Maintenance mowing of a new planting of a windbreak (Hanns Kirchmeir)

Rehabilitation of Windbreaks (Georgia)

DESCRIPTION

Windbreaks are an integrated technology to increase land productivity and biodiversity at different levels. Along six kilometres, located between a road and agricultural fields, windbreaks were rehabilitated or newly established to protect the soil wind erosion. Four lines of seedlings including seven tree species were planted in two meters distance to each other. The survival rates of different tree species have been accessed and evaluated.

Agriculture plays a key role in the economy of Georgia. 74% of wheat is produced in Kakheti. Within the region, the main wheat-growing area is Shiraki valley located in Dedoplistskaro Municipality in Eastern Georgia. The valley has deep soil with high humus content offering significant potential for high agricultural yields. Among others, wind erosion and increase of evaporation due to degradation of windbreaks have led to reduced agricultural yields. At the end of the Soviet Union, there were 1.800 km of tree windbreaks in Shiraki. More than 90% of them were destroyed either by fire or illegal cuttings for firewood. Fires are caused by farmers burning harvest residues and by shepherds burning pastures and windbreaks to facilitate the growth of new grass and clear land. Today, fire still pose the greatest threat to the rehabilitation of windbreaks. Grazing by migrating sheep and by local (cattle) herds as well as firewood extraction is still causing additional damage to windbreaks in specific areas of Shiraki valley.

In Dedoplistskaro, the SLM-pilot activities focus on the establishment of a windbreak/agroforestry system to reduce wind erosion, which is here the main degradation factor and threatens agricultural production. Windbreaks are a well-known measure against wind erosion. They consist of several rows of trees and bushes on the edges of agricultural fields to reduce the wind-speed on the surface level. Slowing down of wind-speed protects the topsoil from wind erosion. Windbreaks improve the micro-climate for crops growing in their shelter by reducing moisture loss. Windbreaks also provide shelter and habitats for a wide range of plants, pollinating insects, wildlife and birds, including predators of agricultural pests.

Selection of seedlings:

Tree species well adapted to the regional conditions (climate, soil, etc.) were selected such as Pinus (Pinus eldarica, survival rate: 90%), Pistacia (Pistacia mutica, survival rate 60%) and Elm (Ulmus minor, survival rate 60%), Wild Almond (Prunus argentea, survival rate 40%), Persian olive (Eleagnus angustifolia, survival rate: 40%) and Robinia (Robinia pseudoacacia, survival rate 16%). The survival rates are based on the assessment in September 2018, 6 months after planting.

The seeds were prepared for planting in a nursery. Seedlings to be transported over long distances must be grown in special containers to ensure good root system development and minimise damage during transport. If they are grown near the planting site and the transport time is short, seedlings may also be bare-rooted.

Preparation of soil and planting:
The pilot site of the project "Applying Landscape and Sustainable Land Management (L-SLM) for Mitigating Land Degradation and Contributing to Poverty Reduction in Rural Areas", implemented by the Regional Environment Centre for the Caucasus, is six km long and located on the main road on state-owned land. Before planting the seedlings, the vegetation (grass and herbs) was cut and removed. No ploughing was done. During

LOCATION

Location: Dedoplistskaro, Kakheti, Georgia

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 46.25252, 41.40968

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

In a permanently protected area?: No

Date of implementation: 2018

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

the implementation in 2018, the design of the site was changed to a 6 km long U-shaped form with three 10 m wide segments of windbreaks. The total area of the pilot site is 6 ha, but since there were already intact hedges in some parts, the total area where windbreaks were either newly planted or rehabilitated is 3 ha. Each windbreak consisted of four lines of tree seedlings of different species in two meters distance to each other (inter-row spacing) and 2 m distance between the seedlings within a row (intra-row spacing). First, holes were dug (30 cm diameter, 40 cm deep), then water accumulation granulate was added to keep the water better, then the seedlings of 10-40 cm height and 2-3 years old depending on species were inserted. No compost or fertiliser was used. The seedlings were protected by plastic tubes from the cold and dry winter season. Every 2nd seedling was marked with a wooden pole to distinguish them from weeds and to control the survival rate. If the survival rate falls below 50%, the trees should be replaced. After the planting of the seedling, the herbs and grass were cut again. Further cuttings took place several times to avoid shading and competition.

Maintenance

Besides cutting of weeds for 2 times in the main growing season (Mai-July) regular watering was applied. Young seedlings should be watered 2-4 times per year (first 2 years) – about 15-20l per tree. After 2 years the root system should be established in such a way that it can take care of itself. The implementation area was not fenced, but there is no pastureland around and pressure by browsing is low.

The Regional Environment Centre for the Caucasus (REC) in cooperation with GIZ has conducted a cost-benefit analysis to estimate the value of protecting remaining windbreaks, the economic impact of banning crop residue burning and the benefits of straw as a fertilizer. The survey data shows that a ban on crop residue burning will help to protect the existing windbreaks. Consequently, shredding of straw during the harvest and subsequent incorporation of straw into the soil builds up soil organic matter and helps to retain the moisture in the ground. Unclear ownership and institutional responsibility are the most relevant constraints for sustainable windbreaks management as a measure. At the political level, issues were noted, and steps were taken: A working group under the National Forest Programme selected windbreaks restoration and protection as their key topics. The Ministry of Environmental Protection and Agriculture with the support from REC and GIZ developed a policy for rehabilitation and protection of windbreaks. Based on this, a new law on windbreaks was initiated which will clarify the situation by ascribing clear responsibilities on windbreak maintenance and management. This law is still at the stage of preparation in the Agrarian Committee.


Intact windbreaks between crop fields (Hanns Kirchmeir)


Removal of dry biomass (Hanns Kirchmeir)

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

Land use

Land use mixed within the same land unit: Yes - Agroforestry

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

Number of growing seasons per year: 2
Is intercropping practiced? No
Is crop rotation practiced? No

Forest/ woodlands
- Tree plantation, afforestation: temperate steppe plantation. Varieties: Mixed varieties

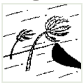
Tree types (mixed deciduous/ evergreen): Pinus species, Ulmus minor, Pinus eldarica, Elaeagnus angustifolia, Cotinus coggygria , Pistacia mutica, Ulmus

minor, Robinia pseudoacacia, Prunus argentea
Products and services: Fuelwood, Nature conservation/ protection, Protection against natural hazards, Protection soil from wind erosion

Water supply
- [x] rainfed
- [ ] mixed rainfed-irrigated
- [ ] full irrigation

Purpose related to land degradation
- [ ] prevent land degradation
- [x] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [ ] not applicable

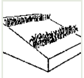
Degradation addressed


soil erosion by wind - Et: loss of topsoil


water degradation - Ha: aridification

SLM group
- agroforestry
- windbreak/ shelterbelt

SLM measures


vegetative measures - V1: Tree and shrub cover

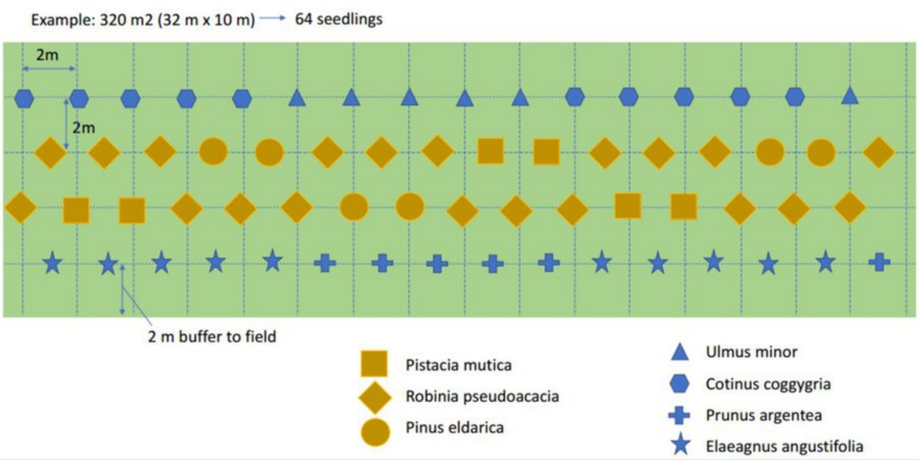
TECHNICAL DRAWING

Technical specifications
Location of windbreaks along the main and side roads. During implementation the design of the site was changed to an u-shaped form built by 3 windbreaks. The windbreaks that are included in the rehabilitation were segmented into four:
Windbreak A1 - Replanting new seedlings - 458 length (m);
Windbreak A2 - Removal of dry biomass - 403 length (m);
Windbreak B - Replanting new seedlings - 2.560 length (m);
Windbreak C - Replanting new seedlings - 2.354 length (m).
While in the segments A1, B and C the tree cover is very low and new seedlings are needed, in segment A2 there is still a dense crown cover.

To protect the existing trees in segment A2, the dry biomass under the crown (dry herbs and grass, dead trees & branches) was removed to reduce the amount of fuel in the case of a fire. This process was just started at the north end of A2.
In Segment B Pistacia mutica, Ulmus minor, Robinia pseudoacacia, Cotinus coggygria and Wild almond (Prunus argentea) have been planted.
In Segment C Pinus eldarica, Elaeagnus angustifolia Pistacia mutica, Ulmus minor, Robinia pseudoacacia and Wild almond (Prunus argentea) have been planted.

Author: Hanns Kirchmeir

Planting scheme for windbreaks rehabilitation.
The distance between the lines is 2m and the distance between seedlings within a line is also 2m. About every second seedling is marked with a wooden pole (50 cm). This is done on the one hand to control the survival rate (if every second seedling is, the next seedling is only 2m away and easy to find) and on the other hand to identify and leave the seedlings standing when the weeds are cleared.



Author: Hanns Kirchmeir

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs
- Costs are calculated: per Technology area (size and area unit:

Most important factors affecting the costs
How often weeds need to be cut, survival rate of trees

3 ha)
- Currency used for cost calculation: **GEL**
- Exchange rate (to USD): 1 USD = 2.7 GEL
- Average wage cost of hired labour per day: 15 USD

Establishment activities
1. Marking sites in the field (Timing/ frequency: April-May)
2. Cut grass and remove dead wood (Timing/ frequency: April)
3. Planting of seedlings (planting, adding wooden poles and water accumulation granulate (Timing/ frequency: April-May)
4. Irrigation and weed-cutting (Timing/ frequency: July, August (to be repeated for 3 years))
5. Scientific Monitoring (Timing/ frequency: October - October (five years))

Establishment inputs and costs (per 3 ha)

Specify input	Unit	Quantity	Costs per Unit (GEL)	Total costs per input (GEL)	% of costs borne by land users
Labour					
Clearing and preparation of sites (3 ha)	person days	40.0	30.0	1200.0	
Weed cutting 2 x on 3 ha	person days	110.0	36.0	3960.0	
Planting of 7.300 seedlings (digging hole, adding water accumulation granulate, planting seedling, adding wooden pole and tube)	person days	73.0	45.0	3285.0	
Irrigation 4 x 7.300 seedlings	person days	73.0	75.0	5475.0	
Equipment					
Wooden poles	pieces	7300.0	0.9	6570.0	
Water accumulation granulate	kg	73.0	70.0	5110.0	
Water for irrigation	m³	300.0	3.0	900.0	
Transport of water (water truck)	applications	4.0	1300.0	5200.0	
Plant material					
Pistacia mutica	pieces	470.0	3.0	1410.0	
Robinia pseudoacacia	pieces	1825.0	1.0	1825.0	
Pinus eldarica	pieces	117.0	5.0	585.0	
Ulmus minor	pieces	1355.0	2.0	2710.0	
Amygdalus communis	pieces	1238.0	1.0	1238.0	
Elaeagnus angustifolia	pieces	1237.0	0.75	927.75	
Other					
Transportation of workers and materials by lorry	transfers	50.0	60.0	3000.0	
Total costs for establishment of the Technology				**43'395.75**	
Total costs for establishment of the Technology in USD				*16'072.5*	

Maintenance activities
1. Watering the seedlings (Timing/ frequency: Every 2-3 weeks during dry period in July-September)
2. Preparing fire-break around windbreak (Timing/ frequency: August, after harvesting the crops)
3. Weed cutting between seedlings (Timing/ frequency: 1-2 times between June and August)
4. Replacing dead trees by new seedlings (if needed) (Timing/ frequency: October/November)

Maintenance inputs and costs (per 3 ha)

Specify input	Unit	Quantity	Costs per Unit (GEL)	Total costs per input (GEL)	% of costs borne by land users
Labour					
Weed cutting 2 times on 3 ha	person days	110.0	37.0	4070.0	
Irrigation 4*7.300 seedlings	person days	73.0	75.0	5475.0	
Protect firebreak around windbreak	person days	4.0	100.0	400.0	
Equipment					
Water (10l/seedling*4)	m³	300.0	3.0	900.0	
Transport of water (water truck)	application	4.0	1300.0	5200.0	
Total costs for maintenance of the Technology				**16'045.0**	
Total costs for maintenance of the Technology in USD				*5'942.59*	

NATURAL ENVIRONMENT

Average annual rainfall
- < 250 mm
- 251-500 mm
- ✓ 501-750 mm
- 751-1,000 mm
- 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
- sub-humid
- ✓ semi-arid
- arid

Specifications on climate
Average annual rainfall in mm: 697.0
The driest month is January, with 25 mm of rainfall. The greatest amount of precipitation occurs in June, with an average of 108 mm. The difference in precipitation between the driest month and the wettest month is 83 mm.
Name of the meteorological station: Dedoplistskaro Met. Station
The climate is warm and temperate in Dedoplistskaro. The average annual temperature in Dedoplistskaro is 11.3 °C. The warmest month of the year is July, with an average temperature of 22.7 °C. The lowest average temperatures in the year occur in January, when it is around 0.1 °C.

Slope

Landforms

Altitude

Technology is applied in

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

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

- [ ] 0-100 m a.s.l.
- [x] 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.
- [ ] > 4,000 m a.s.l.

- [ ] convex situations
- [ ] concave situations
- [x] not relevant

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

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

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

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

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

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

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

Water quality refers to: ground water

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

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

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

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

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

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

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

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

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

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

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

Gender
- [ ] women
- [x] men

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

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

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

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

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

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

Access to services and infrastructure

health	poor		✓		good
education	poor		✓		good
technical assistance	poor		✓		good
employment (e.g. off-farm)	poor	✓			good
markets	poor	✓			good
energy	poor		✓		good
roads and transport	poor		✓		good
drinking water and sanitation	poor		✓		good
financial services	poor	✓			good

IMPACTS

Socio-economic impacts

Crop production	decreased					✓			increased	The positive effect on crop yields will be visible when trees in the windbreak get higher than 3 meters.
wood production	decreased					✓			increased	First harvest of firewood is expected in 15-20 years

Socio-cultural impacts

Ecological impacts

evaporation	increased ☐☐☐☐✓☐☐ decreased	Due to an expected reduction in wind speed near the ground, the evaporation rate is expected to decrease after the trees have reached a height of more than 5 m. So far, no data from measurements are available.
soil moisture	decreased ☐☐☐☐✓☐☐ increased	Due to an expected reduction in wind speed near the ground, the evapotranspiration rate is expected to decrease after the trees have reached a height of more than 5 m, which would lead to an increase in soil moisture. So far, no data from measurements are available.
soil loss	increased ☐☐☐☐✓☐☐ decreased	Due to the reduction in wind speed, it is expected that the amount of soil erosion caused by wind will decrease when the trees have reached a height of more than 5 m.
plant diversity	decreased ☐☐☐☐✓☐☐ increased	Windbreaks are refuge areas for plant species sensitive to herbicides and plowing.
animal diversity	decreased ☐☐☐☐✓☐☐ increased	The windbreaks provide shelter and breeding habitat for birds and small mammals. Tree litter improves soil conditions and has positive effect on soil-invertebrate diversity.
wind velocity	increased ☐☐☐☐✓☐☐ decreased	The expected impact is a reduction of wind velocity up to 200 m after the windbreak, which will lead to reduced wind erosion of top soil. This effect is related to tree height and will need 2-3 decades to gain full impact.
micro-climate	worsened ☐☐☐☐✓☐☐ improved	The expected impact is a reduction of wind velocity up to 200m after the windbreak, which will lead to a decrease in evaporation. This effect is related to tree height and will need 2-3 decades to gain full Impact.

Off-site impacts

wind transported sediments	increased ☐☐☐☐✓☐☐ reduced	By reducing the wind speed, the amount of soil erosion by wind is expected to decrease when the trees have reached a height of more than 5 m. The positive influence on the neighbouring field can be observed up to a distance of twice the height of the trees.
damage on neighbours' fields	increased ☐☐☐☐✓☐☐ reduced	By reducing the wind speed, the amount of soil erosion by wind is expected to decrease when the trees have reached a height of more than 5 m. The positive influence on the neighbouring field can be observed up to a distance of twice the height of the trees.
impact of greenhouse gases	increased ☐☐☐☐✓☐☐ reduced	Quantity before SLM: 10 t CO2-eqiv/ha Quantity after SLM: 200 t CO2-eqiv/ha The increase in the volume of wood on the windbreak increases carbon storage in the ecosystem. The rehabilitation of a completely destroyed windbreak can increase the biomass volume by 100-200 m³/ha, which corresponds to 100-200 t carbon dioxide.

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns	very negative ☐✓☐☐☐☐☐ very positive
Long-term returns	very negative ☐☐☐☐✓☐☐ very positive

Benefits compared with maintenance costs

Short-term returns	very negative ☐✓☐☐☐☐☐ very positive
Long-term returns	very negative ☐☐☐☐☐✓☐ very positive

It is a significant investment to establish a windbreak and it takes several years (5-10) before the measure will show effects on the increase of crop fields' productivity. But when established, the windbreak does not need investment for maintenance but can deliver additional benefit (fuel wood).

CLIMATE CHANGE

Gradual climate change

annual temperature increase	not well at all ☐ ☐ ☐ ✓ ☐ very well	
annual rainfall decrease	not well at all ☐ ☐ ✓ ☐ ☐ very well	

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)

The selection of tree species and planting technologies was adapted to the rising temperatures. Special protection tubes against winter storms were used.

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Increase of yields in the neighbouring fields
- Availability of firewood

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

- Seedlings can be produced locally in tree nurseries using local tree species.
- Increase of protection from wind erosion and drought by wind impact.
- Increase of habitat diversity

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

- Fires → protecting the windbreak by ploughing the soil along the line
- Lack of maintenance of planted seedlings → cutting the grass and removing it from the field, continue mulching and watering the seedlings over the next few years, replanting the dead seedlings

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

- High investment for seedlings, wooden poles and irrigation → It is much cheaper to protect existing windbreaks from burning. Integrating fruit trees and/or vegetables into the windbreak can result in a faster return on investment.

REFERENCES

Compiler
Hanns Kirchmeir

Reviewer
Rima Mekdaschi Studer

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Last update: Feb. 19, 2020

Resource persons
Hanns Kirchmeir - SLM specialist
Kety Tsereteli - co-compiler
- co-compiler
Amiran Kodiashvili - co-compiler

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_4274/

Linked SLM data
n.a.

Documentation was faciliated by
Institution

- GIZ Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)
- Regional Environmental Centre for the Caucasus (REC Caucasus) - Georgia

Project

- Applying Landscape and Sustainable Land Management (L-SLM) for mitigating land degradation and contributing to poverty reduction in rural area (L-SLM Project)

Key references

- Applying Landscape and Sustainable Land Management (L-SLM) for mitigating land degradation and contributing to poverty reduction in rural areas - Implementation Evaluation Report June 2018 – Windbreaks.:

Links to relevant information which is available online

- Approach for "Rehabilitation of Windbreaks in East Georgia":https://biodivers-southcaucasus.org/uploads/files/Approach%20Windbreak%20Rehabilitation%20Georgia.pdf