthly and annual mean value of precipitation. The data come from the data platform “CHELSA – Climatologies at high resolution for the earth’s land surface areas”. For the soil type factor (K), a soil map of 1:200,000 was taken. Then, depending on the soil type, different contents of sand, silt,

LOCATION

Location: Tusheti region, Akhmeta municipality, Georgia

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 45.2009, 42.03922

Spread of the Technology: applied at specific points/ concentrated on a small area

In a permanently protected area?:

Date of implementation: 2016

Type of introduction
- [ ] through land users' innovation
- [ ] as part of a traditional system (> 50 years)
- [ ] during experiments/ research
- [x] through projects/ external interventions

loam and clay were used to calculate the K factor. The slope length and steepness factor (LS) is calculated from a digital elevation model (DEM) with a raster resolution of 10x10m. The DEM is derived from the topographic map 1:25,000. The global elevation model derived from SRTM data (Shuttle Radar Topography Mission) has a resolution of 30x30 m and is available worldwide free of charge. The land cover factor (C) describes the vegetation cover that protects the soil from erosion. The vegetation cover slows down the speed of the raindrops and reduces the erosive effect of the rain. It slows down surface water runoff and stabilises the soil through root systems. The main indicators, land cover and productivity, can be assessed by remote sensing. The technology for the evaluation of indicators with Sentinel 2 satellite images was used in 2016 in the Tusheti region (Akhmeta municipality) in the framework of the GIZ-IBiS project. Based on spectral information from airborne or satellite images, the density of the vegetation was calculated and mapped. There are well developed vegetation indices and classification systems to derive different land cover types and vegetation densities (mainly described by the Leaf Area Index LAI or biomass indices). The LAI is the area of the leaf surface (in square meters) per square meter ground surface. Since the real surface area of the leaves is hardly measurable, the amount of biomass is a proxy for the LAI. The P-factor is rarely considered in large-scale modelling of soil erosion risk as it is difficult to estimate it with very high accuracy. Therefore, to refine the model, a more detailed DEM (digital elevation model) is required (e.g., from satellite images). Based on the input factors, a soil erosion risk map was calculated for the whole territory of the Tusheti Protected Areas (113,660 ha). Based on the different spectral bands of the Sentinel 2 satellite image, a land cover map was calculated using the Support Vector Machine (SVM) technology and spectral image information.

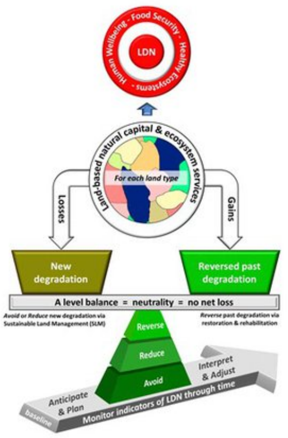


Figure 1: Monitoring indicators of LDN through time

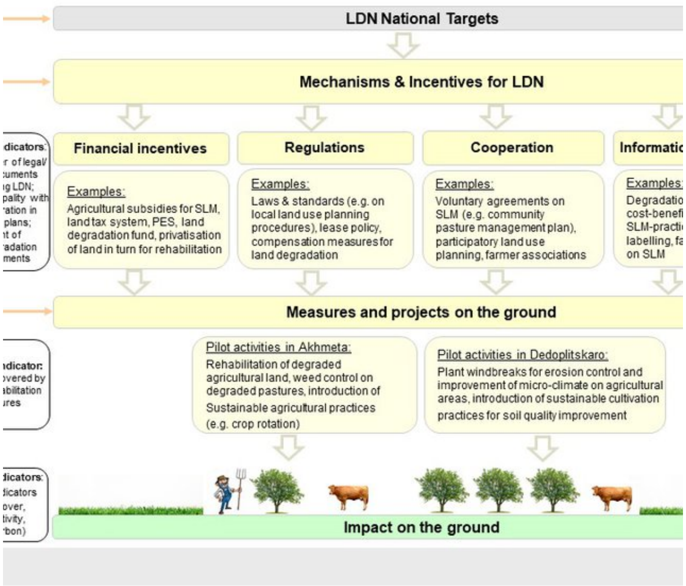


Figure 2: LDN National Targets

CLASSIFICATION OF THE TECHNOLOGY

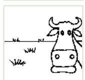
Main purpose

- ✓ improve production
- ✓ reduce, prevent, restore land degradation
- ☐ conserve ecosystem
- ☐ protect a watershed/ downstream areas – in combination with other Technologies
- ✓ preserve/ improve biodiversity
- ☐ reduce risk of disasters
- ☐ adapt to climate change/ extremes and its impacts
- ☐ mitigate climate change and its impacts
- ☐ create beneficial economic impact
- ☐ create beneficial social impact
- ✓ provide information to make a spatial-territorial planning

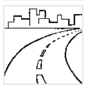
Land use

Land use mixed within the same land unit: Yes - Agro-pastoralism (incl. integrated crop-livestock)

Cropland
- Annual cropping: cereals - barley, cereals - wheat (spring), cereals - wheat (winter)



Grazing land
- Ranching



Settlements, infrastructure - Traffic: roads, railways

Water supply

- ☐ rainfed
- ☐ mixed rainfed-irrigated
- ☐ full irrigation
- ✓ rainfed and mixed rained-irrigation

Purpose related to land degradation

- ✓ prevent land degradation
- ✓ reduce land degradation
- ☐ restore/ rehabilitate severely degraded land
- ☐ adapt to land degradation
- ☐ not applicable

Degradation addressed

soil erosion by water -

soil erosion by wind -

chemical soil deterioration -

physical soil deterioration -

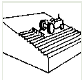
biological degradation -

other - Specify: Degradation of forest resources

SLM group

- improved ground/ vegetation cover

SLM measures

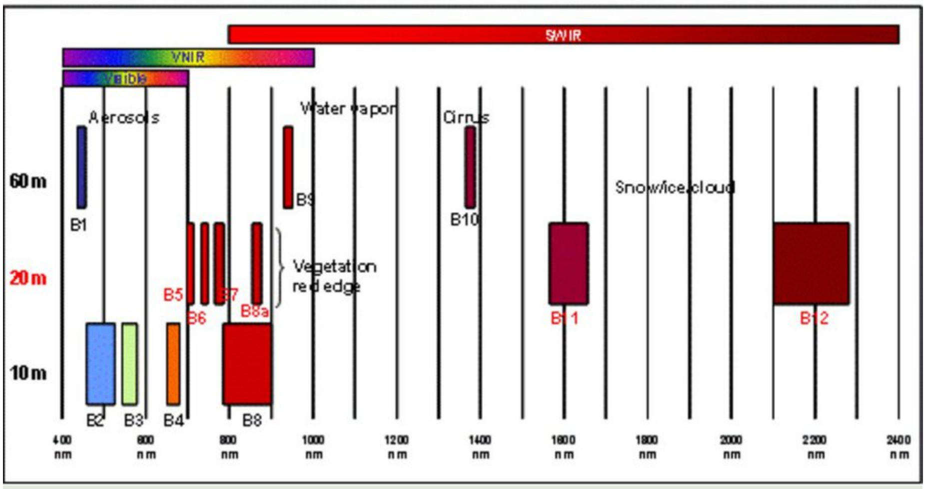


agronomic measures - A2: Organic matter/ soil fertility, A5: Seed management, improved varieties, A7: Others

TECHNICAL DRAWING

Technical specifications

The Sentinel-2 mission was launched in spring 2016. It provides images for 13 different bands, and the data is provided free of charge by the European Space Agency (ESA). The resolution of the spectral bands used is 10 and 20 m per pixel. The same spatial extent is scanned every then days by one satellite and every five days by two satellites, allowing high flexibility in selecting images without clouds, creating time series or analysing data for a specific season. The width of the scan is 290 km, allowing an analysis of large areas with data from the same day.
The calibration of the remote sensing images requires field samples. Based on the initial analysis and the classification of the images, a stratified sampling design for the collection of field verification data should be developed.
The size of field sample plots shall correlate with the pixel size of the classified image and the accuracy of the spatial position of the sample plot. An accuracy of 10-15m can be achieved by using portable GPS devices to determine the coordinates of the sample plot. The resulting map could provide the spatial dimension as a basis for degradation assessments and hotspots (e.g., in 3-5 classes). Field sample points should be distributed over the whole country. The selection of the specific sites for the field assessment should be based on a first analysis of the spectral data to cover different spectral types efficiently. The remote sensing assessment should provide a 1:25,000 scale digital map showing erosion sites or sites with low vegetation cover.
The minimum size of the land pattern that can be displayed on the map would be 20x20 meters. If smaller patches frequently occur, this will affect the spectral composition of the satellite image. Results of more frequent small patches of erosion are detected as sites with lower phytobiomass.
The erosion risk map can help to identify degraded landscapes and develop land-use change strategies to avoid further damage to the vegetation cover or to introduce vegetation restoration activities. Based on the same methodology, a time series can be started and used to monitor changes in land degradation. On the one hand, the success of measures to combat land degradation can be monitored at the national level. On the other hand, new sites or an increase in the spatial coverage of land degradation can help to prioritise activities.



Author: Technical drawing: Sentinel-2 is ESA's operational mission for the observation of land surfaces with a decametric resolution. ESA (http://www.cesbio.ups-tlse.fr/us/index_sentinel2.html)

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated:
- Currency used for cost calculation: **n.a.**
- Exchange rate (to USD): 1 USD = n.a
- Average wage cost of hired labour per day: n.a

Most important factors affecting the costs

Field sample collection; Remote sensing experts.

Establishment activities

1. National level. Baseline: Field assessment for remote sensing calibration (1x/20 years) (Timing/ frequency: 2017)
2. Sentinel satellite image classification (multi temporal data from 2017) (Timing/ frequency: 2017)
3. Statistical data from GEOSTAT Agricultural census (Timing/ frequency: 2014-2016)
4. Analysis of soil carbon content from existing profiles (Timing/ frequency: 2003 - 2006)
5. Conduct ongoing monitoring (Timing/ frequency: 5 years intervals)
6. Update sentinel satellite image classification (Timing/ frequency: 1x year)
7. Update statistical data from GEOSTAT Agricultural census (Timing/ frequency: 4x/year)
8. Resempling of soil carbon content near existing profiles (Timing/ frequency: 1x/5 years)

9. Municipal level. Spatial planning: Assessment of current stage of land degradation, anticipated gains and losses (Timing/ frequency: 1x/10 years)
10. Revision of spatial planning on Municipal level. (Timing/ frequency: 1x / 5 years)

Maintenance activities
1. Re-sampling (Timing/ frequency: with 5 years interval)

NATURAL ENVIRONMENT

Average annual rainfall
- [ ] < 250 mm
- [ ] 251-500 mm
- [x] 501-750 mm
- [ ] 751-1,000 mm
- [x] 1,001-1,500 mm
- [ ] 1,501-2,000 mm
- [ ] 2,001-3,000 mm
- [ ] 3,001-4,000 mm
- [ ] > 4,000 mm

Agro-climatic zone
- [ ] humid
- [x] sub-humid
- [x] semi-arid
- [ ] arid

Specifications on climate
Average annual rainfall in mm: 800.0
The climate is generally suitable for agriculture with an annual precipitation of up to 800 mm, with hot and humid springs, rainfall peaks in May and June with hot and dry summers.

Slope
- [x] flat (0-2%)
- [ ] gentle (3-5%)
- [ ] moderate (6-10%)
- [ ] rolling (11-15%)
- [x] hilly (16-30%)
- [ ] steep (31-60%)
- [ ] very steep (>60%)

Landforms
- [x] plateau/plains
- [ ] ridges
- [x] mountain slopes
- [ ] hill slopes
- [ ] footslopes
- [ ] valley floors

Altitude
- [x] 0-100 m a.s.l.
- [ ] 101-500 m a.s.l.
- [ ] 501-1,000 m a.s.l.
- [ ] 1,001-1,500 m a.s.l.
- [ ] 1,501-2,000 m a.s.l.
- [ ] 2,001-2,500 m a.s.l.
- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [x] > 4,000 m a.s.l.

Technology is applied in
- [ ] convex situations
- [ ] concave situations
- [x] not relevant

Soil depth
- [ ] very shallow (0-20 cm)
- [ ] shallow (21-50 cm)
- [ ] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [ ] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [ ] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Topsoil organic matter content
- [ ] high (>3%)
- [ ] medium (1-3%)
- [ ] low (<1%)

Groundwater table
- [x] on surface
- [ ] < 5 m
- [ ] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [ ] good
- [ ] medium
- [ ] poor/ none

Water quality (untreated)
- [ ] good drinking water
- [x] poor drinking water (treatment required)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Water quality refers to: both ground and surface water

Is salinity a problem?
- [ ] Yes
- [x] No

Occurrence of flooding
- [ ] Yes
- [x] No

Species diversity
- [ ] high
- [x] medium
- [ ] low

Habitat diversity
- [x] high
- [ ] medium
- [ ] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [ ] mixed (subsistence/ commercial)
- [ ] commercial/ market

Off-farm income
- [ ] less than 10% of all income
- [ ] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [ ] very poor
- [ ] poor
- [ ] average
- [ ] rich
- [ ] very rich

Level of mechanization
- [ ] manual work
- [ ] animal traction
- [ ] mechanized/ motorized

Sedentary or nomadic
- [ ] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

Individuals or groups
- [ ] individual/ household
- [ ] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [ ] women
- [ ] men

Age
- [ ] children
- [ ] youth
- [ ] middle-aged
- [ ] elderly

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [x] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha

Scale
- [ ] small-scale
- [ ] medium-scale
- [ ] large-scale

Land ownership
- [x] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [ ] individual, not titled
- [ ] individual, titled

Land use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [ ] individual

Water use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [ ] individual

☐ > 10,000 ha

Access to services and infrastructure

IMPACTS

Socio-economic impacts

Socio-cultural impacts

Ecological impacts

Off-site impacts

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Benefits compared with maintenance costs

CLIMATE CHANGE

-

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- ☐ single cases/ experimental
- ☐ 1-10%
- ☐ 11-50%
- ☐ > 50%

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- ☐ 0-10%
- ☐ 11-50%
- ☐ 51-90%
- ☐ 91-100%

Has the Technology been modified recently to adapt to changing conditions?

- ☐ Yes
- ☑ No

To which changing conditions?

- ☐ climatic change/ extremes
- ☐ changing markets
- ☐ labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

Strengths: compiler’s or other key resource person’s view

Weaknesses/ disadvantages/ risks: land user's view → how to overcome

Weaknesses/ disadvantages/ risks: compiler’s or other key resource person’s view → how to overcome

REFERENCES

Compiler
Hanns Kirchmeir

Reviewer
Rima Mekdaschi Studer

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Resource persons
Hanns Kirchmeir - SLM specialist
Natia Kobakhidze - co-compiler
Giorgi Mikeladze - co-compiler

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_5488/

Linked SLM data
n.a.

Documentation was faciliated by
Institution

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Project

- Integrated Biodiversity Management, South Caucasus (IBiS)

Key references

- Land Degradation Neutrality 25.10.2017: https://e-c-o.at/files/publications/downloads/D00813_ECO_policy_brief_LDN_Georgia_171025.pdf

Links to relevant information which is available online

- Data for atmospheric correction: http://step.esa.int/main/snap-2-0-out-now/
- UNCCD Good Practice Guidance on SDG Indicator 15.31. (Sims et al. 2017): https://www.unccd.int/sites/default/files/relevant-links/2017-10/Good%20Practice%20Guidance_SDG%20Indicator%2015.3.1_Version%201.0.pdf