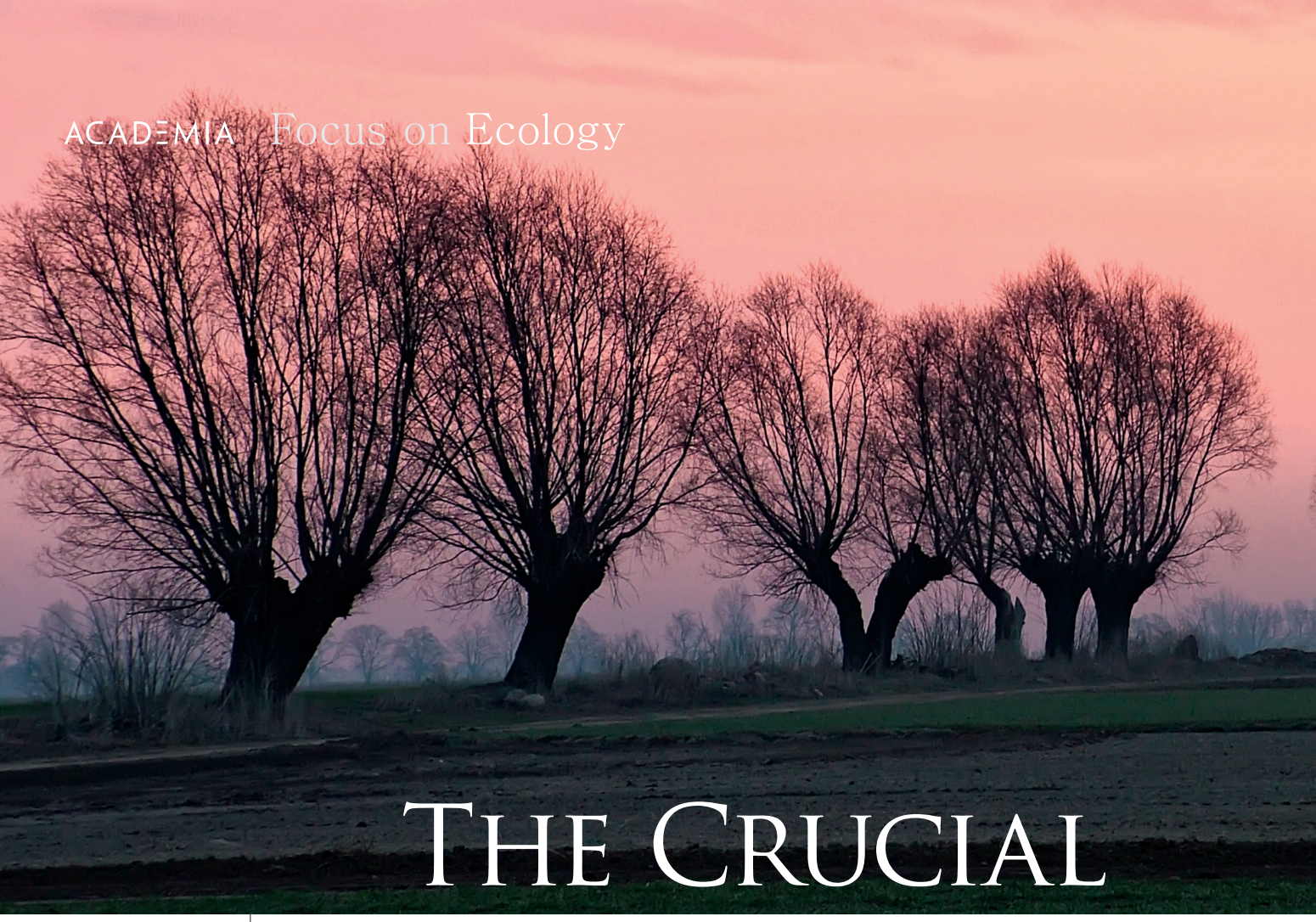

The Crucial Role of Woodlots

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Small woodlots and shelterbelts in agricultural areas can partially stand in for larger forests. What role do they have in the context of climate change and conservation?

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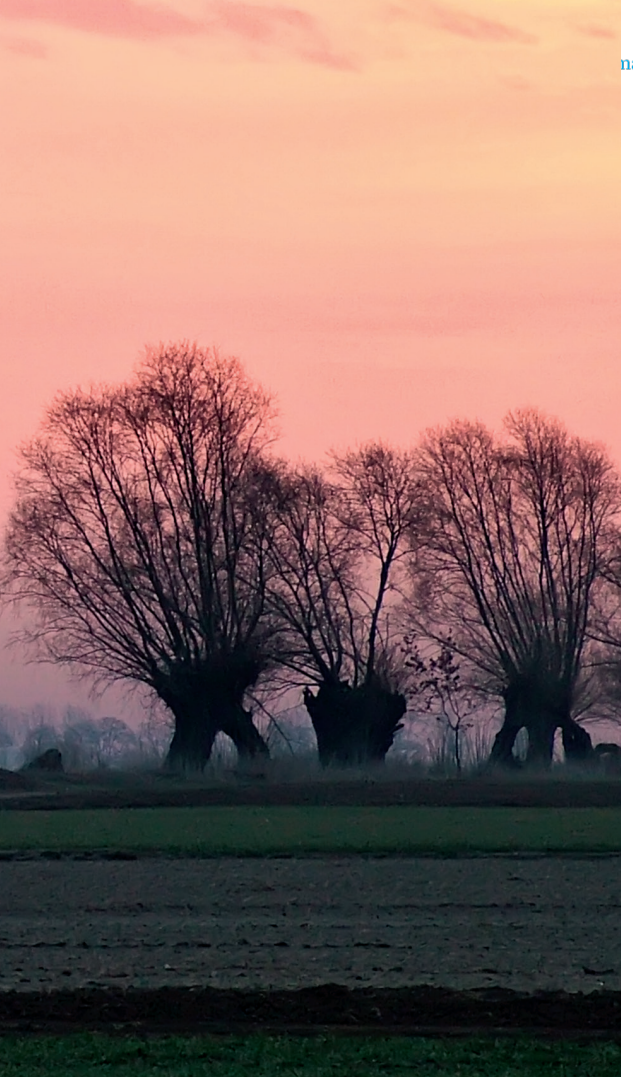
At the end of the twentieth century (starting with the 1992 Earth Summit in Rio de Janeiro), humans started to become increasingly aware of the overwhelming impact we are exerting on the Earth with our rapid economic growth and increasing affluence. Thanks to numerous scientific publications and environmental monitoring programs, we now know that we are living in an era of dynamic global change, caused by rapid population growth combined with increased consumption. Scientists from various disciplines view these global changes as strongly negative, because they threaten not only our civilization, but the very survival of humanity in the near future.

Some of the most important global changes include: (1) rising CO_2 concentrations in the atmosphere and the resulting increase in the Earth's temperature, (2) increasing water, soil and atmosphere pollution



(including plastic waste), and (3) the disappearance of natural ecosystems. The effects (or manifestations) of these changes have a negative impact on our living conditions in two ways. First, they worsen or at least destabilize the physical and chemical living conditions for humans. The continuous rise in CO_2 emissions (caused by burning fossil fuels, as well as turning forests into arable land and draining wetlands) increases global temperature, which in turn increases the frequency and intensity of extreme weather phenomena, such as droughts, torrential rains, and destructive winds. Secondly, they cause a sharp population decline in many species and the disappearance of species (both locally and globally), and thus decrease the level of biodiversity and planetary resources of plants, animals and fungi. The ecosystem functions needed for human existence depend on the scale and diversity of these resources.

Agricultural areas, which take up about 40% of land in the European Union and nearly 60% in Poland, are very sensitive to global changes. The significant human impact on ecosystems accumulates here, including: (1) changes in water conditions (most often due to drainage), (2) deforestation in favor of arable fields, (3) elimination of unusable land (marginal habitats), such as wetlands, slopes, clusters of shrubs and trees, and roadside areas, (4) excessive amounts of nutrients due to the use of mineral and organic fertilizers, (5) change in soil pH, such as due to liming, and (6) severe environmental pollution from using plant protection products (pesticides). Agricultural areas often have an extremely simplified habitat structure, dominated by arable fields and strongly impoverished fauna, flora and fungi. Due to drastic biological depletion and homogenized environmental conditions, the resistance of agricultural areas to various weather anomalies (including drought, heavy rains, frost, heat, and strong winds) is very low. Also, the biological regulatory mechanisms are severely weakened, which leads to numerous outbreaks of crop-damaging insects.

Agricultural areas are therefore in a particularly precarious position when it comes to global change. Is there anything that can be done about it? Yes, there is. Studies clearly show that the key to improving this situation is ensuring a heterogenic agricultural landscape with diverse non-arable land. Of these, shelterbelts play the most important and comprehensive role.

Forest-substitutes in agricultural areas

Shelterbelts are a type of mid-field woodlots, a term that is not easy to rigorously define. In this article we understand mid-field woodlots as referring to small

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Two types of landscapes: a forest (relatively stable) and a simple agricultural landscape, more sensitive to disturbance

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areas (up to several hectares) of the agricultural landscape consisting of clusters of trees or shrubs. Due to their small area, such woodlots are very susceptible to external factors, as opposed to large forest complexes. It is sometimes said that woodlots consist solely of a forest edge, without any interior.

More generally, woodlots are also very diverse because they vary in origin, degree of human interference in their creation and development, as well as shape and location within the landscape. Woodlots can be classified according to various criteria, including location, architectural structure, species composition, and number of vegetation layers. In terms of location, we distinguish the following types of woodlots:

- agricultural woodlots (e.g. mid-field woodlots, or shelterbelts),
- woodlots in transport areas (e.g. roadside or railway woodlots),
- woodlots near water areas (e.g. along river banks or drainage ditches, known as riparian buffer zones),
- woodlots in industrial areas and landfills (e.g. protective and insulating woodlots).

In terms of their physical structure, shape and size, mid-field woodlots are classified into the following types: individual shrubs or trees, single rows of trees or shrubs, strips with at least two rows of trees or shrubs, woodlot groups covering less than 0.02 ha not forming rows or strips, woodlot clusters covering areas between 0.02 and 0.1 ha not forming rows or strips, and surface woodlots covering at least 0.1 ha.

Woodlots have been a part of human settlement patterns since time immemorial. To this day, the agricultural landscape in various regions of the world often includes row or strip woodlots. Roadside woodlots were even found in ancient Greece, Rome, and Egypt.

Roadside woodlots were popular in Europe in the heyday of building grand royal and magnate residences. In Poland, laws regarding roadside woodlots have changed considerably over the years. For example, in 1921 laws were passed ordering the planting of trees, including fruit trees, along major roads, but after World War II there was a ban on planting trees at roadside, as well as on planting fruit trees. In the years 1960–1969, many trees were planted thanks to a law adopted by the Council of Ministers on tree planting in the country, including during the celebration of the Millennium of the Polish State. In the 21st century, however, there was a tendency to eliminate woodlots in many areas, but there is not enough data on this topic.

One unique example is that of General Dezydery Chłapowski (a former adjutant to Napoleon), who planted a dense network of shelterbelts on his prop-

An example of a diverse agricultural landscape rich in mid-field woodlots: the General Dezydery Chłapowski Landscape Park

erty near the village of Turew in Wielkopolska in the 1920s in order to protect his crops from the wind. As a result, the area around Turew is widely known for its numerous diverse woodlots.

Another unique woodlot network in Poland is found near Nowy Tomyśl, on the site of the former eighteenth-century Olęder settlement consisting of dispersed farms. The surrounding forests were cut down, but at the same time the settlers created a network of trees and bushes, which to some extent have survived to this day.

A key element of green infrastructure

Mid-field woodlots play such an important role in deliberate, advantageous landscaping that they have recently been mentioned in the context of "green infrastructure" – a planned network of natural and semi-natural areas, designed and managed in a way to ensure a wide range of ecosystem services.

The role of woodlots

Woodlots provide the following ecosystem services:

a) provisioning services – providing food (e.g. fruit, herbs, animal feed), raw materials (e.g. timber, wicker, decorative materials), medicines (e.g. raw materials for the pharmaceutical industry),
b) regulating services – affecting the microclimate (e.g. increase air humidity, lower air temperature), binding carbon dioxide, and cleaning the air, water and soil. Animals living in woodlots help pollinate and spread plants. Woodlots are home to many species of predatory animals and parasites that help keep crop pests to a minimum,
c) supporting services – providing a home for many organisms in the agricultural landscape, thus enhancing biodiversity, and taking part in soil-form-

The landscape near the village of Turew (in the foreground) is famous for the network of mid-field woodlots created in the nineteenth century by its former owner, General D. Chłapowski

Three types of mid-field woodlots – cluster, strip and row

ing processes, formation and decomposition of organic matter, as well as in chemical element cycles and hydrological cycles,

d) cultural/social services – exerting a positive impact on the physical and mental health of humans by providing opportunities for recreation and tourism, intangible benefits, and responding to people's spiritual needs, including those regarding the aesthetics of our surroundings.

Let's take a look at some selected woodlot functions.

Accumulation of carbon dioxide (sequestration). It is estimated that woodlots can accumulate up to 20 t/ha of carbon dioxide annually. Note that given the relatively small possibilities of increasing the forest area in Poland (up to approx. 2 million ha), more mid-field woodlots could be introduced in many agricultural areas in order to increase the amount of CO_2 storage.

Impact on microclimate and water retention. Woodlots are widely used around the world as wind barriers (shelterbelts). As such, they not only keep crops safe by protecting them from very strong winds, but also reduce water evaporation on the farm and mitigate the effects of frost. They also contribute to the accumulation of snow and thus soil water reserves. Mid-field woodlots also cast shade on specific areas of fields, roads or pastures, which, in view of an increasing number of hot days in Poland, makes them even more important. They can significantly reduce the surface runoff of water. At the same time, they collect water, evaporating it through the leaves, thus stimulating water micro-circulation, which also helps reduce the outflow of water from catchments.

Mid-field woodlots protect against soil erosion. Here, one can see the effects of the lack of barrier for the cultivated field on the right (from the west). The vicinity of Stary Gołębin (Wielkopolska region)

Impact on water quality. The roots of trees and other plants found in mid-field woodlots take in significant amounts of nutrients from soil, which they then accumulate. Bacteria and fungi also play an important role in this process, which is why woodlots are often referred to as biogeochemical filters. Dense woodlots can radically reduce the amount of nutrients flowing out of the catchment, thus reducing water eutrophication, including in the Baltic Sea.

Impact on biodiversity. Woodlots support great biodiversity of the agricultural landscape, including small refuges for plants, animals and fungi. Nothing can replace mid-field woodlots in this respect. They offer a habitat features that strongly contrasts with fields, such as the presence of 3–4 vegetation layers (the forest litter, understory, and canopy story, and often also a sub-canopy story, i.e. a layer of trees lower than those forming the highest layer).

Butterflies. The mid-field woodlots found in the Gen. Dezydery Chłapowski Landscape Park, located on agricultural land that has been the subject of ecological research for over 50 years, have been found to be home to 35 species of butterflies (about 20% of the total number of species in Poland), which is 5–10 times more than on the fields themselves. About two-thirds of these species are common in Poland. These include the ringlet, the meadow brown, the Essex skipper, the small heath, and the wall brown. The large copper butterfly also lives here – a species under strict species protection and included in Annexes (II and IV) of the Habitats Directive. Woodlots with sparse trees are most favorable for butterflies, providing excellent habitats for nectariferous plants (e.g. field scabious and creeping thistle).

Spiders. Spiders are a group of species that occurs in woodlots in high numbers. As predators, spiders contribute to reducing the number of plant pests in arable fields. To date, 179 spider species have been identified in the woodlots of the Gen. Dezydery Chłapowski Landscape Park during the growing season (accounting for 22% of all known species in Poland), including seven endangered species and 14 rarely found in Poland. For many species of spiders, woodlots also make good wintering places (thanks to the litter).

Birds. Mid-field woodlots play a very important and beneficial role for many bird species. One hundred species of birds have been found to breed in Polish woodlots, which is about 40% of the country's breed-

Diverse vegetation (herbaceous and woody) on the banks of water reservoirs acts as a filter that cleans water from excess nutrients and other chemicals, improving water quality and protecting against eutrophication

ing avifauna. Among them are typical forest species, such as woodpeckers, treecreepers, thrushes, warblers, and tits, as well as species that inhabit the forest-field ecotone. Some of the latter build nests in trees, but forage in nearby open areas (e.g. buzzards, shrikes, pigeons, and starlings), and some use trees or shrubs for singing, but nest nearby in adjacent arable fields (e.g. the yellowhammer, corn bunting, and ortolan bunting). Among woodlots, the most important habitats for birds are rural parks, while roadside avenues are the least important. However, even the latter are much more valuable as habitats for birds than arable fields themselves. Cultivated fields are home to only a few species (the skylark, yellow wagtail, partridge, quail, sometimes also the corn bunting, whinchat, common whitethroat, and several others), and the total number of breeding birds is much smaller than those living in roadside avenues. Mid-field woodlots are also home to many high conservation priority species. Newly planted mid-field woodlots very quickly become an important breeding place for many bird species, significantly enriching the avifauna of agricultural areas after just 6–8 years.

Fungi. A diversified agricultural landscape, where uncultivated ecosystems have also been preserved (including rural parks, mid-field woodlots, small forests), is home to many species of macrofungi, including protected and endangered ones. In the years 1997–2019, 761 species of fungi were identified in the Gen. Dezydery Chłapowski Landscape Park, roughly the same number as in the Ojców National Park, Gorczański National Park, and Tatra National Park, whereas only 16 species were found in arable fields. In various types of mid-field woodlots the following number of fungal species have been found to date: 167 species in woodlot strips, 124 in clusters, and 117 in road avenues. As many as 17% of fungi occurring in woodlots are valuable species (legally protected, included on the red lists of endangered fungi, or other fungi species that are very rare in Poland).

Conservation status of mid-field woodlots. The status of mid-field woodlots is a good example of the large gap between theory and practice. The fundamental importance of mid-field woodlots for the agricultural landscape (people and nature), including in mitigating global changes, has been confirmed beyond any doubt. This is reflected in the regulations on protecting mid-field woodlots that were included in a number of Polish laws (the Act on Nature Protection, the Act on Environmental Protection, Act on Spatial Planning and Development, and Act on Municipal Self-Government). Unfortunately, mid-field trees are still disappearing, according to researchers and numerous organizations dealing with nature conservation. Poland has not yet developed regulations to support the maintenance and creation of mid-field woodlots on private land, similar to those supporting agricultural production.

Woodlots are a tool that can help improve the quality of the environment in most areas of Poland (about 60%) that have been strongly transformed by man as a result of farming, as well as help mitigate climate change and its effects. As such they are an invaluable, albeit much underestimated resource.

PHOTOGRAPHY BY **KRZYSZTOF KUJAWA**

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