



Master's paper



Shelterbelts as an agroforestry practice in sustainable management

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To prepare this work, digital databases and the textbook "Agroforestry Systems" (Lukić S., Beloica J., 2024) were used. These are the results of the project "AGro FORestry practices in WEst Balkan for sustainable development: weaknesses and strengths" (AGFORWEB), which was funded by the European Union through the ERASMUS+ program KA-220-HED – Partnership in Higher Education (Ref. No. 2022-1-RS01-KA220-HED-000089900).



INTRODUCTION

- Wind erosion
- Protective forest belts
- Agricultural land in the city of Pančevo
- Industrial Zone
- Sustainable management of natural resources

GOALS

The objectives of this work are:



- To identify the functions and services of ecosystems provided by protective forest belts in order to mitigate the main pressures on the environment—such as wind erosion, intensive agriculture, and industrial activities in the Pančevo area—aimed at improving environmental conditions.
- To recognize the significance and role of raising ecological awareness regarding the functions of protective forest belts to facilitate their acceptance by farmers and the local community, and to actively promote ecological awareness from a young age through education.



Description of the Pančevo area

Pančevo is a city located in the southeastern part of Europe, in the northern part of Serbia, within the southern section of the Vojvodina province, in the southern part of the Banat region.

Geographical location

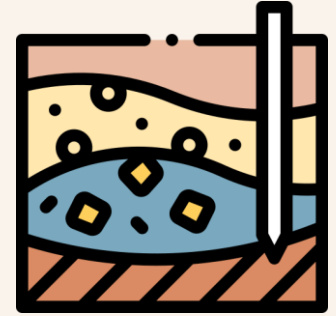


Climatic Characteristics

The area of Pančevo has a moderately continental climate characterized by long, warm summers and autumns, mild winters, and short springs. A notable feature of the climate is the Košava, a strong and dry wind that can last for up to three weeks.

The area of Pančevo is characterized by flat terrain with extensive alluvial plains of the Danube, Tamiš rivers, and Nadel channel, along with loess plateaus in the higher parts of the landscape. The elevation ranges from 67 to 100 meters above sea level.

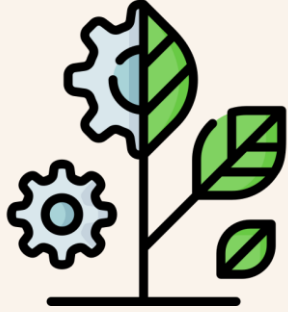
Relief



Pedological Characteristics

Types of soil in the Pančevo Area:

- Chernozem on Gleyic Loess (Chernozem (Gleyic))
- Calcic Chernozem (Calcic Chernozem)
- Alluvium (Haplic Fluvisol)



Environmental Resources

Pančevo is classified as an area with an endangered environment where measures are needed to improve environmental conditions. Due to its chemical and petrochemical industry and oil refinery, Pančevo is considered one of the most endangered areas (hot spots) in the Republic of Serbia.

The assessment of air quality for Pančevo has shown that, based on the exceedance of the permissible values of suspended particles PM₁₀, it is rated as category III, indicating serious air pollution. The main sources of particulate matter in the air come from industry, energy plants, individual heating sources, and traffic.

Air Quality



Soil Quality

The assessment of the tests determined that the concentrations of potentially toxic elements (Cd, Pb, Hg, As, Cr, Ni, Cu, Zn, Fe, and Mn) at all sampling locations are significantly below the maximum allowable concentrations, which guarantees the production of health-safe food.



Conceptual model for
assessing sensitivity to
wind erosion

Analysis of vegetation
status

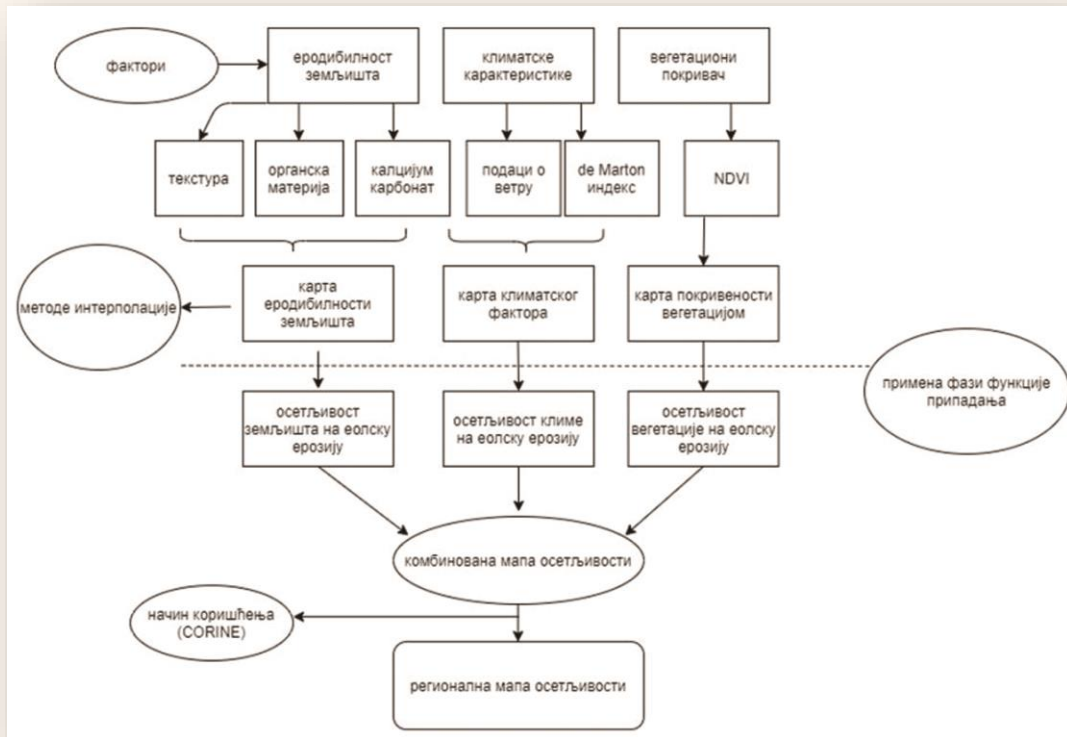
Soil types in the
Pančevo area

Protective forest
belts

Development of
ecological awareness
for sustainable
management

Materials and methodology

Conceptual model for assessing sensitivity to wind erosion



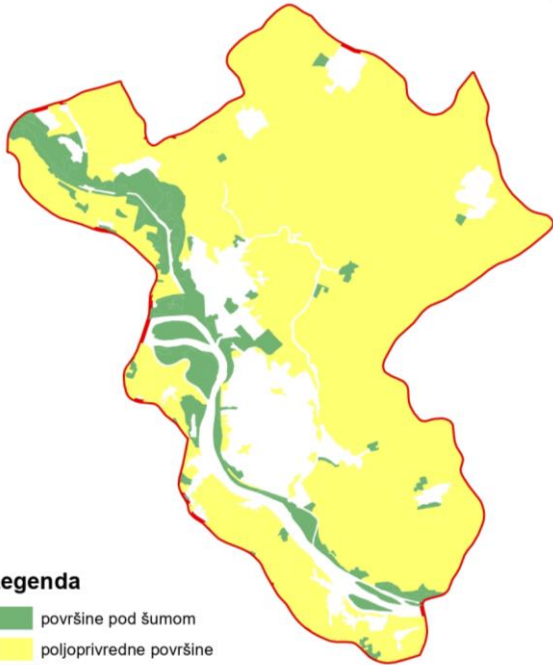
A conceptual model has been developed for the Vojvodina area (Baumgertel et al., 2019). This model can be applied for analyses of various spatial scales.

The main sensitivity factors identified in this area are:




- Soil erodibility
- Climate characteristics
- Vegetation cover

Analysis of vegetation status

Karta načina korišćenja zemljišta grada Pančeva



Legenda

-  površine pod šumom
-  poljoprivredne površine
-  granica Pančeva

0 1.5 3 6 9 12 Kilometers

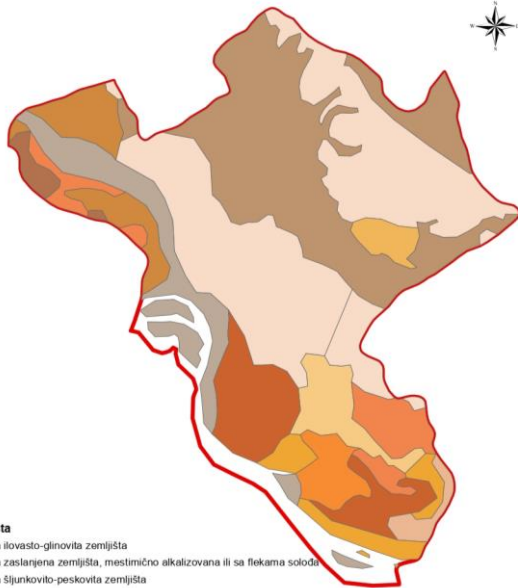
The analysis of vegetation status was conducted based on:

- CORINE database (2018)
- EuroVeg database
- Database from the AGFORWEB project
- LEAP data from the municipality from 2004.

Agricultural land covers 63,820 ha, which is 84.5%, of which 93.6% is arable, while forested areas cover a significantly smaller area of 4,082 ha, or 5.4%.

Soil types in the Pančevo area

Karta tipova zemljišta grada Pančeva



Legenda

tipovi zemljišta

- Aluvijalna ilovasto-glinovita zemljišta
- Aluvijalna zaslanjena zemljišta, mestimično alkalizovana ili sa flekama soloda
- Aluvijalna šljunkovito-peskovita zemljišta
- Livadska crnica beskarbonatna i mestimično oganjnačena
- Livadska crnica karbonatna
- Močvarno-glejno zemljište, mestimično zaslanjeno
- Ritska crnica beskarbonatna
- Ritska crnica karbonatna
- Ritska smonica
- Ritske crnice zaslanjene
- Černozem beskarbonatni
- Černozem karbonatni
- Černozem sa znacima oglejavanja u lesu
- Černozem sa znacima oglejavanja na lesu
- granica Pančeva



The types of soil in the studied area were identified based on:

- Data from the AGFORWEB project database (2023) and
- The pedological map by Živković et al. (1972).

The most prevalent soil types in the territory of Pančevo are calcic chernozem and chernozem with gleying signs on loess.

Forest protection belts

Due to their multifunctional application, it is difficult to classify protective forest belts. One acceptable criterion for classifying these belts is their primary function, which allows us to divide them into:

Protective forest belts for wind speed control, which include:

- Field shelterbelts for protection of arable land
- Living snow fences for snow protection of roads and railways
- Windbreaks for protecting farms and homesteads.

Protective forest belts for improving environmental conditions

Protective forest belts for controlling runoff and filtration



The primary role of field shelterbelts is to safeguard against the negative effects of wind erosion. They are arranged as a network composed of main shelterbelts that are raised perpendicular to the direction of the dominant wind, and secondary shelterbelts that are constructed approximately perpendicular to the direction of the main belts, with a possible deviation of 30 to 45°.

Forest protection belts

Field shelterbelts are used to safeguard arable land and offer numerous benefits for improving environmental conditions in the Pančevo area. The establishment of forest cultures and plantations is crucial for preventing the negative effects of wind.

Protective forest belts are not sufficiently recognized in the existing laws of the Republic of Serbia, despite being fundamental for planning a system of forest protection belts through valid spatial planning and strategic documents. Therefore, there is a need to develop a high-level legal act regarding protective forest belts to implement these systems and ensure adequate sustainability.



Development of ecological awareness for sustainable management

- Education on environmental protection is still evolving; ecological education can be broadly defined as the process of acquiring knowledge about ecological problems as global issues, their causes, and possible solutions.
- Since the protection and improvement of the environment require the engagement of diverse segments of the population of various ages, educational backgrounds, and professional orientations, this education should be tailored to all categories of the population.



Preschool and School Institutions and Environmental Education



- Helping children understand the importance of their participation in maintaining natural balance and preserving the planet contributes to fostering environmental education from a young age.
- The content of ecological activities is selected based on relevance, suitability for the children's age, and their interests.
- Additionally, the mere inclusion of ecological topics in curricula does not guarantee the successful development of ecological awareness; the quality of implementation is also crucial.

Preschool and School Institutions and Environmental Education

Ecological activities include:

- Working with natural materials
- Organizing one-day trips and outdoor competitive games
- Awarding certificates to those who strive to preserve our environment
- Marking important dates:

- 22 September: World Car-Free Day
- 4 October: World Animal Day
- 24 October: World Food Day
- 5 December: World Soil Day
- 11 December: Mountain Day
- 26 January: World Environmental Education Day
- 14 February: World Energy Conservation Day
- 21 March: International Day of Forests
- 22 March: World Water Day
- 22 April: Earth Day
- 10 May: Day of Birds and Trees
- 24 May: European Parks Day
- 5 June: World Environment Day



Results and Discussion

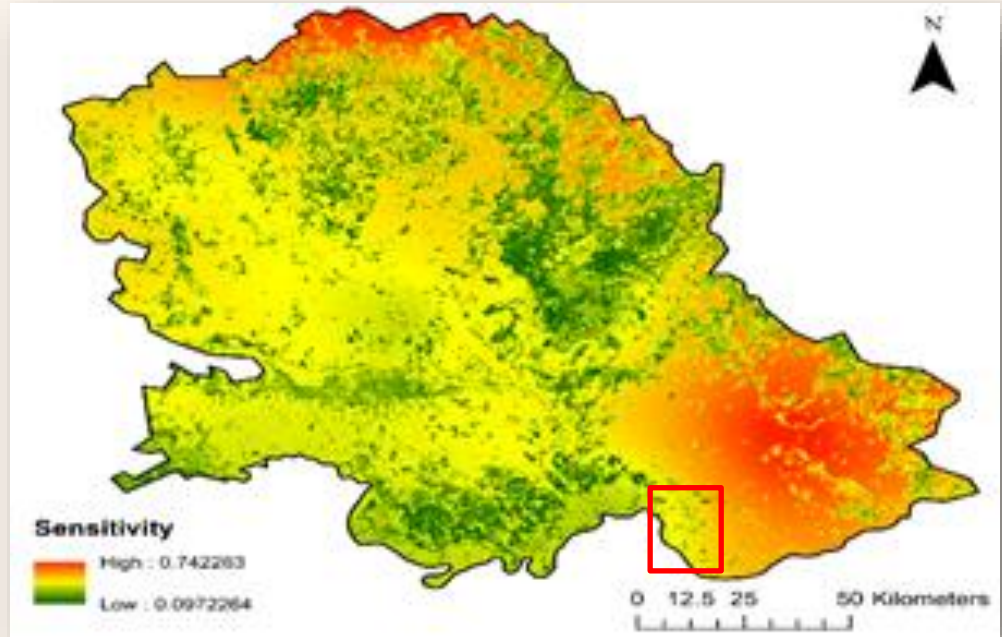
The protection and improvement of environmental quality, especially in the context of urbanized areas like Pančevo, requires the implementation of various strategies and measures.



Sensitivity of the Pančevo area to wind erosion

- Pančevo is at risk of wind erosion due to its natural characteristics and the activities occurring in the area. Intensive land cultivation further increases the risk of erosion and can reduce soil fertility and stability. Climate change may exacerbate these issues, making Pančevo more susceptible to long-term ecological challenges

The Košava, as the dominant wind characteristic of this area, only confirms the potential for negative consequences of wind erosion. According to the wind and drought vulnerability index by Velašević (1970), the city of Pančevo falls into the category of moderate to strong vulnerability.



Sensitivity of the Pančevo area to wind erosion

- The establishment of shelterbelts was a targeted measure to protect against wind erosion.
- The benefits provided by shelterbelts, along with numerous other positive effects—most notably in regulating pollution issues in this area—support the creation of a network of belts across the entire territory of Pančevo.



- The presence of a permanent vegetation cover, especially tree and shrub species, can effectively control and mitigate all these negative impacts. Field shelterbelts have proven to be beneficial in alleviating existing risks.

Sensitivity of the Pančevo area to wind erosion



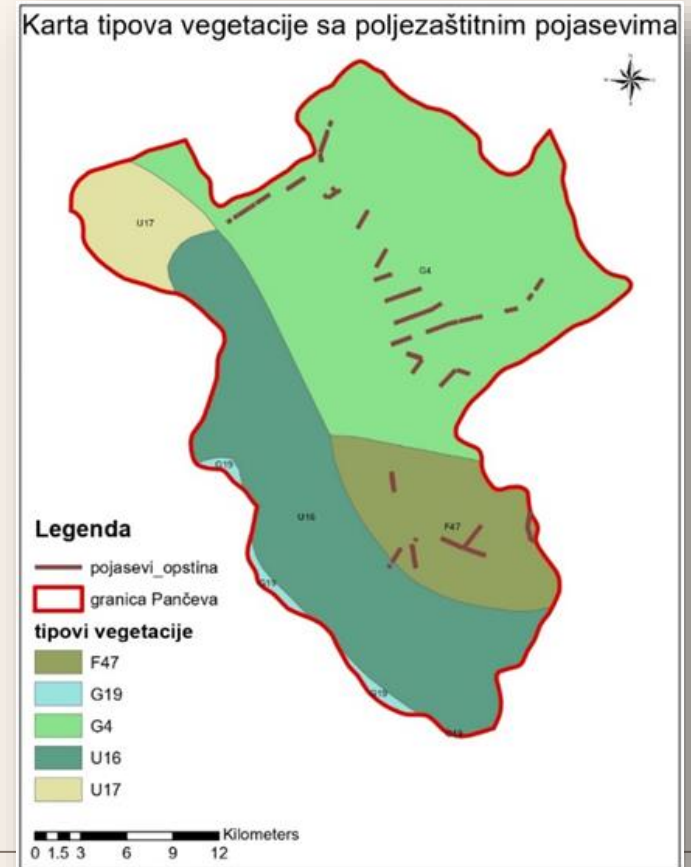
Table of sensitivity to wind erosion

Class of Vulnerability	Interval	Area	Percentage Representation
Low	<0,2	178,5 km ²	23,62%
Moderate	0,2-0,4	334,8 km ²	44,28%
High	>0,4	242,7 km ²	32,10%
		756 km ²	100%

- The sensitivity to wind erosion assessed using the conceptual model in the Pančevo area is primarily moderate to high. Based on the percentage representation of the wind erosion sensitivity classes from the table, the dominant class in the Pančevo area is moderate sensitivity, accounting for 44.28%. In the northern and southern parts of the territory, the high sensitivity class is represented at 32.10%, while in the western and central parts, the dominant class is low sensitivity, at 23.62%.

Current status of shelterbelts in the Pančevo area

- Using the EuroVegMap tool, vegetation units with corresponding codes for trees and shrub species were identified at a selected location in the city of Pančevo.
- Within the AGFORWEB project, a digital database of protective forest belts in the Vojvodina area was created, which recorded 53 shelterbelts in the Pančevo territory.
- According to the AGFORWEB database, the most commonly used trees and shrubs species in the existing shelterbelts in the Pančevo area *Quercus sp*, *Acer sp*, *Ulmus sp*, *Tilia sp*, *Cornus sp*, *Crataegus sp*, *Euonimus sp*



Selection of species for field shelterbelts



- One of the fundamental principles when choosing species for establishing field shelterbelts is to ensure that they provide some of the primary functions of the shelterbelt in a relatively short time, while not being harmful to neighboring agricultural crops.
- The suggested species for establishing shelterbelts based on the natural potential vegetation in the Pančevo area are:

Tree species

Quercus robur



Quercus cerris



Quercus pubescens



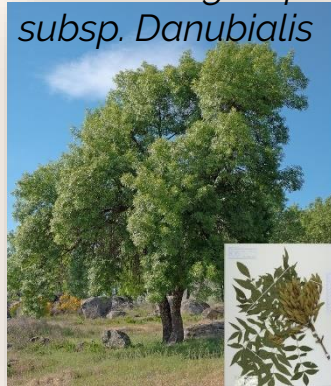
Carpinus betulus



Tilia cordata



Fraxinus angustifolia
subsp. Danubialis



Populus nigra



Populus x canescens



Tree species

Acer tataricum



Acer campestre



Ulmus minor



Ulmus laevis



Prunus avium



Prunus padus



Pyrus pyraster



Sorbus aucuparia



Shrub species

Cornus mas



Cornus sanguinea



Crataegus laevigata



Prunus spinosa



Rosa gallica



Corylus avellana



Euonymus verrucose



Crataegus monogyna

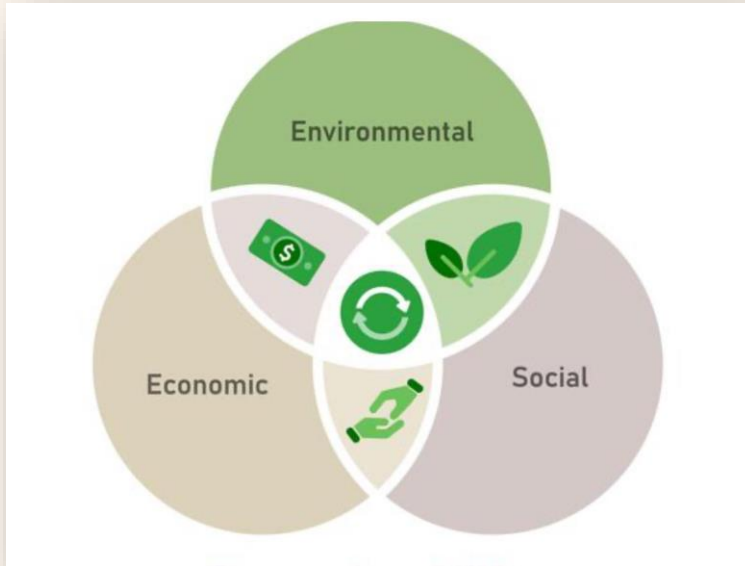


Selection of species for field shelterbelts

- From the offered species that can be used to establish shelterbelts in this area, the selection is based on the characteristics of the location and the specific needs. Factors such as the canopy that provides desired airflow, nectar production, the potential for creating habitats for certain species, and the reduction of air pollution are considered.
- By combining different shelterbelts and selecting 4 to 5 species of varying heights, the shelterbelt will be established in the most suitable way.



Opportunities for raising environmental awareness



- Protective forest belts play a key role in the sustainable development of the broader community by acting on multiple fronts that encompass ecological, economic, and social aspects.
- Due to insufficient recognition in laws, planning documents, etc., certain obstacles often arise in their implementation, affecting their effectiveness and sustainability in a broader sense.
- To successfully achieve all the goals of a project, it is essential to be aware of and rational about the state of awareness among people who are directly and indirectly involved in the project.

Recognition of the lack of environmental awareness

- The ecological awareness of farmers in Vojvodina is of utmost importance in light of the need for sustainable development and environmental protection.
- Vojvodina, as one of the most significant agro-economic regions in Serbia, has great potential for the development of sustainable agriculture.
- The issues faced by the local population in general, along with a degree of distrust towards experts, often lead to project results that are far from satisfactory.



Opportunities for raising environmental awareness

Recommendations and proposals for enhancing children's education



Incorporation of specific ecological topics into the school curriculum: This can include workshops and project assignments that encourage children to explore the effects of shelterbelts and their significance for the environment.



Collaboration with local institutions and environmental organizations: Organizing field visits and guest lectures by professionals in the field can provide practical insights and enhance learning.

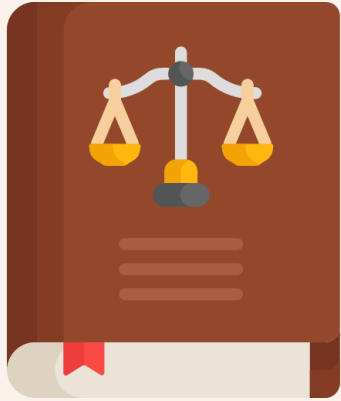


Encouraging active participation of children in environmental protection activities

Recognition of the lack of environmental awareness



For the success of the project to establish field shelterbelts in the municipality of Pančevo, the implementation of these recommendations would be crucial. Educating children plays a significant role in shaping future generations that are prepared and capable of caring for their environment and contributing to its sustainable development.



Recognition of the lack of environmental awareness

- In order to recognize protective forest belts from a legal perspective and improve their acceptance by the local community, it is essential to enhance existing laws and planning documents related to protective forest belts. This requires a comprehensive approach that includes integrated planning, legal-financial mechanisms, and strengthening coordination among various sectors and levels of governance.
- Improving the laws and planning documents for protective forest belts is crucial for creating a sustainable environment and enhancing the quality of life. However, the mere development of legal and planning frameworks is insufficient without a parallel focus on education and raising environmental awareness among the population.



Conclusion

Conclusion

- **Importance of field shelterbelts:** Shelterbelts are essential for moderating wind erosion, improving microclimatic conditions, protecting watercourses, and enhancing air quality. They also contribute to the aesthetic appeal of the area and the overall improvement of the environment.
- **Species selection and maintenance:** The success of establishing shelterbelts requires careful selection of tree and shrub species and their ongoing maintenance. This process demands collaboration among experts, the community, and local authorities.
- **Environmental awareness and education:** Raising environmental awareness is crucial for successful implementation. Educating children about environmental protection and integrating ecological topics into educational institutions play a vital role. It's also important to enhance public awareness regarding the impacts of air pollution and individual contributions to environmental health.
- **Social and legislative support:** Improving laws and planning documents, along with active community involvement, contributes to the project's success. Broader social education and the proactive role of local authorities can significantly influence sustainable development and environmental protection.

The potential of shelterbelts for the sustainable development of Pančevo is emphasized, highlighting the need to integrate all mentioned factors to achieve long-term ecological and economic benefits.

THANK YOU FOR YOUR
ATTENTION!