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Decoupling of greenhouse gas emission and economic performance of the accommodation and food services section in Hungary

A szálláshely-szolgáltatás és vendéglátás szektor üvegházhatású gázkibocsátásának és gazdasági teljesítményének szétválása Magyarországon

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Abstract: There is a twofold relationship between the tourism industry and climate change. On one hand, tourism affects climate through e.g., energy consumption, but on the other hand, tourism is affected by the climate, as e.g., weather plays a role in choosing a destination. This study aims to investigate the link between the economic performance (using the economic indicator of Gross Value Added) and the greenhouse gas emissions of the Hungarian national economy and the section of Accommodation and Food services (Section I), keeping in mind that it does not cover the entire tourism industry. For the sake of the environment, the absolute decoupling of economic performance (in this study GVA) and environmental pollution (in this study the total GHG emissions) is desirable, and in Hungary, the national economy did achieve absolute decoupling during the period 1995–2019. Decoupling can be analysed first by the trends of the economic indicator and the total GHG emission, and second, calculating the Tapio's decoupling elasticity index. Both methods indicate that the Hungarian economy shows decoupling, in other words: the rise of the economic indicator (GVA) is accompanied by the decrease of the total GHG emission. When sectioning the timespan under analysis, strong, weak and recession types of decoupling can be detected. In the case of Section I, however, there were inconclusive, though not totally successful or consistent, attempts at decoupling. Short periods of coupling could be detected (1997–1999, 2003–2005, 2009–2011). It is unfavourable in the aspect of climate change. In Section I, the biggest greenhouse gas emitter is energy consumption, and so it would seem that the best way to achieve and stabilize absolute decoupling in Section I would be increases in energy efficiency and a higher rate of renewable energy use.

Keywords*: decoupling, greenhouse gas emission, Hungary, Section I*

Összefoglalás: E tanulmány célja, hogy feltárja a magyar nemzetgazdaság, valamint a szállás- és vendéglátóipari ágazat (I. ágazat) gazdasági teljesítménye és üvegházhatású gázkibocsátása közötti összefüggéseket, még ha nem is fedi le a turisztikai ágazat egészét. A turisztikai ágazat és az éghajlatváltozás között kettős kapcsolat áll fenn. Egyrészt az idegenforgalom hatással van az éghajlatra, például az energiafogyasztás révén, másrészt viszont az éghajlat is hatással van az idegenforgalomra, mivel például az időjárás szerepet játszik az úti cél kiválasztásában. A környezet védelme érdekében kívánatos a gazdasági teljesítmény és a környezetszennyezés abszolút szétválasztása, és Magyarországon a nemzetgazdaság egészében véve valóban elérte az abszolút szétválasztást az 1995–2019 közötti időszakban (a kutatásban vizsgált időszak, amelyben az üvegházhatású gázok kibocsátására helyeződik a hangsúly). Az I. szekció esetében azonban voltak ugyan szétválasztási kísérletek, de azok nem voltak teljesen sikeresek vagy következetesek. Az I. szektorban a legnagyobb üvegházhatású gázkibocsátó az energiafogyasztás, ezért úgy tűnik, hogy az I. szektorban az abszolút szétválasztás elérésének és stabilizálásának legjobb módja az energiahatékonyság növelése és a megújuló energiaforrások nagyobb arányú felhasználása lenne.

***Kulcsszavak**: decoupling, üvegházhatású gázok kibocsátása, Magyarország, I szektor*

1 Introduction

It is beyond any debate that climate change is one of the most urgent issues that humanity will have to face in the near and long-term future. An extensive list could be written of the possible effects of climate change on the atmosphere-water-soil system and, in consequence, on our way of life, added to which is the fact that changes in climate conditions often cause cascade impacts.

There is no doubt that anthropogenic activities have added to the increase in atmospheric greenhouse gas content, a direct cause of present climate change (Sun et al., 2014). The Kyoto Protocol adopted in 1997 (UNFCCC) targets the reduction of the greenhouse gas emissions. China recently overtook the USA to become the biggest GHG emitter (World Bank Data, 2020). The European Union's commitment to the reduction of GHG emissions has wide support. Between 2008 and 2020 declines in emissions are noticeable in all economic activity in the EU according to the Eurostat database. *In 2020, emissions of greenhouse gases generated by the economic activities of EU resident units stood at 3.5 billion tons of CO_2 equivalents, nearly 24% lower than in 2008* (EUROSTAT, 2022, *https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Greenhouse_gas_emission_statistics_-_air_emissions_accounts*). The sectors with the greatest emissions in the EU are the supply of electricity, gas, and steam, and air conditioning (EUROSTAT, 2022), and in the USA these are transportation and electric power generation (US-EPA, 2020).

The aim of this study is to examine the association between economic performance (the total amount of produced Gross Value Added (GVA) of the national economy) and greenhouse gas emissions in the Hungarian national economy and the Section of Accommodation and Tood Services (Section I), even if it does not cover the entire tourism industry. There is a dual relationship between the tourism industry and climate change. The absolute decoupling of economic performance and environmental pollution is desirable, and the goal of this research is to discover when this absolute decoupling can be achieved. The topic introduced has strong environmental science's link beside its importance in environmental economy. It is strongly associated with climate change, as it explores decoupling of greenhouse gas emission from economic performance.

1.1 Connection between environmental damage and economic growth

It is commonly accepted that there is a correlation between economic growth and environmental pollution. During industrialisation, growth is linked to pollution, therefore, more production will require increasing expenditure on environmental protection. This, however, is usually only valid up to a certain point; beyond this point, a certain level of economic well-being, the tendency reverses. This is known as the environmental Kuznets curve. The basic concept is that without environmental pollution, there cannot be economic growth. The most common shape is the inverse U-shape described above, but other forms exist; Németh-Durkó (2020) found an inverse N-shape environmental Kuznets curve for CO_2 emissions in Hungary between 1982 and 2016, expanding the model with energy, financial, and demographic macro processes.

Another method to investigate the connection between environmental pollution and economic growth is to determine the degree of decoupling between them. "*Decoupling is when resource use or some environmental pressure either grows at a slower rate than the economic activity that is causing it (relative decoupling) or declines while the economic activity continues to grow (absolute decoupling)"* (UN-IRP, 2017; p. 22.). These are the two basic forms of decoupling (Vavrek and Chovancova, 2016). A third category, absolute decoupling within limits, is suggested by Fedrigo-Fazio et. al. (2016) that regards Earth as a closed system and supports the achievement of sustainability goals.

Wang and Wang (2019) investigated the decoupling in the USA and stated that economic growth had been compatible with carbon reduction since 2007. The environmental effect of EU-28 consumption showed decoupling between 2005 and 2014 (Sanyé-Mengual et al., 2019). Chen et al. (2018) conducted a decoupling analysis for the OECD and found that intensity of energy use and per capita GDP are the main factors driving changes in CO_2 emissions. Wenbo and Yan (2018) evaluated the effectiveness of China's environmental policy using decoupling theory.

1.2 Aspects of tourism

Tourism is defined by UNWTO (Glossary of Tourism Terms) as follows: "Tourism is a social, cultural, and economic phenomenon which entails the movement of people to countries or places outside their usual environment for personal or business/professional purposes. These people are called visitors (which may be either tourists or excursionists; residents or non-residents) and tourism has to do with their activities, some of which involve tourism expenditure" *(https://www.untourism.int/glossary-tourism-terms)*. Large numbers of tourists at a destination may lead to risk of environmental damage (Franzoni, 2015), and the rise in global tourism volume contributes to GHG emissions (Sun, 2016). The GHG emissions from tourism are primarily from highly developed regions (Yu-guo and Zhen-fang, 2014). Tourism, as is the case with other economic activities, adds to the greenhouse gas emissions of a country, but on the other hand, it is vulnerable to climate change and extreme weather events (e.g., floods, heavy precipitation, heat waves). The role of tourism is twofold in terms of climate change, a vector and a victim at the same time (Njoroge, 2015). The contribution of tourism to global greenhouse gas emissions is about 8% (Lenzen et al., 2018). The relationship between tourism and climate change is gaining prominence and exciting increasing scientific interest (Koçak et al., 2020).

Lee and Brahmasrene (2013) stated that tourism stimulates national economic growth. Economic growth leads to rise in CO_2 emissions, partly through higher energy consumption, but increased tourism does not necessarily have to lead to increased emissions in EU, because with appropriate policies and practice, tourism may be made more environmentally friendly.

As, however, tourism is not an independent economic sector as represented in national economic statistics, measuring its performance is problematic (Hinek, 2020), because most products and services consumed by tourists are not exclusive to tourism (Neger et al., 2021). As China became the biggest GHG emitting country and tourist sector is growing, a great deal of research can be found that investigates the relationship between GHG emissions and the tourism industry (e.g., Tang et al., 2014; Wu et al., 2015).

The economic sector of tourism is important for several points: based on previous studies, this sector does not show decoupling on long term (Szilágyi and Kocsis, 2026) in Hungary, but the sector plays a huge role in the economy's performance, and it is in the centre of the economic strategy. Referring to the results of Szilágyi and Kocsis (2026) detailed insight to the progress of decoupling is needed for section I, as on long term, decoupling can't be seen. The aim of this study is to investigate the progress of decoupling in the economic section of Accommodation and food services, even though it covers only a part of the Tourism.

2 Materials and Methods

2.1 Data sources

The data of the open-access database of EUROSTAT (open-source database) have been used, and the data of Gross Value Added (GVA), and Greenhouse Gas Emission (GHG) were downloaded for the period of 1995-2019 in case of the Hungarian national economy and Section I (Accommodation and food services). The end of the chosen period is 2019, when the COVID pandemic seriously affected tourism, and the distorting effect caused by lockdowns became a factor. The data were available as annual sums. It should be emphasized that Section I is not identical with tourism itself, but comparable data are provided only for Section I. Section I covers just a part of tourism, which normally contains not only accommodation and food services, but also e.g., the transport connected to tourism, as counted by the TSA (Tourism Satellite Account), and accommodation, food and drink are only components of the whole tourism industry (EEA SOER, 2015). The TSA contains all the gross domestic product in the sector, but there is no comparable data source for emissions. Data availability is a limitation of the calculations. As data of GHG emission is available only for section I (accommodation and food services), decoupling can be calculated from this limited part of the tourism, nevertheless GDP data are available from the Tourism Satellite Account (TSA). GVA data was used because it doesn't contain subsidies and taxes as GDP, just the pure produced added value of the sector.

Linear trend computed by the ordinary least squares method (OLS) was applied to determine the tendencies of GVA and GHG emissions for the examined period of 1995-2019. To identify potential structural changes in the time series, the Bai–Perron multiple breakpoint test (Bai and Perron, 1998) was applied. This method allows the detection of multiple structural breaks. Time series analysis examines just the progress over time but not answer the question of the driving forces. This can be a limitation regarding the conclusions.

2.2 Decoupling elasticity index

The theory of the decoupling elasticity coefficient (*DI*) was proposed by Tapio (2005) and since then has been widely used to demonstrate the delink between environmental pollution and economic growth (e.g., Wenbo and Yan, 2018; Wang and Wang, 2019; Hao et al., 2019). In the present research, this model is used to explore the relationship between the economic growth of the Hungarian national economy and Section I (Accommodation and food service activities) (NACE Rev. 2, 2008) and their greenhouse gas (GHG) emissions. *DI* (1) can be estimated as a

ratio of the change in GHG emission (*%ΔC*) to the change in the economic indicator (*%ΔG* – in the present study, gross value added, GVA) (Tang et al., 2014; Hu et al., 2017).

$$DI = \frac{\%\Delta C}{\%\Delta G} \quad (1)$$

%ΔC is computed as (2) and *%ΔG* as given in (3):

$$\%\Delta C = \frac{(C_t - C_b)}{C_b} \quad (2)$$

$$\%\Delta G = \frac{(G_t - G_b)}{G_b} \quad (3)$$

where C_t is the GHG emission of the current period, C_b is the GHG emission of the base period, G_t is the GVA of the current period, and G_b is the GVA of the base period. The whole examined period was divided in 3-year-long sections to better understand the processes.

According to the grade classification of decoupling suggested by Tapio (2005) (Hu et al., 2017; Li et al., 2021), the following categories were used (*Table 1*). Among the decoupling categories, recession decoupling and weak decoupling may be considered favourable, while from an environmental perspective strong decoupling represents the most desirable outcome.

Table 1 Grade classification of decoupling between GHG emission and GVA (Hu et al., 2017; Tapio, 2005)

Category	%ΔC	%ΔG	DI
Weak negative decoupling	<0	<0	0<DI<0.8
Strong negative decoupling	>0	<0	DI<0
Growth negative decoupling	>0	>0	DI>1.2
Recession decoupling	<0	<0	DI>1.2
Strong decoupling	<0	>0	DI<0
Weak decoupling	>0	>0	0<DI<0.8
Recessive coupling	<0	<0	0.8<DI<1.2
Growth coupling	>0	>0	0.8<DI<1.2

The overall trends were examined for the whole period, and decoupling elasticity indices were determined following Hu et al. (2017) for 3-year periods with a 1-year overlap. Detailed insight to the progress of decoupling is needed for section I, as on long term, decoupling can't be proven (see the work of Szilágyi and Kocsis, 2026). Three years overlapping periods are the smallest periods, where there is sense to calculate the decoupling index. This sectioning of the time series is based on the work of Hu et. al. (2017). With one year overlapping the smallest change can be detected in decoupling.

3 Results

3.1 National Economy

From 1995 to 2019 the linear correlation ($r = -0.78$) between the Gross Value Added of the national economy of Hungary and the GHG emission is negative and ($p < 0.001$). A significant ($p < 0.001$) increasing trend can be observed for the GVA and a significant declining tendency ($p < 0.001$) can be found for GHG emissions over the examined period (*Fig.1.*). It may be supposed that the growth of the national economy is not accompanied by the total GHG emissions, and absolute decoupling can be observed. To gain a deeper insight, 3-year periods were adopted for the computation of the decoupling elasticity index (*DI*). All of these periods showed decoupling, either weak or strong (*Table 2*). Stepwise examination demonstrates that a continuous decoupling was realized between 1995 and 2019 in Hungary.

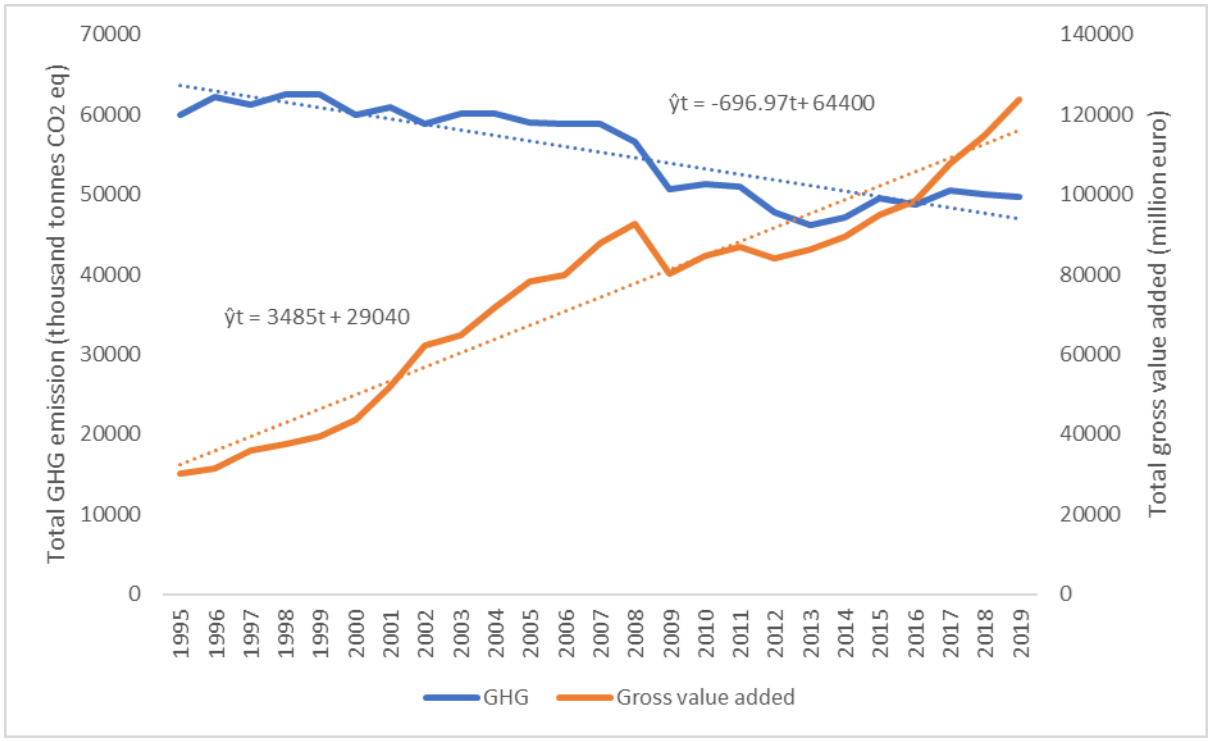


Figure 1 *Tendencies of the total GVA and GHG emissions of the Hungarian national economy (1995–2019)*

Table 2 Decoupling elasticity indices for 3-year periods with a 1-year overlap for the national economy (favourable decoupling categories are in italics)

	%ΔC	%ΔG	DI	Form of decoupling
1995–1997	0.020	0.200	0.101	*weak*
1997–1999	0.023	0.096	0.237	*weak*
1999–2001	−0.027	0.313	–0.086	*strong*
2001–2003	−0.014	0.250	–0.056	*strong*
2003–2005	−0.016	0.208	–0.078	*strong*
2005–2007	−0.004	0.123	–0.031	*strong*
2007–2009	−0.139	–0.088	1.580	*recession*
2009–2011	0.005	0.082	0.059	*weak*
2011–2013	–0.094	–0.008	12.371	*recession*
2013–2015	0.073	0.102	0.714	*weak*
2015–2017	0.019	0.134	0.144	*weak*
2017–2019	–0.015	0.149	–0.100	*strong*

3.2 Section of Accommodation and food services (I)

Tourist consumption and environmental performance depend on many factors and can be highly variable in a brief period as well as in long term. The share of Section I within the GVA of the national economy is 1.92% on average in the period of 1995-2019, with a range of 0.77%. The share rate declines until 2013, then begins to rise (*Fig.2.*). The share of Section I in the total GHG emissions is 0.32%, with a range of 0.15%. This share alternated between growing and decreasing on almost a yearly basis, and a significant tendency cannot be identified (*Fig.2.*). The share of the latest years (2018-2019) was similar to that of the beginning of the period examined (1996–1997).

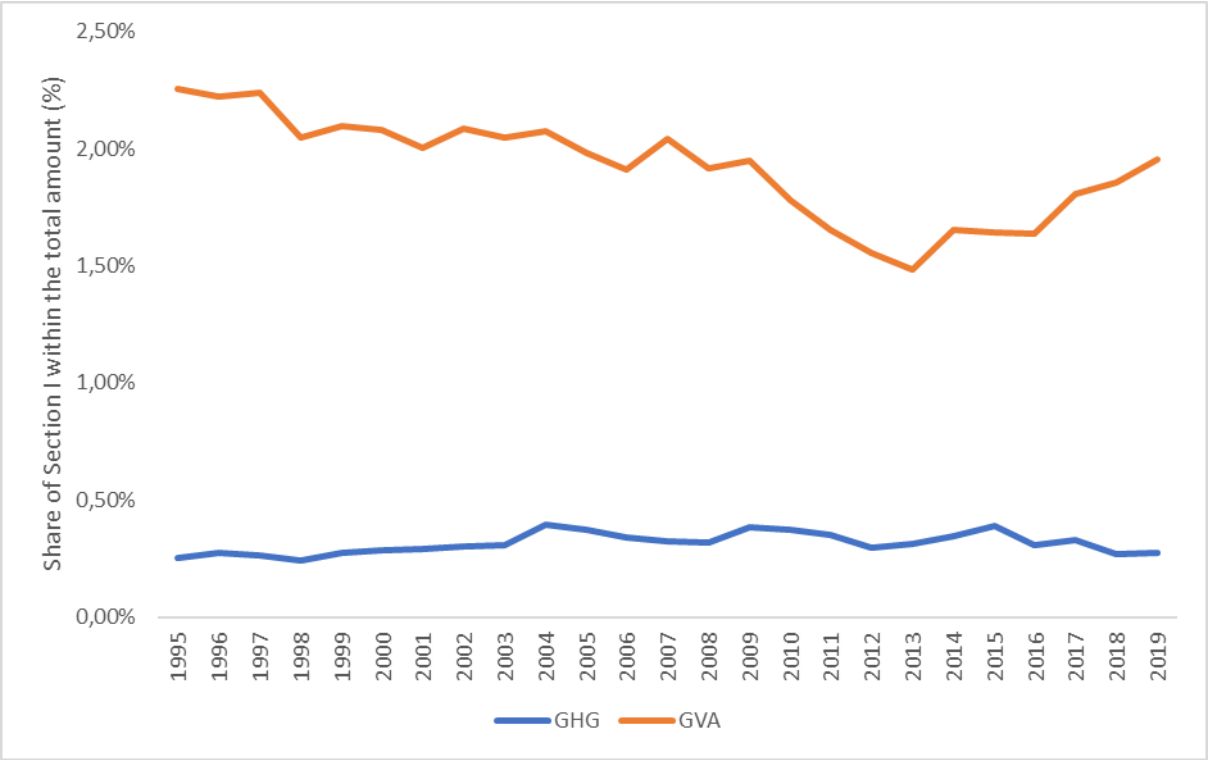


Figure 2. *Share of Section I in the total GVA and GHG emissions*

The correlation between GVA and the GHG emissions of Section I is positive, but not significant ($r = 0.011$, $p = 0.957$). GVA produced by Section I shows a significant increasing tendency between 1995 and 2019 ($p < 0.001$). The GHG emissions of Section I do not, however, demonstrate any significant linear trend ($p = 0.255$) (*Fig. 3.*), but until 2004 there was an emerging tendency. Therefore, a polynomial trend was used to describe the tendency, and it has a better fit than the linear one (*SSE linear = 14358*; *SSE polynomial = 7493*). The polynomial trend suggests that there was a change point, and after the peak in GHG emissions of Section I, a declining tendency can be observed. This turning point can be detected visually on *Figure 3* around 2004 and its existence was confirmed by the Bai–Perron structural break test. It is not the approved reason of the structural breakpoint in the time series, but it might be that it was the year when Hungary joined the European Union and the implementation of the European legislation on energy and environmental policy. Hungary joined the European goals for improving the rate of renewable energy production and its use in the energy mix and implemented the strict rules of environmental protection of the EU. A law for energy tax was issued in this year that enhance this process. From 2004 an intensive rise can be seen in the energy production from renewable energy sources. According to the data available in the database of the Hungarian Central Statistical Office, an increase of 220.4% occurred in the volume of the energy produced from renewable sources and thermal recovery of waste from 2004 to 2019. As Section I is a big consumer of energy, these facts may facilitate the decrease of GHG emissions by the section after 2004. The variability of the GHG emissions emphasizes the need to look deeper and use the decoupling elasticity indices of 3-year steps. Decoupling can be identified in the following short periods: 1995–1997, 1999–2001, 2001–2003, 2005–2007, 2011–2013, 2015–2017, 2017–2019. Between 2003 and 2005 the GHG emissions were linked to the growing economic performance and between 2009 and 2011 to the declining GVA. A stronger positive link can be seen between 1997 and 1999 and between 2013 and 2015.

Between 2007 and 2009 a strong negative decoupling can de observed while economic performance was declining accompanied by the growing GHG emissions of the Section (*Table 3*).

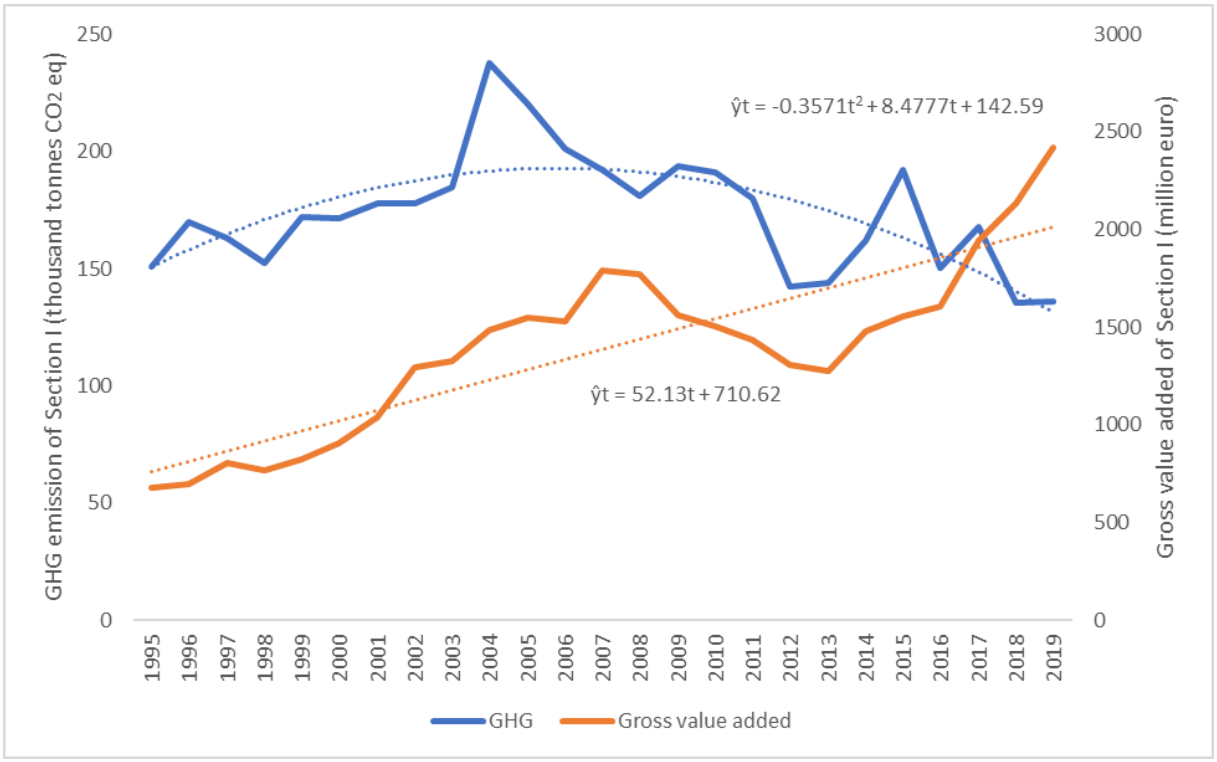


Figure 3 *Tendencies of GVA and GHG emissions of Section I in Hungary (1995-2019)*

Table 3 Decoupling elasticity indices for 3-year periods with a 1-year overlap for Section I (favourable decoupling categories are in italics)

	%ΔC	%ΔG	DI	Form of decoupling
1995–1997	0.080	0.191	0.420	*weak*
1997–1999	0.056	0.027	2.082	growth negative
1999–2001	0.032	0.254	0.125	*weak*
2001–2003	0.041	0.278	0.147	*weak*
2003–2005	0.192	0.170	1.127	growth link
2005–2007	–0.129	0.156	–0.827	*strong*
2007–2009	0.010	–0.129	–0.075	strong negative
2009–2011	–0.072	–0.081	0.893	recession connection
2011–2013	–0.199	–0.110	1.809	*recession*
2013–2015	0.331	0.219	1.512	growth negative
2015–2017	–0.126	0.247	–0.512	*strong*
2017–2019	–0.190	0.246	–0.774	*strong*

4 Discussion

Tourist activity has strategic value in the global economy. However, the tourism activities are related to increased emissions, due to the sector's energy intensity (Pablo-Romero et al., 2023). The tourism industry has become a key sector of the European economy (EEA SOER, 2015), and it is an emerging sector in the Hungarian economy, as well. Tourism is a sector that is suffering from the effects of climate change, but its GHG emissions are also an important element in generating climate change. There is an interactive relationship between the tourism industry and climate change. In order to protect the environment, the decoupling of economic performance and environmental pollution is required. In Hungary, focusing on the overall national economy, absolute decoupling can be detected during the examined period 1995–2019.

Data availability is a limitation of the calculations regarding Section I. As data of GHG emission are available only for section I (Accommodation and Food services), decoupling can be calculated from this limited part of the Tourism, nevertheless GDP data are available for the Tourism Satellite Account (TSA). In the case of Section I (Accommodation and Food services), decoupling was inconclusive and not valid for the entire period. Strong decoupling is observable at the end of the period, coinciding with the outbreak of the COVID pandemic. The biggest GHG emitter of Section I is probably energy consumption. Pablo-Romero et al. (2023) showed a positive, increasing relationship, between energy consumption and tourist arrivals for 15 countries between 2000 and 2019. These activities are heating and cooling rooms, air-conditioning, ventilation, lightning, hot water use, swimming pools and other facilities, and food preparation (EEA ETC/ULS Report, 2018). The higher rate of renewable energy consumption (e.g., photovoltaic energy) and the development of energy efficiency can help stakeholders in Section I to achieve greater decoupling of economic performance from GHG emissions. Hungary's total energy consumption has been trending downward, while electricity demand has increased. The renewable electricity generation has been growing steadily since 2013. In 2024, the amount of electricity generated from renewables exceeded that from fossil fuels for eight months (from March through October) (KSH, 2024). The carbon-intensity of the primary energy consumption is declining (Our World in Data). Total energy supply per unit of GDP (PPP) in Hungary changed by –44% in the period of 2000–2024 (IEA). Metrics of energy use are improving in Hungary, but further investigation should focus on the energy efficiency of Section I, and improvement may help stabilizing decoupling.

Chang and Lee (2026) demonstrated significant macro-level absolute decoupling for EU-27 counties: a 1% rise in international tourism receipts correlates with a 0.184% decline in aggregate CO_2 emissions in the period of 2010–2024. Xu et al. (2023) investigated the factors that affect decoupling of tourism in China and highlighted the importance of large numbers of visitors, high levels of per-person tourism spending, and low passenger traffic volume per unit of energy consumption as key positive factors. Driha et al. (2025) examined the decoupling of tourism sector across the EU states (27). The Tapio analysis revealed heterogeneous decoupling paths among member states in the period 2008–2022, with strong decoupling observed in countries such as France, Portugal, and Sweden. In Eastern Europe a weak or negative decoupling was revealed in several countries. They suggested the need for integrated mitigation strategies that combine technological innovation, spatial planning, and sustainable infrastructure development. EU Tourism Platform points out the importance of circular economy models, and sustainable food practices that can help decarbonisation of tourism, e.g. reduce of food waste and promote plant-based, locally sourced menus, investing directly in on-site emission reduction through renewable energy, efficient heating and cooling, and smart water management, upgrades to energy-efficient buildings and implementing improved waste and water systems.

5 Conclusions

Hungary achieved decoupling in the national economy, while Section I (Accommodation and food services) exhibited unstable and inconsistent decoupling. Decarbonization of Accommodation and Food service activities should be improved to achieve a continuous and stable decoupling of this sector. Further investigation would be needed to explore the driving factors of the GHG emissions.

In the case of the tourism sector, it is important to make available a targeted source of subsidies for energetic modernization, which would enable or even require the use of renewable energies and the installation and development of the necessary equipment and infrastructure. Reducing energy demand and meeting it from renewable energy sources could significantly reduce greenhouse gas emissions. Although the COVID epidemic had a significant impact on the tourism sector (and Section I as well), there are also striking changes in the preceding periods that might have significant impacts on the decoupling index. One such event might be Hungary's accession to the EU in 2004. The impact of the 2008 economic crisis is also probable for short periods, in which, although there was a fall in revenues in the Section of Accommodation and Food services, this was not accompanied by a fall in GHG emissions. In the long term, energy greening could bring about the decarbonization of the sector, which would require significant support.

The limitation of this research is that in Section I (Accommodation and food services), many externalities caused by tourism cannot be considered. Other limitation of the study is that the results show the state of art of decoupling, but the underlying reasons cannot be given exactly, and they may vary from period to period resulting in synergistic outcome.

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Literature review and data of distribution of *Taphrina* species in Northern Hungary, special the Mátra region

Adatok a Taphrina-fajokhoz és szakirodalmi áttekintésük Észak-Magyarországról, különös tekintettel a Mátravidékre

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Abstract: During our work, we reviewed the literature on the species five *Taphrina* and provided data on their distribution in northern Hungary, with focusing on the Mátra region. From all 22 data 11 data comes from oak habitats. Some of the species found cause witches' broom, while others cause leaf curling on the infected plant. After reviewing the literature, it is likely that the fungistics data reported in the enumeration for the Mátra region are new data and the first confirmed occurrence of the pathogens. It can be stated that the species described in the publication are relatively common and generally distributed, and more data is expected to appear with further field work.

Keywords: *witches' broom, hypertrophic lesion, distribution, host plant*

Összefoglalás: Munkánk során áttekintettük hat *Taphrina* faj szakirodalmát és adatokat szolgáltattunk az észak-magyarországi elterjedésükhöz, különös tekintettel a Mátravidékre. Az összes 22 adatból 11 adat tölgyes élőhelyről származik. A megtalált fajok közül van, amelyik boszorkányseprőt, valamint van, amelyik levélfodrosodást okoz a megtámadott növényen. A szakirodalom áttekintése után valószínűsíthető, hogy a Mátravidékre nézve az enumerációban közölt fungisztikai adatok új adatnak és első igazolt megjelenésnek számítanak. Megállapítható, hogy a közleményben leírt fajok viszonylag gyakoriak és általánosan elterjedtek, további terepmunkával több adat megjelenése várható.

Kulcsszavak: *boszorkányseprű, hipertrófiás elváltozás, elterjedés, gazdanövény*

1 Introduction

Taphrina species belong to the regnum *Fungi*, phylum *Ascomycota*, class Taphrinomycetes, order *Taphrinales*, family *Taphrinaceae*, genus *Taphrina* (GBIF, 2023a). A common characteristic of these pathogens is their biotrophic lifestyle, which induces morphological changes, deformations, and hypertrophy in their host plants. These fungi have not a sporocarp, a thin hymenium layer forms on the host plant, which lacks paraphyses and forms a frost-like whitish-gray coating on the plants, typically on the leaves (Bánhegyi et al., 1985). The fungus

does not penetrate the cells, does not form haustoria (Mix, 1935, Csorba, 1952), but the mycelium spreads in the passages between the cells, causing the plant cells to grow abnormally (Csorba & Berend, 1965). Common lesions are the leaf curl, witches' broom formation, pocket plum and protrusions presence on the pseudo-cones and flowers. These typically appear in spring (Bánhegyi, 1968). *Taphrina* species are distributed worldwide (Mix, 1949; http2; GBIF, 2023e), and Ubrizsy (1967) reports several species of the genus from Hungary. They are typically hosspecialists, often tied to a specific plant genus or species.

Leaf curl is a lesion when wrinkled-vesicular phenomena and distortions can be observed on the surface of the leaf and sometimes a color change can also be detected (e.g. pinkish-reddish in *T. deformans*, red in *T. crataegi*) (Moesz, 1935; Bánhegyi et al., 1985). According to Csorba and Berend (1965), the reason for the color change is the chlorophyll defect, which causes other plant pigments become visible (e.g. carotenoids, xanthophyll) at the expense of green chlorophyll.

Witches' broom is a hypertrophic growth disorder induced by the fungus, characterized by excessive branching and distortion of the shoots, resulting in a structure resembling a witches' broom (Haracsi, 1956; Bánhegyi et al., 1985). It can appear on both trees and shrubs, for example, on the hornbeam *T. carpini (C. betulus)* or the blackthorn *T. insititiae (P. spinosa)* (Győrfi, 1963).

Pocket-plum is a phenomenon when the fruit of *Prunus* species such as plums, becomes distorted. The fruit affected by the disease is elongated, flat, has a wrinkled surface, is slightly curved and does not contain seeds (Szigeti-Gyula, 1902; Moesz, 1935; Bánhegyi et al., 1985).

Also in the case of *T. alni*, the scales of the pseudocone of the *Alnus glutinosa* (L.) Gaertn. 1790 or the *Alnus incana* (L.) Moench 1794 become abnormally elongated, and tongue-like structures appear on them (Hazslinszky, 1885; Moesz, 1923; Bánhegyi et al., 1985). Such species are also *Taphrina johansonii* and *Taphrina rhizophora*, which cause tongue-like, hollow-inside lesions resembling galls on the inflorescences of aspens, from which their name also arises: aspen tongue (Mix, 1949; Rodrigues & Fonseca, 2003).

The aim of our work is to present the *Taphrina* species specific of the Mátra region and to provide data on the distribution of the species.

1.2 Description and literature review of the species found during our work

***Taphrina carpini* (Rostr.) Johanson 1886**

Microscopic characters of the species are the unstemed, cylindrical asci, 20–30 × 7–14 μ, wider at the bottom, 20–24 μ, hyaline, containing 8 oval or round ascospores measuring 2.5–3.5 × 2–3 μ (Mix, 1949; Bánhegyi et al., 1985; Bacigálová, 1992). Its macroscopic recognition is ensured by its characteristic witches' broom formation (Figure 1), as well as the host, which is always hornbeam *(C. betulus)* or oriental hornbeam *(C. orientalis)* (Mix, 1949; Bacigálová, 1992), although data on oriental hornbeam have not yet been reported from our country. Witches' broom is a formation consisting of distorted and very densely growing shoots (Ubrizsy, 1953), resembling bird's nests in winter, without leaves. The leaves on diseased shoots are smaller, light green, wavy, and during spring the hoar like grayish coating of the fungus is visible (Ubrizsy, 1953), and the leaves dry out sooner than the healthy leaves on the foliage (own observation). It can be up to 1 meter wide (Ubrizsy, 1953). It does not cause significant damage to the tree (Ubrizsy, 1953; Haracsi, 1956). According to Csorba (1952) it is quite common, according to Bánhegyi et al. (1985) it is rare in Hungary. According to Kibby (2018), the fungus is more common than we think, but it is rarely reported because most of the nature enthusiast and professional forest walkers do not assume that the phenomenon is caused by a

fungus. Based on Kibby's (2018) observations, the occurrence of the fungus was more common where the trees grew in shady and humid places. According to Reid (1969), it is also rare in Great Britain.

Synonymous or formerly used names: *Ascomyces trientalis var. carpini* (Rostr.) Quél. 1886, *Exoascus carpini* Rostr. 1881, *Lalaria carpini* Á. Fonseca, J. Inácio & M. G. Rodrigues, 2004 (GBIF 2023b, Mycobank).



Figure 1 *Witches' broom on a hornbeam (C. betulus)*

Taphrina cerasi (Fuckel) Sadeb. 1980

It lives on *Cerasus avium* (L.) Moench 1794, *Prunus cerasus* L. 1753, *Prunus padus* L. 1753, *Prunus fruticosa* Pall. 1784 and *Prunus serotina* Ehrh. 1788 species, where it causes witches' brooms up to 3 m in diameter (Figure 2) (except for *P. padus*, which is only 0.5 m), which are almost spherical in shape (Bánhegyi et al., 1985). Its occurrence is scattered, and its damage to plantations is more frequent during rainy weather (Schweigert & Makó, 2003).

The ascus is knobstick-shaped or cylindrical, hyaline, 17–53 × 5–15 µ in size, the ascospores contained within are 6–9 µ in size. It is more likely to appear in trees growing on lime-deficient soils (Csorba & Berend, 1965). The leaves of witches' broom are smaller, light green, even slightly reddish, and have a hoar like coating on the backside (Csorba, 1952). It is interesting that the leaves have a hay-like coumarin odor (Csorba & Berend, 1953).

Synonymous and formerly used names: *Exoascus wiesneri* Ráthay, 1880, *Taphrina wiesneri* (Ráthay) Mix, 1954, *Exoascus cerasi* Fuckel 1870 (GBIF. 2023f, Mycobank).

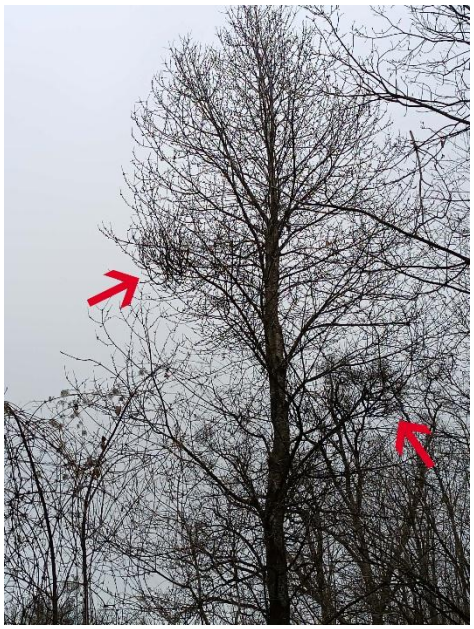


Figure 2 *Witches' broom on a wild cherry (C. avium)*

Taphrina crataegi Sadeb. 1890

It lives on *Crataegus monogyna* Jacq. 1775 and *Crataegus laevigata* (Poir.) DC. 1825 species, causing significant changes mainly on their leaves, which are manifested in red bumps and leaf curl (Figure 3). The leaf blade thickens in places, with a whitish-grey hoar coating visible (Csorba & Berend, 1965). In rare instances, it may appear on flowers or cause upward-facing witches' broom formation of shoots (Csorba & Berend, 1965; Bánhegyi et al., 1985). The red bumps on the leaves are similar to the galls caused by *Dysaphis crataegi* Kaltenbach, 1843 (Hawthorn-carrot aphid) (http1), but they do not have a white-grey fungal coating, and in this case the fungus is not visible in the microscopic specimen. Its microscopic recognition are the cylindrical-conical asci measuring 25–36 × 8–15 µ, and the colorless, spherical spores measuring 4–6.5 µ (Csorba & Berend, 1965; Bánhegyi et al., 1985). According to Bánhegyi et al. (1985) it is not frequent.

Synonymous and formerly used names: *Exoascus crataegi* (Sadeb.) Sadeb 1892, *Exoascus marginatus* Lambotte & Fautrey, 1893, *Taphrina marginata* Lambotte & Fautrey, 1895 (GBIF 2023c, Mycobank).



Figure 3 *Leaf curl on C. monogyna leaves*

***Taphrina deformans* (Berk.) Tul. 1866**

According to several sources, it is the most significant fungal pathogen of peach (*Prunus persica* (L.) Batsch, 1801), and can also occur on almond (*Prunus dulcis* (Mill.) D. A. Webb, 1967), which is the closest relative of peach (Alioto et al., 2020). The most visible symptoms are observed on the leaves, the leaf blade thickens and it becomes wavy and bumpy, and its color becomes yellowish-green, yellowish-brown or reddish-pink. In addition, the shoot may be affected, which becomes curved, the fruit may become bulging, and even the flower, in which the petals, stamens and the seed coat may thicken (Laubert, 1928 in Csorba & Berend, 1965). In all cases, a grayish-white hoar like fungal coating can be detected on the plant parts (Csorba, 1952, Glits, 2000). The ascus is cylindrical-ovate, hyaline, widening at the apex, 17–56 × 7–15 µ in size, containing 8, rarely 4 ascospores with a diameter of 3–7 µ, which can emerge (Csorba, 1952; Csorba & Berend, 1965; Bánhegyi et al., 1985). It infects at low temperatures, 4–14 °C, and it prefers rainy, foggy weather (Glits, 2000). The disease can be controlled using copper-containing fungicides (Csorba, 1952; Bánhegyi, 1968). Multiple infections can weaken trees to the point they necrose. Different peach varieties are not equally susceptible to diseases (Gyökös et al., 2015). It is widespread, occures almost everywhere where peaches are cultivated (Csorba & Berend, 1965; Bánhegyi et al., 1985).

Synonymous or formerly used names: *Ascomyces deformans* Berk. 1857, *Ascosporium deformans* (Berk.) Berk. 1860, *Exoascus amygdali* Jacz. 1926, *Exoascus deformans* (Berk.) Fuckel 1870, *Lalaria deformans* R.T. Moore 1990, *Taphrina amygdali* (Jacz.) 1936 (GBIF 2023d, Mycobank).



Figure 4 *Leaf curl of P. persica*

***Taphrina insititiae* (Sadeb.) Johanson 1886**

It occurs most often on Prunus domestica L. 1753 (Fig. 8), *Prunus insititia* Fr. ex M. Roem. 1847 and *Prunus spinosa* L. 1753 (Gombocz, 1925; Gulyás, 1936; Ubrányi 1936), but Csorba & Berend, 1965 also describes it on *Prunus pennsylvanica* Sarg. 1892. On these hosts, it produces an upward-curving witches's broom consisting of many buds (Figure 4), which can be up to 1.5 meters wide (Ubrányi, 1936; Bánhegyi et al., 1985). The leaves are curled and wavy, their undersides often have a gray hoar like coating typical of *Taprhina* species, and they

often fall off earlier than healthy ones (Csorba & Berend, 1965). The witches's broom is not developing any fruits, the shoots are infertile, containing only leaf buds (Schilberszky, 1908; Csorba, 1952). This is especially noticeable during spring (Figures 5, 6), in April, when the blackthorn is in blooming and the formations that are devoid of flowers and just bearing green leaves are visible. The asci are hyaline, knobstick-shaped, cylindrical, rounded or slightly pointed at the top, measuring 17–33 × 5–10 µ, containing round spores measuring 3–5 µ. Previously, it was often considered synonymous with the species *Taprhina pruni* (Fuckel) Tul. 1866 (Mix, 1949), but genetic studies confirme that it represents a distinct species (Petrydesová, 2013). In Hungary, it is mentioned by Hazslinszky (1885) and Moesz (1942) from Budapest, and according to Bánhegyi et al. (1985) it is rare in the country.

Synonymous or formerly used names: *Exoascus insititiae* Sadeb., 1883 (GBIF 2023f, Mycobank).



Figure 5 *Witches' broom on P. spinosa*



Figure 6 *Witches' brooms can be easily observed in spring, on flowering P. spinosa before the leaves emerge*

2 Materials and Methods

The datas of the species presented in our work were collected during field work between 2019–2026. The samples were taken from the diseased plant we found and identified it using a Bresser Researcher Bino light microscope based on the identification of Bánhegyi et al. (1985). The identification of the host plants was based on the work of Gencsi and Vancsura (1992). All data shown are collected by the authors. The results provide the collection of location, time, host, and habitat type or vegetation of the detected species. The detected species and their data are summarized in Tables 1, 2, 3, 4, 5, 6.

3 Results, enumeration

Table 1 The found habitats of Taphrina carpini, date of collecting, the host and vegetation or habitat

Location of habitats	Date of collection	Host	Habitat or vegetation
Mátraháza, near road 24	05. 04. 2025.	*C. betulus*	oak-hornbeam-beach forest
Mátraháza, Nagy-Hidas Brook valley	06.25.2023.	*C. betulus*	oak forest
Gyöngyösoroszi-Károlytáró	10. 04. 2023.	*C. betulus*	oak-hornbeam forest
Gyöngyössolymos, Nagy Bükk	04.20.2023.	*C. betulus*	oak-hornbeam forest
Parádsasvár, Köszörű Brook valley	04.17.2023.	*C. betulus*	oak-hornbeam-beach forest
Mátraszentlászló, side of Ágasvár	06.21.2025.	*C. betulus*	oak-hornbeam forest
Mátraszentlászló, Büdös-lápa saddle	06.21.2025.	*C. betulus*	oak-hornbeam forest
Mátraszentimre, at the end of Deák Ferenc St.	07.06.2025.	*C. betulus*	Village
Mátraszentimre, side of Nagy-nyak	07.06.2025.	*C. betulus*	oak-hornbeam forest

Table 2 The found habitats of Taphrina cerasi, date of collecting, the host and vegetation or habitat

Location of habitats	Date of collection	Host	Habitat or vegetation
Mátraháza, near the training camp	26. 03. 2026.	*C. avium*	oak-hornbeam forest with wild cherry

Table 3 The found habitats of Taphrina crataegi, date of collecting, the host and vegetation or habitat

Location of habitats	Date of collection	Host	Habitat or vegetation
Verpelét, Várhegy	20. 04. 2025.	*C. monogyna*	Dry-semidry pioneer scrub with blackthorn and hawthorn

Table 4 The found habitats of Taphrina deformans, date of collecting, the host and vegetation or habitat

Location of habitats	Date of collection	Host	Habitat or vegetation
Gyöngyös, near the Toka-brook	10. 05. 2019.	*P. persica*	Garden
Kisnána, Béke Street	20. 04. 2025.	*P. persica*	Garden

Table 5 The found habitats of Taphrina insititiae, date of collecting, the host and vegetation or habitat

Location of habitats	Date of collection	Host	Habitat or vegetation
Gyöngyöspata near road 2406	26. 02. 2025.	*P. spinosa*	Dry-semidry pioneer scrub with blackthorn and hawthorn
Pálosvörösmart, Benehát szíjja parcel	12. 03. 2025.	*P. spinosa*	Intensive wineyards shrubby with blackthorn
Tar, before Villástelep	14. 04. 2025.	*P. spinosa*	Dry-semidry pioneer scrub with blackthorn
Pásztó, Gépállomás housing estate, bus stop	14. 04. 2025.	*P. spinosa*	Dry-semidry pioneer scrub with blackthorn
Novaj, between Ostoros-brook and Novaj-brook	17. 04. 2025.	*P. spinosa*	Dry-semidry pioneer scrub with blackthorn
Verpelét, Várhegy	20. 04. 2025.	*P. spinosa*	Dry-semidry pioneer scrub with blackthorn and hawthorn
Salgótarján-Salgópuszta	19. 05. 2025.	*P. spinosa*	oak-hornbeam forest
Parádfürdő, Ilona-valley	03. 04. 2026	*P. domestica*	Farm near the oak forest

Location of habitats	Date of collection	Host	Habitat or vegetation
Gyöngyös-Sástó, tourist rest area	05.04.2025.	*P. spinosa*	Dry-semidry pioneer scrub with blackthorn and hawthorn of a recreation area near the Sástó



Figure 8 *Numerous witches' broom on plum*

4 Discussion

In conclusion, it can be said that *Taphrina* species are widespread in the studied areas of Hungary (Mátra region and its surroundings), and it is likely that more data will be obtained in the future during more field work. Based on Kibby's work, which states that the fungi registration system of Great Britain and Ireland contained only 40 records of the species *T. carpini* in 2018. This is similar in Hungary, there are only a few described data, but the fungi may be much more common than previously reported in the literature. This may be because these fungi are less of a focus for mycologists and even less data are published. Their forestry-economic importance is negligible (except for T. deformans, which is a significant pathogen), but from an ecological point of view they can be viewed positively in terms of biodiversity.

Each such hypertrophic lesion also creates a useful microhabitat for the microbiome, which has already been demonstrated in beech trees (goiter, witches' broom) (Frank & Aszalós, 2024). In Hungary, the only *Taphrina* species that specifically lives on oaks is *Taphrina caerulescens* (Desm. & Mont.) Tul. 1866 (Bánhegyi et al., 1985), which causes oak leaf blister (Birdwell, 1996), and we did not find it during our work. No species causing witches' broom has yet been found on oaks in our country. Witches' broom is caused by *Taphrina kruchii* (Vuill.) Sacc. 1892, mainly on *Quercus ilex* L., 1753 species in its distribution area, in the Mediterranean region (Spooner, 2007). However, we have managed to detect data of five species 11 from oak habitats, thus proving that *Taphrina* species are characteristic elements of the oak ecosystem of the Mátra region.

In this work, we report 22 data of five species on seven host plant, which contribute to the knowledge of the fungi of Northern Hungary and to the understanding of the distribution and

host plants of the species. Considering that, most likely only one *Taphrina* species, *Taphrina pruni* (Fuckel) Tul. 1866, has been reported yet from the Mátra region (Hódosi, 1965), the number of species recorded of the genus increases to six of the mesoregion.

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The French SAFER Model and Hungarian Land Governance: A Comparative Assessment from the Perspective of Rural Sustainability

A francia SAFER-modell és a magyar földforgalmi szabályozás összehasonlító értékelése a vidéki fenntarthatóság szempontjából

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Abstract: Land is a limited and multifunctional production factor, while land policy determines who may gain access to it, under what conditions, and for which rural development purposes. This paper compares the French SAFER model with Hungarian land governance from the perspective of the economic, social and environmental pillars of rural sustainability. The analysis is based on a qualitative comparison of legal instruments, official institutional documents, CAP Strategic Plan materials, Eurostat data and international land tenure guidelines. The French model is characterised by a specialised land agency network, systematic market information, pre-emption powers, public-interest allocation and post-sale commitments. The Hungarian system relies more strongly on statutory acquisition limits, pre-emption order, administrative approval and local land-commission type control. The findings indicate that both systems aim to protect agricultural land and family farming, but they differ in institutional capacity, transparency mechanisms and direct steering of land allocation. The SAFER experience suggests that land governance can support generational renewal and environmental objectives when market monitoring, public-interest selection criteria and long-term land-use commitments operate together.

Keywords: *land policy, SAFER, land governance, generational renewal, rural sustainability, Hungary, France*

Összefoglalás: A föld korlátozott és többfunkciós termelési tényező, a birtokpolitika pedig alapvetően meghatározza, hogy ki, milyen feltételekkel és milyen vidékfejlesztési célok érdekében juthat földhöz. A tanulmány a francia SAFER-modellt és a magyar földforgalmi szabályozást hasonlítja össze a vidéki fenntarthatóság gazdasági, társadalmi és környezeti pillérei szerint. A vizsgálat jogszabályok, hivatalos intézményi dokumentumok, KAP Stratégiai Tervek, Eurostat-adatok és nemzetközi földhasználati irányelvek kvalitatív elemzésén alapul. A francia modellt specializált földintézményi hálózat, rendszeres földpiaci információs rendszer, elővásárlási jog, közcélú földjuttatás és utólagos vállalások jellemzik. A magyar rendszer inkább a szerzési korlátokra, az elővásárlási sorrendre, a hatósági jóváhagyásra és a helyi kontrollra épül. Az eredmények szerint mindkét rendszer a termőföld védelmét és a családi gazdálkodás erősítését célozza, ugyanakkor eltérnek az intézményi kapacitás, az átláthatóság és a földallokáció aktív irányítása tekintetében.

Kulcsszavak: *birtokpolitika, SAFER, földkormányzás, generációváltás, vidéki fenntarthatóság, Magyarország, Franciaország*

1 Introduction

Land policy is not a narrow property-law question. In agriculture, land is simultaneously a production factor, a territorial resource, a landscape element, a basis of rural identity and a precondition for ecological services. The governance of land markets therefore affects the three classical pillars of sustainability: economic viability, social cohesion and environmental protection. Secure and equitable access to land is also emphasised in the FAO Voluntary Guidelines on the Responsible Governance of Tenure, which link tenure governance to food security, poverty reduction and sustainable development (FAO, 2022).

The issue has become particularly important in Europe because land access is increasingly connected with demographic renewal. The European Commission notes that farmers under the age of 40 manage only a small minority of EU farms, while the average age of farmers remains high; this makes generational renewal a structural policy challenge rather than only a financial-support issue (European Commission, 2025a). The 2023–2027 CAP Strategic Plans recognise this challenge through young farmer income support, start-up support and rural development interventions (European Parliament and Council, 2021; European Commission, 2025b; 2026a).

At the same time, farm structures are changing. Eurostat data show that the number of farms in the EU has continued to decline while the total area used for agricultural production has changed only moderately, which indicates ongoing land consolidation (Eurostat, 2026a). This trend can strengthen efficiency, but it may also reduce the number of entry points for young farmers and smaller local producers. The central policy question is therefore not whether land markets should function, but how market transactions can be embedded in public-interest safeguards.

France and Hungary provide a useful comparison. France operates the SAFER system, a territorially organised network of land agencies with information, acquisition, pre-emption and allocation functions. Hungary regulates farmland through detailed statutory acquisition rules, pre-emption rights, administrative approval and local community control under the Act CXXII of 2013 on agricultural and forestry land transactions (Nemzeti Jogszabálytár, 2026). The aim of this paper is to assess how these two models contribute to rural sustainability and to identify transferable lessons for Hungarian land governance.

2 Materials and Methods

The study applies a qualitative comparative institutional method. The two cases were selected because both countries are EU Member States operating within the same CAP framework, but their land-policy instruments are institutionally different. The French case represents a specialised land-agency model, while the Hungarian case represents a statutory land-market control model. The comparison focuses on instruments that influence farmland access, land-market transparency, generational renewal and long-term land use.

The documentary basis consists of official legal and policy sources: the French Code rural et de la peche maritime, the Hungarian Act CXXII of 2013, SAFER official material and activity reports, CAP Strategic Plan documents, Eurostat agricultural structure statistics, FAO tenure guidelines and OECD land-use policy reports. These sources were assessed according to four analytical dimensions: (1) institutional design, (2) market intervention tools, (3) social effects with special attention to young farmers, and (4) environmental and territorial sustainability effects.

The paper does not measure causal impacts statistically. Instead, it develops an evaluative framework that can be used as a basis for later empirical research. This is appropriate because land governance systems differ not only in legal text but also in administrative practice, information flows, stakeholder participation and enforcement capacity.

3 The French SAFER model

The Sociétés d'aménagement foncier et d'établissement rural (SAFER) were created to steer rural land transfers in line with public-interest objectives. The Code rural defines SAFER missions broadly: they contribute to the protection of agricultural, natural and forest areas; support the installation, maintenance and consolidation of viable agricultural holdings; contribute to landscape diversity, natural-resource protection and biodiversity; support sustainable rural development; and ensure transparency in the rural land market (Légifrance, 2026a).

The model combines market observation with intervention capacity. SAFER bodies receive information on intended rural land sales, which makes them an institutional observatory of land-market movements. Their pre-emption right allows them, under legal conditions, to purchase before the initially selected buyer and then reallocate the land to another candidate whose project better fits local planning, agricultural or environmental objectives (SAFER, 2026a; Légifrance, 2026b). This does not mean that every transaction is interrupted, but it means that the market operates under a public-interest review mechanism.

SAFER allocations are not only sales. They may involve temporary holding, resale, substitution mechanisms, leasing support and cooperation with local authorities. The selected acquirer undertakes commitments through a cahier des charges, which can preserve the agricultural or natural vocation of the property and restrict later transfer for a defined period. According to the national 2024 activity synthesis, the SAFER network organised 14,340 sales covering 96,900 ha and a value of EUR 1.859 billion, and 1,088 departmental technical committees were held in 2024 (FNSafer, 2025a). These figures indicate that SAFER is not a marginal advisory body, but a land-governance infrastructure.

The French model is especially relevant for generational renewal because land allocation can be connected directly with installation projects. Where a young farmer has a viable business plan but lacks access to land, SAFER can use information, mediation, temporary holding or acquisition instruments to connect land supply with entrant demand. This is a qualitative advantage compared with systems that provide grants but leave the applicant to compete in the open land market. The model also supports environmental goals when allocation criteria give weight to organic farming, parcel restructuring, water protection, landscape management or biodiversity-related objectives.

The model is not without limitations. Because SAFER decisions affect private transactions, legitimacy depends on transparent criteria, balanced representation in technical committees and effective appeal possibilities. Local conflicts can occur when several candidates present credible projects or when established farms and new entrants compete for the same land. For this reason, the institutional lesson is not only that a land agency should have strong powers, but also that those powers must be embedded in procedural safeguards, published reasoning and measurable follow-up of commitments.

4 Hungarian land governance

Hungarian land governance after 2013 is based on the protection of agricultural land, the priority of farmers, acquisition limits and administrative approval. Act CXXII of 2013 regulates the acquisition of ownership of agricultural and forestry land, the establishment of usufruct, land use, control of acquisition restrictions and the operation of local land committees (Nemzeti Jogszabálytár, 2026). The law reflects several objectives: preventing speculative acquisition, supporting local agricultural producers, limiting excessive concentration and maintaining land for agricultural use.

The Hungarian system uses pre-emption rights, but their logic differs from the French SAFER model. Instead of a specialised land agency selecting among projects and reallocating

land, the Hungarian framework mainly defines priority categories of eligible buyers. The sale contract is subject to administrative review and publication so that pre-emption right holders may step in. This protects certain categories of local and agricultural actors, but it is less project-based than SAFER allocation. In practice, the effectiveness of the system depends on the clarity of priority rules, the quality of administrative review, the functioning of local opinions and the accessibility of information for potential entrants.

Generational renewal is addressed mainly through CAP and national support schemes rather than through a land agency. Hungary's CAP Strategic Plan includes young farmer income support, start-up support and rural development interventions, together with climate and environmental measures (KAP, 2026; European Commission, 2025b). These instruments can improve the financial position of young entrants, but the land-access problem remains if land is scarce, expensive, fragmented or tied up in long-term use relations.

Hungary also has a specific structural context. Agricultural census materials show that Hungarian agriculture combines many small holdings with a considerable area operated by larger farms, and the utilised agricultural area remains a key national resource (KSH, 2020; FAO, 2023a). This dual structure makes land policy sensitive: overly rigid rules can reduce mobility, while overly liberal rules can accelerate concentration. A balanced system has to support viable family farms, allow efficient farm development and reserve real opportunities for new entrants.

A further issue is that land policy and farm-transfer policy are often treated separately. A young farmer may satisfy professional criteria and may receive CAP support, yet still face high land prices, weak information about available land, or competition from farms that already have stronger capital positions. In such cases, the formal priority order alone may not create a functioning pathway into farming. Hungarian land governance would therefore benefit from closer coordination between land transactions, farm succession advisory services, credit instruments and rural development calls.

5 Comparative assessment

The comparison shows that the two systems are built on different governance philosophies. France uses a delegated public-interest land agency with operational tools, while Hungary relies on legal eligibility rules and administrative approval. Both systems restrict a purely liberal land market, but they do so through different instruments and therefore create different sustainability effects.

Table 1 Comparative elements of the French SAFER model and Hungarian land governance

Analytical dimension	France - SAFER model	Hungary - land governance	Sustainability relevance
Institutional design	Specialised land-agency network under state supervision; local technical committees and market observatory role.	Statutory regulation, administrative approval, pre-emption hierarchy and local land-committee type involvement.	Determines transparency, steering capacity and accountability.
Market intervention	Information on sales, pre-emption, temporary holding, resale and project-based allocation.	Eligibility rules, ownership and use limits, publication of contracts and exercise of pre-emption by priority holders.	Shapes who can enter the land market and at what speed.
Young farmers	Direct link between land allocation and installation projects; possibility of	Financial support through CAP and national schemes; land access	Important for social sustainability and rural renewal.

Analytical dimension	France - SAFER model	Hungary - land governance	Sustainability relevance
	prioritising viable entrants.	mediated mainly by legal priority and market availability.	
Environmental goals	Allocation criteria and post-sale commitments can protect agricultural, natural and forest vocation of land.	Environmental goals mainly linked to CAP conditionality, eco-schemes and land-use rules.	Affects soil, water, biodiversity and landscape functions.
Main risk	Discretion, local conflicts and possible pressure from established interests if transparency is weak.	Formalism, administrative complexity and limited project-based steering of land transfers.	Risks must be managed to maintain legitimacy.

Economically, the SAFER model can reduce information asymmetry and help match land with economically viable projects. Its strength lies in connecting market monitoring with active allocation. Hungary's strength is legal predictability: parties can identify statutory categories and acquisition limits. However, predictability does not automatically guarantee that the best long-term rural project receives land. A more project-sensitive review could improve the economic pillar without abandoning legal safeguards.

Socially, the decisive issue is access for young and new farmers. Financial support is necessary but insufficient when suitable land is unavailable. France's system creates an institutional channel through which land can be directed to installation projects. Hungary has several support instruments, but the land-access channel remains more fragmented. This matters for village population retention, local employment, farm succession and the renewal of agricultural knowledge.

Environmentally, both systems recognise that land has public-good functions. The difference is operational. In France, environmental objectives may be built into the land-allocation decision and into commitments attached to the transfer. In Hungary, environmental sustainability is more strongly linked to CAP conditionality, agri-environmental payments, eco-schemes and general land-use rules. A stronger connection between land-transfer approval and environmental land-use commitments could make Hungarian land governance more integrated.

The question of transparency is also different. SAFER transparency is based on institutional information flows from notaries and on the publication of opportunities and decisions within the agency system. Hungarian transparency is based mainly on contract publication and administrative procedure. The first model gives more analytical capacity to the institution; the second gives more legal certainty to the actors. A sustainable land policy should combine both: strong procedural rights for parties and a public database capable of detecting concentration, price pressure and land-use change.

The comparative lesson can be summarised as a shift from person-based priority to project-based sustainability. Person-based priority remains important because local farmers and young farmers need legal protection. However, sustainable rural development also requires asking what the land will be used for, whether the proposed project is viable, whether it contributes to local employment, and whether it protects soil, water and biodiversity. This project-based element is where the French experience offers the most relevant inspiration.

6 Effects on the pillars of rural sustainability

The economic pillar concerns viable farm structures, efficient parcel use, investment security and competitiveness. A well-designed land policy should avoid both excessive fragmentation and excessive concentration. The OECD argues that sustainable land use requires the alignment

of planning, fiscal, environmental and sectoral policies (OECD, 2017; 2020). SAFER contributes to this alignment by making land transactions visible and by allowing public-interest steering before land is locked into a new ownership structure. Hungary contributes through restrictions that aim to keep land in the hands of farmers, but the system could benefit from stronger ex ante evaluation of the economic viability and territorial value of proposed acquisitions.

The social pillar is linked to generational renewal, rural demographic stability and community trust. The European Commission's strategy for generational renewal emphasises that young people need the right conditions to build careers and lives in rural areas (European Commission, 2025a). Land access is one of these conditions. A support scheme that gives money without land may help only those who already have family assets or favourable networks. SAFER demonstrates that a land-policy institution can reduce this barrier by mediating between retiring farmers, landowners, local authorities and new entrants.

The environmental pillar relates to soil protection, water management, biodiversity, landscape continuity and climate adaptation. Agricultural land markets tend to price private productive value more easily than public ecological value. For this reason, land governance needs instruments that can incorporate ecological criteria into transactions. In the French model, the public-interest missions of SAFER include natural-resource protection, biodiversity and sustainable rural development. In Hungary, similar objectives appear in policy documents and CAP interventions, but the legal land-transfer process itself is less explicitly designed as an environmental allocation instrument.

A key lesson is that the three pillars should not be treated separately. A young farmer who gains access to an economically viable holding and accepts environmental commitments contributes to all three pillars at once. Conversely, a land transfer that is legally valid but increases concentration, reduces local employment and ignores landscape functions may weaken sustainability even if it respects formal ownership rules.

7 Policy implications for Hungary

The French model cannot be copied mechanically. Hungary has different historical land relations, constitutional sensitivities, administrative traditions and farm structures. Nevertheless, several elements are transferable at the level of policy design. The first is stronger land-market transparency. A more accessible, regularly updated and territorially detailed land-market observatory would help policymakers, municipalities and young farmers understand where land is moving and which areas are under concentration or speculation pressure.

The second transferable element is project-based evaluation. Hungarian pre-emption rules already prioritise certain persons, but a complementary assessment of the proposed land-use project could improve the link between land transfers and rural sustainability. Such assessment should be transparent, rule-based and appealable, so that it does not become arbitrary. It could give weight to first installation, farm succession, organic or low-input production, parcel rationalisation, soil and water protection, and contribution to local employment.

The third element is temporary land holding or land banking for young farmers and succession cases. Many young farmers cannot purchase land immediately when it becomes available, while retiring farmers may need a reliable transition mechanism. A public or mixed land-bank instrument, operating with strict transparency and limited holding periods, could bridge this timing problem. The experience of SAFER shows that land policy can mediate between private transactions and public territorial goals.

The fourth implication is the use of post-transfer commitments. If public policy gives a buyer priority because of a sustainability-oriented project, the buyer should maintain that project for a defined period. This could include maintaining agricultural use, respecting environmental

commitments, avoiding quick resale and cooperating with local landscape or water-management objectives. Such commitments would strengthen legitimacy because public preference would be tied to measurable public benefit.

Table 2 Possible SAFER-inspired instruments for Hungarian land governance

Instrument	Expected benefit	Safeguard needed	Priority link to sustainability
Land-market observatory	Earlier detection of land concentration, price pressure and regional entry barriers.	Open methodology, data protection and regular public reporting.	Economic and social
Young-farmer land bank	Bridges the time gap between land availability and the financial capacity of entrants.	Limited holding period, transparent calls and independent review.	Social and economic
Project-based preference	Links priority to concrete farm, employment and land-use commitments.	Clear scoring criteria and appealable decisions.	All three pillars
Post-transfer commitments	Ensures that public preference produces lasting public benefit.	Monitoring, proportional sanctions and legal clarity.	Environmental and social
Succession mediation	Connects retiring farmers, successors and new entrants before land is sold elsewhere.	Voluntary participation and professional advisory support.	Social

An adaptation pathway should proceed in stages. The first stage would be diagnostic: create a national and regional land-market observatory using existing land registry, contract and agricultural administration data. The second stage would be experimental: pilot a young-farmer land bank in selected counties where generational renewal problems and land concentration pressures are strong. The third stage would be regulatory: introduce transparent project-based criteria into the evaluation of selected land transactions without replacing the existing legal priority order.

The proposed approach should also protect legal certainty. A common criticism of active land policy is that it may create discretion and political conflict. This risk can be reduced if the decision criteria are published, if all candidates receive written reasons, if decisions are open to review, and if the same scoring system is used across comparable cases. In other words, stronger public-interest steering should be balanced by stronger procedural transparency.

Finally, a Hungarian adaptation should be connected to CAP measures. Young farmer start-up grants, investment support, advisory services and agri-environmental commitments could be coordinated with land-access instruments. Such coordination would make public spending more effective: instead of supporting an entrant after land has already been secured, the system could help create the land-access opportunity itself.

7.1 Implementation risks and safeguards

Any strengthening of land-market steering has to confront three risks. The first is administrative overload. If every transaction were subject to a complex sustainability assessment, the system would become slow and unpredictable. A proportional approach is therefore necessary. Project-based evaluation should focus on transactions above a certain area, on strategically important parcels, on land offered with public support, or on cases where several priority holders compete.

The second risk is unequal access to information. Young farmers and new entrants often do not have the same legal, financial and local-network resources as established farms. A SAFER-inspired Hungarian system should therefore include advisory support before the transaction, not

only control after the contract has already been signed. Municipalities, chambers, advisory services and agricultural education institutions could help identify potential successors and entrants before farms leave production or are absorbed by neighbouring holdings.

The third risk is weak enforcement of commitments. If a buyer receives priority because of a young-farmer, environmental or local-employment project, the commitment must be verifiable. Monitoring should not be excessive, but it should include simple indicators such as continued agricultural use, implementation of the submitted business plan, participation in environmental measures where promised, and compliance with resale restrictions. Without monitoring, public-interest allocation becomes symbolic.

A further safeguard is territorial differentiation. Hungary's regions face different land-market problems. In some areas the key issue is fragmentation and abandonment; in others it is concentration, high prices or competition between agricultural and non-agricultural uses. A uniform national tool may therefore be less effective than a common legal framework combined with county-level implementation plans. The French experience is instructive because SAFER operates nationally but evaluates cases through territorial structures.

Finally, land policy should be communicated as a sustainability instrument rather than as a restriction on property rights alone. Farmers and landowners are more likely to accept intervention when they see clear public benefits: viable successors, preserved agricultural landscapes, improved water protection, and stronger local food systems. This communication aspect is important because land governance depends not only on rules but also on trust in the institutions applying them.

8 Conclusions

The comparison confirms that land policy is a core instrument of rural sustainability. The French SAFER model and the Hungarian land governance system share common aims: protecting agricultural land, supporting farmers and limiting undesirable land-market outcomes. Their main difference lies in the mode of governance. SAFER operates as an active institutional intermediary that can observe, acquire, reallocate and attach commitments to land. Hungary operates mainly through legal restrictions, pre-emption categories and administrative approval.

From the perspective of the sustainability pillars, the SAFER model is stronger in connecting land access with generational renewal and territorial projects. The Hungarian model is stronger in formal legal restriction and national protection of farmland ownership, but weaker in project-based allocation and integrated environmental steering. Therefore, the most useful lesson for Hungary is not to establish a direct copy of SAFER, but to strengthen those functions that the SAFER system performs well: transparency, mediation, young-farmer land access, temporary land holding and enforceable public-interest commitments.

Future research should test these conclusions empirically through regional land-market data, interviews with young farmers, analysis of administrative decisions and case studies of successful and unsuccessful farm transfers. Such evidence would help determine which institutional improvements could support a more sustainable, transparent and generation-sensitive Hungarian land policy.

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