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# CASE STUDY

## Tree shelterbelts in the Ovche Pole Region (North Macedonia)

**Project full title:** Enhancing Technical and Vocational Skills for Implementing Nature-Based Solutions (NbS) to Combat Land Degradation
**Project acronym:** NbS4LD
**Project number:** 2025-1-TR01-KA220-VET-000357096
**Project activity:** WP2 Developing Educational Resources on NbS for Combating Land Degradation

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# 1. INTRODUCTION

This case study has been analysed by REFORD - Regional Center for Forestry and Rural Development, a non-governmental, non-profit organization registered in North Macedonia in 2010, which is a partner organisation of the NbS4LD project. REFORD aims to contribute to rural development by providing support to rural communities in their efforts to use natural resources in a sustainable manner, mainly through: sharing of new technologies, experiences and work methods; increasing and strengthening the awareness, social and economic power of the rural population; building the capacities of local organizations and institutions in the region; collaboration and networking with similar organizations, individuals, donors and institutions in order to achieve its mission and goals. REFORD provides support in the networking of the private forest owners in the Balkans, through its "Balkan Network" cooperation platform. Currently, 6 national organizations of forest owners from the Balkans participate in the "Balkan Network": Slovenia, Croatia, Bosnia and Herzegovina, Montenegro, North Macedonia and Bulgaria. From 2024, REFORD become a national body for administration of the PEFC system in North Macedonia.

The tree shelterbelts of the Ovche Pole Region in North Macedonia are a large-scale nature-based solution established to address soil degradation, wind erosion, and declining agricultural productivity in one of the country's largest agricultural regions (649 km²). The area is characterised by a dry sub-humid to semi-arid climate, with high temperatures and insufficient precipitation during the vegetation period, creating strong risks of drought and desertification (Aksoy et al., 2018). In response to these challenges, a national programme was launched in the 1950s to establish windbreak systems across vulnerable agricultural landscapes. In Ovche Pole, approximately 555 ha of shelterbelts were planted, arranged in a rectangular network of tree rows 10–20 m wide and up to 15 km long, positioned perpendicular to prevailing northwest winds. The shelterbelts have provided multiple ecosystem services by reducing wind speed, controlling soil erosion, lowering evapotranspiration, improving soil moisture retention, and stabilising agricultural production. They also contribute to climate change mitigation by increasing soil organic carbon storage, reducing non-$CO_2$ greenhouse gas emissions, and enhancing carbon sequestration compared with exposed croplands (Amadi et al., 2017; Bitog & Lee, 2012). In addition, the integration of trees into agricultural areas improves habitat connectivity, supports biodiversity, and strengthens landscape resilience.

The shelterbelts also function as living laboratories for research, education, and innovation in agroecology, climate adaptation, and sustainable land management. However, despite their ecological and economic value, many shelterbelts are currently degraded due to insufficient maintenance and limited monitoring. Their restoration and improved management are essential to preserve their role in erosion control, climate resilience, and sustainable agricultural development.

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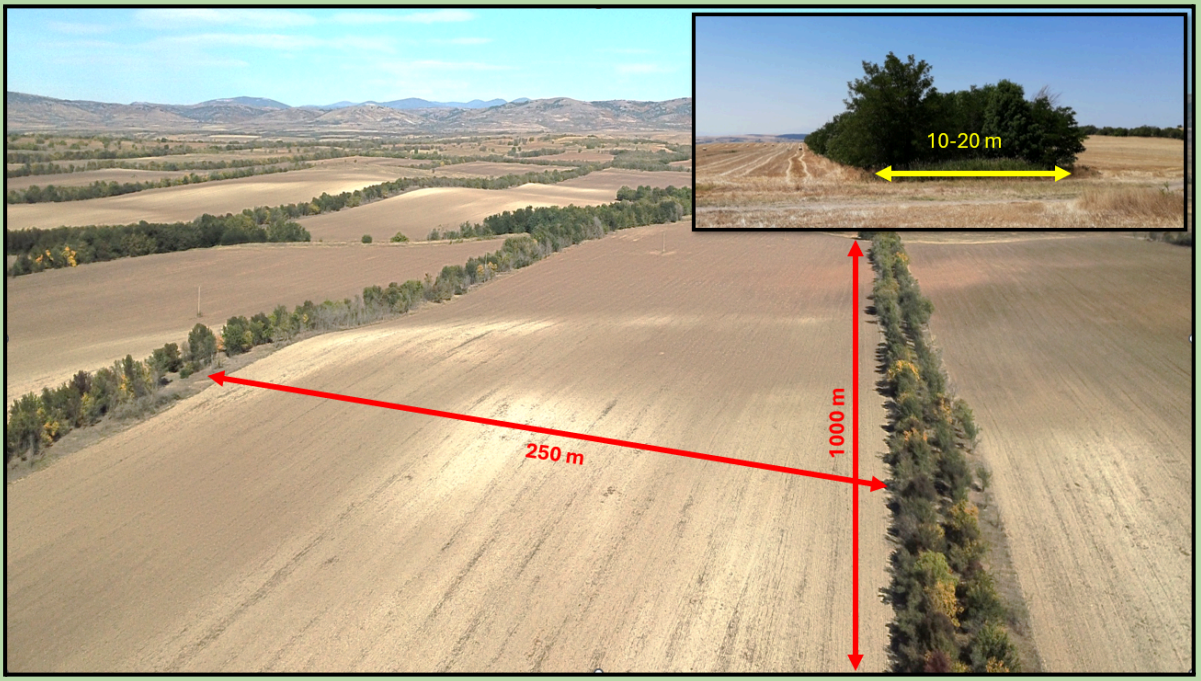


[Width and spacing between the tree windbreaks in the Ovche Pole Region - Source: Onchevski & (Mihara, 2026)]

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# 2. CONTEXT

## 2.1 LOCATION

Country: North Macedonia. Region: Ovche Pole Region. Province: Central part of the Republic of North Macedonia. Site: Ovche Pole agricultural area (Area: 649 km²). Approximate GPS coordinates: Latitude 41.647° N - 41.992° N; Longitude 21.803° E - 22.024° E.


[Macedonia (in red) and Ovche Pole region (white border) - Source: Onchevski & Mihara, 2026]

## 2.3 LANDSCAPE TYPE

Croplands.

## 2.4 LAND DEGRADATION CHALLENGE

Desertification. Soil erosion. Poor land management. Intensive agriculture and irrigation.

## 2.5 BASELINE DATA

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| **Land condition** | • Site: Ovche Pole Region, North Macedonia. The area is one of the country's largest agricultural regions, covering approximately 649 km² and characterised by extensive |

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| | cropland systems with integrated tree windbreaks/shelterbelts.<br>• Soil: the dominant soil type is Vertosols, covering more than 60% of the region. These heavy clay soils have a limited moisture availability range due to swelling clay minerals, creating challenges related to waterlogging, drought stress, and management. Naturally occurring saline soil complexes also occur due to high groundwater salt concentrations, increasing vulnerability to soil salinisation.<br>• Vegetation cover: natural vegetation cover is limited and degraded. Forests occupy only about 2,600 ha, while agricultural land and pastures dominate the landscape. Shelterbelts represent important tree-based vegetation structures introduced to improve land protection and agricultural productivity.<br>• Erosion status: the region is highly affected by wind erosion due to strong and frequent winds, low vegetation cover, dry conditions, and exposed agricultural soils. Wind erosion contributes to soil moisture loss and the redistribution of salts, with shelterbelts established as a mitigation measure. |
| **Environmental context** | • Climate: modified warm continental climate with Mediterranean influence. Mean annual precipitation is approximately 471 mm, while evapotranspiration reaches about 734 mm, resulting in an aridity index of 0.64. The area is classified as semi-arid and vulnerable to desertification processes.<br>• Hydrology: water availability is limited due to high evapotranspiration and irregular precipitation. Irrigation is essential for stable agricultural production. Groundwater salinity contributes to the development of saline soil conditions.<br>• Biodiversity: Biodiversity is influenced by the dominance of agricultural land, degraded forests, and limited natural vegetation. Shelterbelts provide additional habitat structures within the agricultural matrix.<br>• Ecological pressures: major pressures include drought, climate variability, wind erosion, soil salinisation, strong winds, low vegetation cover, and increasing water stress. These factors contribute to land degradation and desertification risk. |
| **Socioeconomic context** | • Population: the municipality of Sveti Nikole had approximately 15,320 inhabitants according to the 2021 census (compared with 18,977 in 1953), indicating a relatively low-density rural population. |

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| | • Livelihoods: local livelihoods are strongly dependent on agriculture. The main activities include cultivation of cereals, industrial crops, and vegetables, supported by fertile soils, high solar radiation, and irrigation infrastructure. Livestock farming is also present.<br>• Land management: agricultural management has historically been centralised. During the socialist period, land resources were managed through state agricultural organisations, and shelterbelt establishment was implemented as part of large-scale land protection strategies.<br>• Resource dependency: the regional economy depends heavily on agricultural productivity and irrigation systems due to semi-arid conditions and frequent drought periods. |
| **Policy and governance** | • Institutional framework: shelterbelt establishment in Ovche Pole during the 1950s was supported by state-led planning within the former Yugoslav socialist system. Windbreak development was integrated into national strategies for soil conservation, forestry, and agricultural productivity, with involvement from scientific institutions such as forestry research bodies and coordinated technical guidelines. |

# 3. INTERVENTION

### 3.1 TIMEFRAME

The development of shelterbelts in the Ovche Pole region occurred in two main periods. The first period (1929–1945) involved the establishment of experimental tree windbreak plots, beginning with the first trials in Ovche Pole in 1929 and continuing with additional plots near Erdzelija and Rzanichino between 1936 and 1950. The second period (1946–1957) was led by the Institute of Forestry, which expanded research activities and developed plans for large-scale shelterbelt establishment across the country. Large-scale implementation started in 1950 and continued until 1957 (Nichota, 1960).

### 3.2 TYPE OF INTERVENTION

Afforestation.

### 3.3 IMPLEMETING ORGANISATIONS

In 1949, experts from the Forestry Institute prepared and submitted a general project to establish three shelterbelts across the People's Republic of Macedonia. After receiving the report from the expert commission and the general plans, the Presidency of the Government of the People's Republic of Macedonia approved the creation of five enterprises to implement the

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shelterbelt system. The funds were secured from government sources dedicated to agricultural development. In 1951, the Yugoslav Federal Administration for Agricultural Development assigned the Forestry Institute of the People's Republic of Macedonia as the leading organisation for the research and development of shelterbelts in Yugoslavia.

### 3.4 FUNDING SOURCES

The development of shelterbelts was financed through government budgets allocated to agriculture, forestry, and water management sectors, reflecting their recognition as strategic infrastructure for land protection and productivity enhancement.

### 3.5 IMPLEMENTATION ACTIONS AND MEASURES

In the 1950s, the government approved a large-scale programme for the establishment of tree windbreak systems across several agricultural regions of the country. The plan aimed to create 5,030 ha of shelterbelts to protect approximately 181,000 ha of agricultural land. However, between 1946 and 1956, only 1,685 ha (33%) of the planned area was implemented. The Ovche Pole Region was one of the main target areas, with 771 ha of shelterbelts planned and 546 ha (67%) successfully established, representing the highest implementation rate among the selected regions (Nichota, 1959). The other targeted regions achieved lower implementation rates, including Tikvesh (29%), Kumanovo (37%), Prilep (20%), and Bitola (20%).

## 4. IMPACT

### 4.1 ENVIRONMENTAL IMPACT

☑ Improved soil health or reduced soil erosion. ☑ Increased vegetation cover or habitat restoration. ☑ Improved biodiversity (species richness, abundance, habitat quality). ☑ Improved water quality or water availability. ☑ Reduced land degradation. ☑ Improved ecosystem services.

The Ovche Pole Region is part of the dry agroecological zone, where water shortage is the main constraint on agricultural production (Aksoy et al., 2020). Water irrigation systems in the area are degraded, and farmers face difficulties irrigating their crops, especially during summer when temperatures are high and rainfall is scarce. Moreover, climate change is expected to cause water shortages for irrigation in the latter half of this century and to lead to more frequent heatwaves (UNDP, 2020). In this context, the tree windbreak systems in the region play a vital role in reducing water use and boosting agricultural productivity. Tree windbreaks offer many ecosystem services that greatly lessen the negative impacts of climatic conditions on farmland and enhance land productivity (Weninger et al., 2021b). Several studies have confirmed increased yields on farmland protected by tree windbreaks (Campi et al., 2009a; Iwasaki et al., 2021; Liu et al., 2022b; Osorio et al., 2019). A study investigating the effects of shelterbelts in

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Ovche Pole found that evapotranspiration in the protected zone was 13.9% lower than in open-field conditions during the data collection period. This finding closely matches other research conducted under similar climate conditions. The water-saving potential of tree windbreaks is demonstrated by a simple calculation of irrigation requirements for sunflowers and wheat during the data-collection period. The results show that, during the same period, the irrigation water needed in the sheltered zone of the tree windbreak for both crops is reduced by 4 mm/day (4 m³/ha/day) compared to open-field conditions (Onchevski & Mihara, 2026). Nichota (1960) reported that the relative humidity in the protected zone is higher than in open-field conditions. On average, there is an increase of 7.7% in May, 3.1% in June, 2.2% in July, and 3.7% in August. Most reviewed studies showed that yield decreased up to a distance of one to two windbreak heights, then increased up to about 8–12 heights, before returning to free field conditions.

### 4.2 COMMUNITY IMPACT

☑ Increased household income. ☑ Improved food security. ☑ Strengthened community resilience.

The establishment and maintenance of shelterbelts in Ovche Pole have yielded significant socioeconomic advantages, including increased household income, improved food security, and strengthened community resilience. Early research from the 1960s (Nichota, 1960) indicated that in moderately dry years, agricultural yields in areas protected by shelterbelts rise considerably, whereas in wetter years, the difference is less pronounced. On average, wheat production increased by 18.1%, barley by 15.1%, and cotton by 26.9% in protected zones, directly contributing to more stable and higher household incomes through increased agricultural productivity. Shelterbelts also bolster food security by stabilising production amidst changing climate conditions. By reducing wind erosion, conserving soil moisture, and tempering microclimate extremes, they help ensure more reliable yields, especially during drought periods typical of the region. This buffering effect lowers the risk of crop failure and promotes stability in local food supply. Beyond crop benefits, shelterbelts serve as a tangible biomass resource. According to recent data (Municipality of Sveti Nikole, 2024), the average wood stock is approximately 65 m³/ha, with a total estimated reserve of roughly 13,000 m³ across 200 hectares and an annual increase of 342 m³. This provides an economic and energy resource for local communities, further enhancing household resilience.

Overall, these functions bolster community resilience by reducing vulnerability to climate fluctuations, diversifying benefits (both agricultural and biomass), and supporting the long-term sustainability of rural livelihoods in Ovche Pole.

### 4.3 INSTITUTIONAL IMPACT

☑ Strengthened institutional coordination. ☑ Increased community participation in

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decision-making. ☑ Establishment of new management structures or partnerships. ☑ Capacity building for institutions or communities.

Regarding the institutional governance of the shelter belts, it is important to note a challenge arising from policies and management practices related to tree windbreak systems. Neither previous nor current forest laws explicitly mentioned windbreaks. The 2020 revision of the Rulebook on Forest Planning introduced some provisions (e.g., sanitary cuts) related to windbreaks, but these were not explicitly defined. The draft version of the new law on forests from 2022 in article 6 (2) stated that forests could be considered "windbreaks, shelterbelts, and corridors of trees with an area of more than 500 m2 and a width of more than 20 meters", however, no explicit definitions are provided. It excludes cases where the tree windbreak width is less than 20 meters. There are three promotion programmes prepared for them. The first was prepared in 1991 with validity from 1991-1995, the second is valid for the period from 1996-2000, and the last was prepared in 2021.

### 4.4 SUSTAINABILITY OF THE RESULTS

☑ Long-term funding mechanisms. ☑ Integration into policies or development plans. ☑ Institutional support or partnerships.

The long-term sustainability of the shelterbelts in Ovche Pole was largely guaranteed by a combination of stable institutional and policy support mechanisms. Dedicated long-term state funding provided the financial resources necessary for their establishment and ongoing maintenance, which were channelled through the public enterprise "Water Economy," the responsible institution. Simultaneously, these windbreak systems were incorporated into broader agricultural land management and land-use planning, securing their functional role in soil protection, erosion control, and agricultural productivity. This policy alignment was further supported by strong institutional backing, where public authorities and expert bodies were responsible for planning, supervision, and technical management, ensuring continuity, accountability, and the sustained effectiveness of the shelterbelt network over decades. However, the change in the political and economic systems in the 90s led to many institutions.

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## 5. CONCLUSION

- **Community relevance:** mostly.
  The shelterbelt intervention directly addressed major challenges affecting local communities in Ovche Pole, including soil degradation, wind erosion, crop losses, and vulnerability to drought and climate variability. By reducing wind impacts and stabilising agricultural soils, shelterbelts improved farming conditions, protected productivity, and supported local livelihoods and food security in a semi-arid environment.

- **Technical effectiveness:** mostly.
  The intervention effectively reduced the main drivers of land degradation by lowering wind speed, limiting soil erosion, reducing evapotranspiration, and improving soil moisture retention. Shelterbelts protected topsoil, enhanced microclimatic conditions, and contributed to ecosystem restoration by introducing tree and shrub vegetation into an exposed agricultural landscape. Their long-term maintenance ensured continued erosion control and landscape resilience.

- **Economic efficiency:** mostly.
  The shelterbelt system proved economically beneficial by improving agricultural productivity and providing additional biomass resources. Protected areas showed increased crop yields, including higher wheat, barley, and cotton production. The shelterbelts also generated wood biomass, creating additional economic value while reducing long-term losses caused by erosion and drought-related impacts.

- **Institutional support:** fully.
  Strong institutional support enabled the large-scale establishment and long-term management of shelterbelts. The intervention was integrated into national land management strategies during the socialist period, supported by state planning, technical expertise, funding, and coordination between forestry institutions, public authorities, and agricultural sectors.

- **Innovation:** partially.
  For its time, the shelterbelt programme represented an innovative approach by applying nature-based solutions and combining forestry with agriculture to address land degradation. The strategic design of windbreak networks and their integration into land-use planning were advanced practices. However, similar approaches had already been applied elsewhere, limiting its level of innovation.

- **Replication & Scaling Potential:** fully.
  The shelterbelt approach has strong potential for replication in semi-arid and erosion-prone agricultural regions. Its principles—wind reduction, soil conservation,

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biodiversity enhancement, and climate resilience—are transferable. Successful replication requires adaptation to local climate, soils, wind patterns, species selection, and integration into long-term land management policies.

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