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LAND CONSOLIDATION TO PROVIDE AGRICULTURAL LAND FOR LARGE PUBLIC PROJECTS – THE EXAMPLE OF GERMANY AND ITS USE FOR THE UKRAINE

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ABSTRACT

Motives: New infrastructure and settlement areas required for the development of a state regularly reduce the amount of agricultural land available. However, the latter is needed to produce food and biomass. If military activities take place on the territory of a country such as Ukraine, agricultural land will inevitably be damaged in the medium to long term so that it cannot be used for agricultural purposes or only to a minimal extent. Such land use must be carried out with the least possible negative impact on the agricultural structure, and any resulting disadvantages must be compensated for as much as possible.
Aim: This article presents "Unternehmensflurbereinigung," a land consolidation instrument successfully used in Germany for decades, and analyzes its potential applicability in Ukraine for infrastructure development and mitigating war-related damage.
Results: This article shows which methodological approaches can be used to make land available for such large public projects as repairing war damage. It also develops the requirements and possible solutions for implementing the instrument in practice.

Keywords: agricultural land, compensation, expropriation, land consolidation, public projects, "Unternehmensflurbereinigung"

INTRODUCTION

Every state requires sufficient agricultural land to ensure the food security of its society. The crises of recent years have shown how vulnerable a society is when its supply of products depends on global supply chains. At the same time, agricultural land is being used for a wide range of non-agricultural purposes. This includes restrictions on the use of agricultural land, e.g., for landscape protection purposes, as well as the use of land for renewable energy production, e.g., to produce biomass or as a location for windmills. Another major use of agricultural land is for large infrastructure projects, starting with areas for transport infrastructure (e.g., motorways) and extending to large-scale settlement developments (e.g., for new

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public facilities, e.g., university or clinic locations, or residential and commercial areas); both are summarized below under the term large public projects.

If such utilization of agricultural land cannot be avoided, then it must at least be efficient, i.e., with the smallest land requirement and the least negative impact on the surrounding agricultural land.

In this respect, suitable instruments are needed to ensure that land is provided for a project and that possible negative impacts can be avoided.

A comprehensive instrument is necessary to plan and coordinate the rebuilding of Ukrainian agriculture and the sustainable development of rural areas to achieve these goals. One such well-proven tool is land consolidation, which has been successfully implemented in many countries, including Germany, for several decades. In Germany, for example, land consolidation has been used to rebuild war-torn settlements, safeguard rural agriculture, and provide land for re-naturalizing water bodies or nature and water conservation efforts. Since there is no land consolidation in Ukraine, the purpose of this article is to examine Germany's extensive experience with land consolidation for large public projects ("Unternehmensflurbereinigung") and outline the essential framework for implementing this approach in Ukraine.

This article presents such a land consolidation instrument for large public projects, named "Unternehmensflurbereinigung", which has been successfully used in Germany for several decades to provide land previously used for agriculture for such projects while minimizing the negative effects of the project on agriculture. In addition, it is analyzed to what extent this instrument can also be used in Ukraine, not only to establish new infrastructure but also to support the elimination of war-related destruction.

BACKGROUND

Trends in agriculture in Ukraine since the 1990s

Ukraine is currently undergoing several transformation processes. Firstly, the process of converting from a socialist to a free-market economy is almost complete. The resulting privatization of agricultural land has led to a changed ownership structure without the agricultural structures having adapted accordingly. Even if agriculture will play a significant economic role in Ukraine in the future, industrialization will continue to progress and require the necessary infrastructure in a wide variety of areas. Agricultural land will have to be utilized for this purpose, which will entail changes in the agricultural structure. In addition, land previously used for agriculture will not be available for agricultural use in the medium to long term due to military activities. As the outcome of the war cannot be predicted at present, no concrete statistical data on war damage that can be remedied by land consolidation procedures is known at this time. Nevertheless, land consolidation instruments will be required to implement these changes in the agricultural structure in a sustainable manner.

Following the land reforms of the 1990s, Ukraine's agricultural (arable) land (28 mm ha) comes to resemble a patchwork or "chessboard" of approximately 6.9 mm private land parcels (commonly referred to as land shares) designated for commercial agricultural production. These land parcels have an average size of 4 ha, ranging from 1.1–1.5 ha in the western regions to 7.0–7.9 ha in the southern regions. Such land parcels area gradation is a consequence of the socialization of the land reform, which aimed to ensure a fair distribution of land among the rural population (Popov, 2016). All land parcels within a particular collective agricultural enterprise's territory subject to sharing have the same normative[1] monetary value. This is due

[1] The normative monetary valuation of a land parcel is the capitalized rental income from the parcel, calculated according to the established and approved norms. The normative monetary valuation is not market-based.

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to the socialized approach to land sharing, ensuring that each member of a particular collective agricultural enterprise gets a land parcel of equal monetary value within the farm. As a result, physical land parcels within the territory of a particular former collective agricultural enterprise have an equal normative monetary value. However, the physical parcel size differs from the soil quality – the better the soil, the smaller the land plot area.

Agricultural land use is characterized by excessive dependence on leases in Ukraine. This situation arose primarily due to the land moratorium in place until 2021, which restricted the agricultural land market. As a result, 39.7 mm ha of private agricultural land could not be the object of purchase and sale, which was 95.9% of all agricultural land in Ukraine, or 65.8% of the country's total territory (Popov, 2016). Given these limitations, leasing land became the primary mechanism for agricultural enterprises to concentrate land. As a result, approximately 64% of agricultural land, or 26.5 mm ha, is currently leased to agricultural enterprises and farms. Notably, the largest 117 companies (agroholdings) control a significant portion of this leased land, holding 16% or 6.45 mm ha of agricultural land (AgroPolit & Feodal, 2020).

Existing processes of land degradation significantly threaten agricultural land use in Ukraine. The effects of wind and water erosion are of great concern, affecting approximately 40% of the country's arable land, or 12.9 mm ha. Deterioration of the protective condition of the shelter belts network within agricultural landscapes only exacerbates the problem of land degradation. Currently, only 30% of agricultural landscapes are protected by field shelter belts, and another 10% are protected by other shelter belts (Popov et al., 2022).

Intensive and large-scale agriculture leads to a decline in biodiversity, whether through the removal of hedges and other habitats for animal and plant species or intensive fertilization (Anton et al., 2020). In the event of Ukraine's planned accession to the EU, the targets of the EU Biodiversity Strategy for 2030 would also have to be implemented in Ukraine as part of the European Green Deal (European Commission, 2020). According to this, protected areas are to be created on at least 30% of the country's territory in Europe as an extension of the existing Natura 2000 areas. The use of pesticides is to be reduced by 50% by 2030, and 3 billion trees are to be planted across the EU. With the 2023 Nature Restoration Regulation (GSC, 2023), the EU has adopted measures to restore at least 20% of land areas by 2030 and all ecosystems in need of restoration by 2050.

The condition of agricultural landscapes and rural areas in Ukraine has significantly deteriorated and continues to worsen due to Russia's military invasion. The full-scale war, which the Russian Federation started, led to the displacement of more than 8 mm Ukrainians within the country, and another 6 mm were forced to go abroad. For many people, returning home is currently impossible due to the destruction of homes and even entire villages. Agricultural lands in areas that were previously or are still occupied by Russian forces, as well as where active hostilities are taking place, suffered two main types of damage: contamination by landmines and unexploded ordnance on an area of 1,740 ha (EPRS, 2023) and direct physical destruction. Physical damage to agricultural land includes fortification networks, funnels from artillery and missile strikes, as well as disturbance of the fertile topsoil caused by the movement of tanks and other military equipment.

Estimated at about $80 billion by the end of 2023 (EPRS, 2023), the Russian invasion seriously disrupted the Ukrainian agricultural economy. According to the estimates of the Kyiv School of Economics (Nivievskyi & Neyter, 2024), this economic impact encompasses $10 billion in asset damage where 57% involved machinery and equipment and resulted in $70 billion in financial losses due to revenue declines and heightened production expenses. The data does not account for farmland degradation that occurs due to landmines and environmental harm resulting from military activities. Ukraine faces an immense task in clearing mine contamination from 16 million hectares of land which includes 11.2 million hectares of farmland (Nivievskyi & Neyter, 2024). This contaminated farmland covers an area that

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matches all of Germany's farmland which highlights the problem's massive scale.

The ongoing conflict caused Ukraine to lose 19.3% of its agricultural land, resulting in more than 5 mm ha becoming unusable from destruction or abandonment. According to NASA Harvest (2023) calculations, a farmland loss of 7%, which includes 2.5 mm ha, results in $2 billion worth of lost harvests that would otherwise feed over 25 mm people each year. The Ministry of Environment reports indicate that soil damage reached a value above UAH 900 billion (VRU, 2024). The combined negative effects resulted in a major reduction in crop production as yields dropped from 106 million tons of grain and industrial crops in 2021 to 77 million tons by 2024 (Stezhensky, 2025).

About a third of the nation's forest fund (SFRAU, 2024) was destroyed by active hostilities: 3 mm hectares of forest. In addition, almost all shelter belts were destroyed in the front-line and near-front zones. The undermining of the Kakhovskaya Dam affected the surrounding ecosystems and agricultural means of livelihood, aggravating the situation and the problems listed above. The catastrophic flooding claimed hundreds of lives across 46 towns and villages, displaced thousands of residents, and destroyed the oblast's agricultural infrastructure. The entire economic impact on primary agriculture is estimated at $1.18 billion, which includes $1.15 billion in long-term losses and $25.7 mm in direct damages. Projected over the next five years – the anticipated timeframe for reconstructing the Kakhovka Dam and its related infrastructure – the largest share of losses, estimated at $909 mm, stems from the disruption of irrigation to highly drought-prone farmland in southern Ukraine, covering approximately 262,000 ha (Nivievskyi & Neyter, 2024). As a result, Kherson oblast lost 92% of its irrigation systems, while Zaporizhzhia oblast suffered a 70% reduction. In the southern parts of Dnipropetrovsk and Mykolaiv oblasts, up to 30% of water sources and irrigation infrastructure were destroyed. The loss of irrigated land in Kherson oblast is estimated at 550,000–600,000 ha, and when including affected areas in Dnipropetrovsk and Zaporizhzhia, the total reaches 1.5 mm ha (ICUV, 2024). The consequences of this irrigation loss have been disastrous for agricultural production, with overall crop yields in previously irrigated areas falling by 89% (Agribusiness of Ukraine, 2024). The widespread devastation emphasizes the vital need for large-scale restoration activities to repair critical water infrastructure and protect food production in certain oblasts.

Against this background, a decline in Ukraine's GDP of 28.3% in 2022 seems natural. The Centre for Economic Strategy (Samoiliuk, 2025) notes that the economy showed signs of recovery with GDP growth reaching 5.3% in 2023 and 3% in 2024. According to World Bank calculations (2025), at the end of December, the estimated financial requirements for recovery and reconstruction over the next decade amounted to nearly $524 billion, which is approximately 2.8 times Ukraine's projected nominal GDP for 2024.

These problems can lead to long-term effects such as the non-use (abandonment) of agricultural land, the contamination of fertile land, and significant changes in the farm structure, significantly changing the established patterns of land use and agriculture in the war-affected rural regions. The war made reconstruction and transformation of Ukraine's rural areas and agriculture sector necessary. Major investments in the restoration of soils, agricultural businesses (farms), infrastructure, ecosystems, biodiversity, and novel adaptive ways to rural area recovery would be needed.

Land consolidation for large public projects under German law

In rural areas, large public projects often take up agricultural land, for example, to construct large infrastructure projects such as motorways or new railway lines. The owner of the land to be used for the project is generally paid compensation for the land taken. This is intended to enable him to purchase a plot of land of a similar nature to be given up. On the other hand, compensation is paid for other pecuniary disadvantages, for example,

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if part of the property is taken for the project and the remaining area becomes more difficult to cultivate. In individual cases, the economic disadvantage may be so great that the owner is entitled to have the remaining area taken over and, in extreme cases, to have the entire agricultural estate taken over. Such compensation regulations may indeed replace the individual economic damage arising for the respective property owner, but the unfavorable layout of the properties only partly used for the infrastructure project remains and complicates permanently the management of these areas, provided that another land consolidation procedure is not carried out, by which a reorganization of the unfavorably cut properties is carried out (Thomas, 2011).

At the beginning of the 20th century, these experiences in some cases led Prussia (e.g. the provision of land for the Ottmachau reservoir (today Otmuchów in Poland)) to pass a law that compensation in the form of land was to be granted instead of monetary compensation. For the implementation of land consolidation, the law prescribed the execution of such a land consolidation (Weiß, 2008). After World War II, the experiences gained prompted the legislator in the Federal Republic of Germany to introduce specific regulations into the Land Consolidation Act (LCA – BGBl, 2008) for the provision of land for large public project in the form of a special land consolidation procedure ("Unternehmensflurbereinigung"). So, the procedure of "Unternehmensflurbereinigung" has been used intensively in Germany for many decades. At the end of 2023, 395 procedures were pending in Germany with a procedure area of 364,042 ha (BMEL, 2024). The efficiency of "Unternehmensflurbereinigung" has been analysed in several studies (Berens et al., 2005; Berens et al., 2008; FGSV, 2011; Kötter et al., 2017), all of which have come to the conclusion that the "Unternehmensflurbereinigung" procedure is more efficient than the implementation of expropriation proceedings. Interviews conducted by the author with several experts show that so far no procedure of "Unternehmensflurbereinigung" is known that could not be successfully implemented. "Unternehmensflurbereinigung" procedures have only been cancelled if the project to be implemented through the "Unternehmensflurbereinigung" procedure was aborted. In addition, there are known cases in which "Unternehmensflurbereinigung" was not initiated due to political requirements that disregarded the existing legal situation. These cases have subsequently led to considerable disruption on the agricultural property market. The experts also noted that the procedure of "Unternehmensflurbereinigung" can be used so flexibly that conflicts of interest arising during the procedure can usually be resolved by mutual agreement. Otherwise, there is established case law, meaning that legal action will not be successful if the legal situation is applied correctly.

Ultimately, the instrument of "Unternehmensflurbereinigung" is the milder means compared to the expropriation procedure and should be used in accordance with the legal principle of proportionality if the conditions are met (OLG Hamburg 1960, OVG Frankfurt (Oder) 2003).

Goals of "Unternehmensflurbereinigung"

On the one hand, the instrument of "Unternehmensflurbereinigung" is intended to speed up the provision of land for a large public project and, on the other hand, to minimize the negative impact of the project on agriculture, including the agricultural infrastructure, like agricultural management units and agricultural road network. Improvements to the ecological situation, including biotope networking, can also be achieved.

The term "large public projects" includes infrastructure projects (e.g., roads, railways, airports, canals) (Hendricks & Lisec, 2014) and residential developments (e.g., large public facilities such as universities, hospitals, and new residential and commercial areas), but also nature conservation and environmental protection projects, if expropriation is permissible for such a project.

The "Unternehmensflurbereinigung" replaces the formal expropriation procedure and pursues the following objectives (Thomas, 2024):

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1. Distribution of the loss of agricultural land caused by the public project to a larger group of owners.

In the event of formal expropriation proceedings, the owner is deprived of the land that is needed for the public project's plans. This may result in individual owners having to surrender a large amount of their land, while other owners have to surrender little or no land at all. In individual cases, this may mean that individual farms can no longer be operated economically after the required surrender of land and that further compensation must be provided accordingly. In the case of Unternehmensflurbereinigung, all owners must surrender a portion of the land they brought into the process for the project, so that it is always possible to continue operating the farm economically. In special individual cases, owners can also be exempted from surrendering land for the project. In addition, the public authorities try to purchase agricultural land in the defined area of the Unternehmensflurbereinigung or adjacent to it by private contract. This is then available as exchange land for the land required for the project. In practice, it is often no longer necessary, or only to a limited extent, for the individual owners to surrender land for the project on a pro rata basis.

2. Elimination of disadvantages caused by the project.

As already explained, the provision of land for the project results in residual areas on the partially used properties, which, due to their size and/or layout and, in some cases, a lack of access to public roads, cannot be cultivated in the extreme case, but usually only to a limited extent. Therefore, land consolidation is needed to create economically usable properties and to at least minimize the economic damage that would otherwise occur.

If a public project requires a large area of land at a location specified by the corresponding planning, then the agricultural infrastructure that has existed there up to now is often adversely affected, e.g., agricultural roads are cut through by the planning of a new motorway. Such damage must be remedied, for example, by constructing a bridge over the motorway to re-establish the connection that was secured by the agricultural road. This causes considerable further investment needs in addition to the construction of the project. To reduce this, it usually makes sense not to restore all the severed road connections, but instead to plan and implement a new agricultural road network that requires less additional investment while offering almost the same usability.

Overall, therefore, agricultural infrastructure requires adaptation on the basis of appropriate planning (e.g. road and water planning) that is developed as parallel as possible to the planning of the public project and that should also enable the reorganization of the agricultural parcels in such a way that they can be used at least in an equivalent manner to their previous state, but also to enable improved use if necessary.

3. Provision of land for public projects.

The public project needs planning security at an early stage to ensure that the land required for this will be available when the necessary construction work (e.g. the construction of the motorway) starts. This is achieved in the Unternehmensflurbereinigung by the possibility of the early order (LCA, sec. 87, para. 2), i.e. before the conclusion of the planning for the public project, so that the planning for the Unternehmensflurbereinigung can be coordinated with the planning for the public project. The land required for the project can be made available to the public administration in good time using a preliminary order (LCA, sec. 88, no. 3), so that the implementation of the project can start after the plans required for this have become final.

The instrument of "Unternehmensflurbereinigung" is therefore intended to reduce the negative effects of the project on the owners of the land required for the project to an unavoidable level and, at the same time, achieve benefits through improved agricultural infrastructure and improved management of the remaining agricultural land. The instrument is used in Germany for various purposes, e.g., expansion of open-cast lignite mining areas (Fehres, 2010), reduction of flood hazards (Weitkamp, 2011), species protection (Fehres, 2015), and renaturation of water bodies (Hendricks et al., 2019; Nobis et al., 2020).

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Process of Unternehmensflurbereinigung

To ensure that the land required for the large public project can be made available in good time using a "Unternehmensflurbereinigung" and that the disadvantages of the large public project for agriculture can be identified, there must be early cooperation between the public authority planning the public project and the public authority responsible for carrying out the "Unternehmensflurbereinigung". For example, there is a working group of the land consolidation administration and the road construction administration at the Research Association for Roads and Transport, which continuously exchanges information on the further development of the use of "Unternehmensflurbereinigung" and also publishes information on cooperation (FGSV, 2024).

For this reason, an ongoing comparison of the project planning regarding the effects on agriculture is already carried out during the preliminary planning for the large public project to determine the need for the implementation of a "Unternehmensflurbereinigung" procedure at an early stage. (A detailed description of the procedure for "Unternehmensflurbereinigung" can be found in Hendricks & Lisec [2014], and in Thomas [2024]).

Once the preliminary design for the large public project has been drawn up, these impacts can be further concretized by both responsible public authorities. For example, planning can be used to determine which agricultural roads will be intersected by the project. This then forms the basis for further planning to adapt the agricultural road network by, for example, locating bridges to the intersection in a linear large public project, including the connection of the bridge to the existing agricultural road network.

Once the actual permitting procedure for the large public project has been initiated and the necessity of carrying out a procedure for the "Unternehmensflurbereinigung" has been identified by both responsible public authorities, this procedure itself can also be initiated. In Germany, the responsible public authority for the large public project must apply to the competent expropriation authority. This authority decides whether expropriation for the large public project is permissible in principle and applies to the public authority responsible for the "Unternehmensflurbereinigung" for the execution of the "Unternehmensflurbereinigung".

The public authority responsible for carrying out the "Unternehmensflurbereinigung" determines the procedure area of the "Unternehmensflurbereinigung" based on the scope of the large public project and the recognisable impact on the parties involved and initiates the procedure of the "Unternehmensflurbereinigung". To have as much exchange area as possible available for the large public project, the authority responsible for the "Unternehmensflurbereinigung" starts with the acquisition of agricultural land offered on the property market. This land can also be located outside the "Unternehmensflurbereinigung" procedure area and will be included in the procedure. Of course, suitable exchange areas can also be acquired in advance by the authority responsible for the large public project or, with appropriate coordination between the two authorities, by the authority responsible for the "Unternehmensflurbereinigung".

The authority responsible for the "Unternehmensflurbereinigung" then carries out the valuation of the land in the procedure area as a basis for the exchange of land and for compensation if owners do not receive an allocation of equal value. This authority also carries out the planning and permission procedures for infrastructure that is required to supplement the large public project and the resulting adjustments to agricultural infrastructure.

Based on the results of these two coordinated plans and permission, both authorities agree on the further construction of these infrastructures. The authority responsible for the "Unternehmensflurbereinigung" allocates the land required for the large public project for the realization of the project, possibly only for a limited period, e.g. for storage areas required for the construction period. The authority also reorganizes the ownership of the agricultural land, considering the ideas and wishes of the landowners.

At the end of the "Unternehmensflurbereinigung" process, the developer of the large public project

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was usually able to realize it in a shorter time than would have been possible if the required land had been acquired or expropriated. The owners of the agricultural land affected by the large public project receive economically viable agricultural land with suitable access for cultivation via agricultural roads. In addition, disadvantages in terms of nature and landscape are also compensated. Overall, a situation is created that is optimized in consideration of the large public project.

LITERATURE REVIEW

Separate works of individual Ukrainian scientists regarding land consolidation deserve special attention, but they remain little researched. Martyn et al. (2011; 2022) examine the international patterns and theoretical foundations of land consolidation, primarily focusing on Ukrainian legislative initiatives regarding the application of voluntary and mandatory land consolidation. Shvorak and Yevsiukov (2014) describe tools for agricultural land consolidation, including purchase and sale, trade, long-term lease, organization of landowner groups, and pooling of land parcels, but do not provide procedures for their application. Stupen and Dudych (2015) focus on analyzing lease relations as a mechanism of land consolidation by agricultural enterprises.

In earlier studies (2015, 2016, 2017, 2018), Authors examined the necessity of introducing land consolidation in Ukraine, analyzed the best international practices, and suggested proposals for implementing land re-allotment in the land-use planning system. However, it is important to highlight that Ukrainian scientific literature has yet to explore the essence, processes, and objectives of land consolidation in implementing large public projects. This area is highly relevant to the post-war infrastructure restoration of both agriculture and rural areas in Ukraine yet remains largely unexplored.

FAO experts (2003, 2004), van Dijk (2007), Thomas (2006a, 2006b), Hartvigsen (2014; 2015; 2019), and Veršinskas et al. (2020) conducted a comprehensive analysis of land consolidation, employing various methodological approaches to its implementation across European countries. Their works highlight that land consolidation has evolved in most nations from a specialized measure focused solely on land resource management for agricultural development into a multipurpose tool. This tool now serves diverse objectives, including agricultural and community development, environmental restoration, and even the implementation of large infrastructure projects. In his article, Thomas (2011) explains the advantage of "Unternehmensflurbereinigung" about the individual expropriation of individual parcels of land. Weitkamp (2011) explains the application of the instrument using two practical case studies. Hendricks and Lisec (2014) describe Germany's successful experience in implementing "Unternehmensflurbereinigung" to distribute land losses among affected landowners and minimize the damage caused by land redistribution. Thomas (2024) highlights the challenges of using this instrument based on various case studies.

MATERIALS AND METHODS

This research adopted a comprehensive approach, blending a thorough literature review and a comparative analysis of German and Ukrainian documents about land consolidation for large public projects. The primary goal of the desk review was to explore and examine the literature on procedures and German best practices for land consolidation tailored to public projects. The purpose of such analysis was to find adaptive methods of land consolidation that could meet the various socio-economic and ecological conditions of Ukrainian rural areas, especially those affected by the war. Information was collected through secondary sources of data, namely journals, monographs, books and conference proceedings. Through this desk review, the "Unternehmensflurbereinigung" model was identified as suitable and relevant not only for rebuilding and enhancing agricultural productivity and environmental resilience but also for making these systems more robust against future shocks.

The second research method was document analysis. Using this qualitative approach involved

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examining documents to gain meaningful insight and understanding. The key Ukrainian legal documents that were analyzed in this study included: The Land Code of Ukraine (concerning the main provisions of the voluntary purchase and expropriation of land parcels for public infrastructure facilities), the Law "On Land-Use Planning" No. 858-IV (regarding the procedure for the formation of land parcels, spatial planning, and ensuring the sustainable development of land use), the Law "On Alienation of Land Parcels, Other Real Estate Objects Located on Them, Which Are in Private Ownership, for Public Needs or Reasons of Public Necessity" No. 1559-VI (regarding the procedure for voluntary purchase and expropriation of land parcels for public infrastructure facilities, and compensation), the Law "On State Land Cadaster" No. 3613-VI (concerning the spatial registration procedures for land parcels), the Law "On State Registration of Real Estate Rights and Their Burdens" No. 1952-IV (regarding the registering interests in land parcels).

The statistical data used in this study pertain to current agricultural land use in Ukraine, excluding the temporarily occupied territory of the Autonomous Republic of Crimea and certain areas of the Donetsk and Luhansk oblasts, as of February 24, 2022, prior to the Russian invasion.

NEED FOR UNTERNEHMENSFLURBEREINIGUNG IN UKRAINE

Current situation of land-use planning and land cadaster

Land-use planning is a set of social, economic, and ecological measures designed to regulate land tenure (relations) to ensure rational land use and protection, create a beneficial ecological environment, and improve the natural landscape (VRU, 2003). From the point of view of land-use planning and land cadaster, all land in Ukraine is subdivided into land parcels. The State Service for Geodesy, Cartography, and Cadaster (StateGeoCadaster) is responsible for maintaining a land cadaster containing information about the land parcel such as parcel area, land type, intended use, restrictions, easements, sublease, fixtures (ex. buildings, infrastructure). The land cadaster contains approximately 25 million land parcels with 44,9 mm ha of total area. The land cadaster is 74% full. The Ministry of Justice of Ukraine is responsible for ensuring efficient and legally secure interests in land (property rights).

According to the current legislation, a division into land parcels or change in the structure (form, area) of land parcels caused by various reasons (ex., construction of infrastructure) can be done through a three land-use planning (cadastral) procedure on land parcel formation: subdivision, dividing and amalgamation (VRU, 2001). Forming a land parcel involves measuring its area and boundaries and registering this information in the State Land Cadaster. Forming land parcels can involve creating or changing land parcels and their rights. It is worth emphasizing that the land-use planning procedures on land parcel formation have predominantly been entrusted to the private sector (certified land-surveying engineers). At the same time, the local StateGeoCadaster authorities handle land parcel registration and oversee their immediate supervisory duties.

In the subdivision procedure within the land-use planning framework, an area is separated only from a state and communal land parcel (property) to create a new private, independent land parcel. The new land parcel will have its own designation and be adapted to its intended use in terms of layout and size.

Land parcel dividing is the land-use planning process of separating a single parcel of any property (state, communal, or private) into smaller sections or lots to create a new, independent land parcel. The layout and size of the new separated (divided) land parcel will be adapted to the same (as the original land parcel) intended use. A jointly owned land parcel is divided in conformity with the ownership. The new land parcels receive new designations. Fixtures are transferred from one land parcel to another (ex. buildings).

Amalgamation of land parcels is the land-use planning process whereby two or more land parcels

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with the same ownership conditions are combined to form one new real property, which is given a new designation. The following conditions must be met for the amalgamation of land parcels. All parcels must have the same intended purpose and a shared boundary, be located within the same settlement, and not be arrested.

Dividing or amalgamating land parcels does not remove restrictions or encumbrances placed on them, except when the restriction or encumbrance applied only to a part of the parcel that, following the division, was not included in the newly formed parcel. It is important to stress that the results of dividing and amalgamating land parcels are formalized within a single land-use planning documentation. However, dividing (separate) and amalgamating land parcels simultaneously by one procedure is prohibited under one procedure.

One of the issues that emerges from the aforementioned procedures for land parcel formation is that land restructuring or re-allotment procedures do not exist in Ukraine. There is no option to implement new land allotment (layout) through redistributing or reorganizing land plots to improve land use efficiency or to create more functional and productive landholdings that align with specific areas' economic, social, and environmental goals. The lack of a land re-allotment procedure makes it impossible to address or mitigate the disadvantages caused by large public projects. Land parcels subject to expropriation for large public projects are separated from the original parcels according to the dividing land-use planning procedure. The expropriation procedure involves the creation of hundreds, or even thousands, of land-use planning documents for dividing land parcels for their further voluntary purchase. It resembles simply cutting out the necessary parts of land to assemble a mosaic – a land area required for a large public infrastructure project. After combining different land parcels through purchase and sale agreements into a single project area, a land-use planning procedure for amalgamation is carried out to form a new land parcel for infrastructure. With such an approach, it is impossible to see a complete picture of the impact of large public projects on affected landowners and the landholdings as a whole, which leads to objections related to the specific project.

Expropriation law and procedure

Expropriation for reasons of public necessity is possible only for private land parcels. The basis for land expropriation due to public necessity is the failure to obtain the landowner's consent for its acquisition for public needs. Formal expropriation proceedings can be initiated for public necessity. Public necessities are clearly defined by legislation and include:

- placement of national security and defence objects;
- placement of linear objects and objects of transport and energy infrastructure (roads, bridges, flyovers, main pipelines, power lines, airports, seaports, oil and gas terminals, power plants) and objects necessary for their operation;
- placement of objects related to the extraction of minerals of national importance;
- placement of objects in the nature reserve fund;
- cemetery (VRU, 2009).

On the grounds of public necessity, the expropriation of land parcels and other immovable property located on them is carried out by court decision. No one can take a land parcel from a landowner without a court decision. If part of a land parcel is expropriated and the remaining area cannot be reasonably used for its intended purpose, it is subject to expropriation at the landowner's request. There is also a controversial rule of law. The owner of the expropriated land parcel has the right to request the transfer of another equivalent (according to expert monetary valuation[2]) land parcel into their ownership unless otherwise agreed with the owner of the expropriated parcel (ex., money compensation).

The initiator of the land parcel voluntary purchase for public needs can only be an executive authority, a local self-government body, or a special

[2] An expert monetary valuation determines the market value (the likely selling price on the market) at which a land parcel can be sold or purchased.

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administration responsible for territorial management and nature reserve fund sites. In general, the formal expropriation procedure for large public projects is as follows:

1. The initiator reviews the results of project planning work to assess the need for a public infrastructure project and its location (required land area) and identifies the land parcels subject to purchase for the planned construction.
2. Upon determining that the proposed project is feasible and advisable, the initiator decides to redeem the necessary land parcels and any other real estate located on them.
3. Afterward, the initiator must notify the landowners in writing (by registered letter) of the decision to redeem their land parcels. The letter specifies the voluntary purchase purpose, the area of the land parcel, the cadastral number, the land category, any real estate objects, and the voluntary purchase conditions (such as purchase price, timeline, and source of financing) and (cadastral plan of the land parcel).
4. Within one month of receiving the written notice, the landowner must inform the initiator of their consent to negotiate the terms of voluntary purchase or refusal to sell the land parcel.
   a. If the landowner consents to negotiate the terms of the land's voluntary purchase, the initiator arranges discussions with the landowner concerning the voluntary purchase price, conditions, and other terms. If an agreement is reached regarding the voluntary purchase of the land parcel, the parties sign a purchase and sale agreement, which must be notarized. If the parties do not agree, the initiator has the right to apply to the administrative court with the appropriate claim.
   b. If the landowner does not consent to negotiate within voluntary purchase terms, the specified land parcel and any real estate objects (if any) can be expropriated by the initiator's appeal to the administrative court with the corresponding lawsuit.
5. The initiator applies to the court regarding land expropriation. The court grants the demand for expropriating the land parcel if the initiator demonstrates that constructing a public infrastructure project is impossible without land expropriation and confirms the absence of voluntary consent for land expropriation.
6. If the claims are granted, the court's decision will specify the purchase price, payment procedure, and the list and method for providing an alternative land parcel in place of the expropriated property (if applicable). The court's decision on the expropriation of the land parcel serves as the basis for the state registration of ownership by the state or territorial community.

The current expropriation procedure is too long-lasting and, as a result, not effective enough in the urgent need to implement large public projects. The court's decision on the expropriation of parcels for reasons of public necessity takes on average more than one year (CMU, 2021).

It is worth emphasizing that if the redeemed or expropriated land parcel is no longer needed, the initiator must notify the previous owner of the land parcel (or part of it) or other immovable property located on it, in writing (by letter), within one month. This approach to the voluntary purchase and expropriation of land for public projects highlights inefficiency and a lack of strategic planning in public administration. The process is cumbersome and costly, and puts landowners through a lengthy process of litigation that can last for years. Significant public resources and taxpayers' money are spent on voluntary purchases and expropriations. It may turn out that the redeemed and expropriated land parcels are no longer needed after the construction of infrastructure or other developments. This results in a situation where previous landowners can repurchase the land parcel, they spent years fighting for in court.

While a buy-back option, allowing landowners the right to repurchase land if the project is altered or abandoned, is considered good international practice, the Ukrainian approach requires improvement. It infringes on citizens' rights, imposes significant

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budgetary costs, and reflects inadequate public planning and foresight. The voluntary purchase and expropriation should be based on a clear understanding of the actual necessity for each land parcel in public projects and careful planning to avoid unnecessary expenses and undue restrictions on landowners.

Understanding such problems in implementing large public projects, the Prime Minister of Ukraine proposed a draft law on the simplification of court proceedings regarding land expropriation disputes within up to one month from the date of receipt of the claim statement. Legislators are convinced that implementing this provision will reduce the duration of land expropriation by at least one-third.

The main problem is not the slowness of the court decisions in favour of land expropriation but the lack of understanding of the instruments of land consolidation and "Unternehmensflurbereinigung," and thus the absence of such instruments.

FRAMEWORK OF USING THE SPECIFIC LAND CONSOLIDATION PROCEDURE "UNTERNEHMENSFLURBEREINIGUNG" FOR UKRAINE

In Ukraine, significant investments are needed through public projects with large land requirements to repair war damage and further the country's economic development. This includes, for example, the reconstruction and expansion of transport infrastructure, such as railway lines. However, damage caused by military activities, e.g. trenches, bomb craters, or minefields, will often not be returned to agricultural use in the short term.

Therefore, it is both appropriate and necessary to introduce a specific land consolidation instrument in Ukraine that ensures sustainable agricultural use while considering the ongoing transformation processes. Significant delays and inefficiencies mark Ukraine's current voluntary purchase and expropriation process for public projects. A lack of a comprehensive land consolidation framework tailored explicitly to large public projects exacerbates these challenges. The "Unternehmensflurbereinigung" instrument, established in Germany, offers the opportunity to do so if it is integrated into Ukrainian land-use planning and its practical implementation.

Developing "Unternehmensflurbereinigung" in Ukraine would require creating a structured framework that addresses the specific needs of large public projects while ensuring efficiency, legal clarity, and respect for property rights. Developing a legal framework for "Unternehmensflurbereinigung" requires amending land-use laws to define and authorize land consolidation for such projects of public interest as a distinct category of land re-allotment (reorganization) within land-use planning, including objectives, scope, and permissible activities. Clear criteria must be established to determine which public projects are eligible for land consolidation (for example, transportation networks, energy facilities, environmental protection zones, and new industrial or dwelling zones). These criteria should stress public interest, project magnitude, and the importance of integrated land reallotment.

Legislation and land strategy

Legislation should make clear that such land consolidation is a legally regulated procedure overseen by a public authority. A public authority's oversight helps to establish public trust in the process since a neutral, government-led approach guarantees landowners and other stakeholders that the system serves the public interest rather than private or corporate objectives. However, in Ukraine, this presents a significant challenge due to low levels of public trust in government actions and institutions, including those related to land-use planning.

Since land re-allotment will be a new activity, guidelines that permit flexible re-allotment and consolidation of land parcels for public projects should be developed, including:

– procedures for assessing and consolidating fragmented land parcels into unified, contiguous units,

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– re-allotment options for affected landowners, such as alternative land parcels, fair compensation, or opportunities for shared benefits from the land,
– mechanisms for land consolidation to promote efficient land use, including reorganizing parcel land boundaries and consolidating smaller parcels.

A specific methodological approach is needed for "Unternehmensflurbereinigung", whereby land owned elsewhere by the project developer is exchanged for land where the project is to be implemented. If the project developer lacks sufficient replacement land, a deficit occurs. This deficit is then distributed proportionally among all participants through a proportional land deduction. The distribution is calculated based on each participant's land value contribution relative to the total value of parcels within the land consolidation area. The "consideration" for this public contribution is the enhanced infrastructure provided within the consolidated area, in the form of "joint facilities" under the land consolidation plan. By contrast, land specifically required for the public project itself is acquired through land deductions with monetary compensation at market value.

With the loss of land distributed among many landowners, no farmer needs to fear losing their livelihood because of the public project. Instead, each landowner and farmer can expect equivalent compensation in land for the area taken for the public project. Land consolidation for projects of public interest thus avoids imposing a 'special sacrifice' on individual landholdings. The land deduction becomes a common public contribution from all participants, the compensation for which must be guaranteed by legislation. This approach is highly effective in gaining widespread acceptance among all land consolidation participants.

Voluntary land consolidation for significant public projects should be encouraged through incentives. Offering incentives such as compensation bonuses, preferential tax status, or access to better infrastructure and services can motivate landowners to join willingly in land consolidation initiatives. Landowner interest in participating in large public projects can be increased by providing alternate mitigation and land compensation options in addition to standard monetary compensation. This measure is critical for ensuring fairness, increasing acceptance among landowners, and providing flexibility in land acquisition for large public projects.

One alternative land compensation method could be to provide land with more utility. This strategy entails providing a land parcel with more development potential, such as better infrastructure or utilities access. It can motivate landowners by improving land use conditions or potential (economic, environmental, or social) compared to its initial state. The best option for large-scale land re-allotment projects is to provide landowners with their redistributed parcels within a unified project area where infrastructure and improvements will be created. This approach allows landowners to achieve a higher value for their land parcels within the consolidated area.

It is critical to provide affected stakeholders with accurate information about existing support programs, land redistribution alternatives, and compensation options. Benefits to the community in the form of improved or new social services or local infrastructure should also be considered. The land consolidation process can be made more effective by providing a variety of (landowner-oriented) compensation strategies, which in turn will provide a more sustainable and equitable basis for developing public infrastructure in Ukraine.

PARTICIPATION OF LANDOWNERS AND OTHER STAKEHOLDERS

Initiatives regarding large public infrastructure projects should be developed in close cooperation with local non-governmental organizations to prevent or minimize negative economic, social, and environmental consequences for local communities. Effective public and stakeholder consultation is essential to building trust, resolving concerns, and gaining support from landowners and the community affected by a large public infrastructure project.

Information sessions and public meetings are vital to the success of a large public project and its

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positive reception by participants. To implement land consolidation for public projects, open public meetings must be held to present the project and explain its goals, procedures, and timelines. Providing accessible venues and virtual opportunities to encourage broad participation by all stakeholders is critical. Holding individual meetings with landowners and focus groups of different stakeholders helps resolve problematic issues specific to each group, maintains an open dialogue, and strengthens trust in public authorities. Legislation should mandate comprehensive public consultation, especially for large public infrastructure projects involving many landowners or several communities. Using this approach can help ensure the support of all stakeholders, reduce litigation, and make the land consolidation process more transparent.

German land consolidation practice emphasizes creating public relations and advisory groups. The creation of an advisory committee of interested parties, which includes landowners, residents, business leaders, and officials of local authorities, can contribute to receiving valuable feedback on the project's development and be the voice of the community's interests.

Suggestions to support implementation

To successfully implement a legal method for land consolidation tailored to the public project, it is required to reduce administrative and legal procedures, set clear timelines, and minimize procedural delays. One strategy is establishing precise procedural schedules and deadlines for each step of land consolidation, such as notice, discussions, and adjudication. There may be deadlines for administrative proceedings, appeals, or legal challenges. Mandatory pre-trial mediation is another helpful strategy for resolving disputes. Landowners and the initiating authority can save time and money by using it to settle disputes without the need for drawn-out litigation.

Public infrastructure projects can be completed more quickly if relevant lands are identified and consolidated in advance. Pre-consolidation can be done by introducing land banking, allowing the government or project promoter to purchase and consolidate land in advance in preparation for future public demands. Using this approach will significantly reduce the number of necessary long-term expropriations, thereby ensuring the availability of land for future development.

Ukraine's current multi-level planning process at the national, regional, and local (community) levels needs to be improved or even revised by incorporating land consolidation into land-use planning tools and ensuring alignment with economic, social, and environmental issues. Such a process will require establishing a comprehensive impact assessment framework. The current cost-benefit analysis, environmental impact assessment, and economic justification are not enough. A new type of social impact assessment must be added. This assessment focuses on community participation and stakeholder engagement. It helps analyze the social effects on landowners and communities. Key issues include possible resettlement, service availability, and changes in livelihoods.

Capacity building

The success of implementing large public infrastructure projects through land consolidation depends on the availability of highly qualified experts and the improvement of their human skills. Since there is no land consolidation in Ukraine, developing an appropriate strategy based on international and national approaches to developing human capacity is essential.

In the international arena, human capacity building should be advanced through:

1. Partnerships with German universities and institutes to create educational programs in land consolidation. These programs may include specialized curricula. They can also offer post-graduate certifications and continuing education programs for professionals seeking skills in land consolidation. In addition, such cooperation can facilitate the exploration of new approaches, best practices, and case studies relevant to Ukraine.
2. Government agencies and academia can improve institutional knowledge and interagency coordination by offering in-house training on land consolidation's legal, technical, and social elements in government organizations (such as the State

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Geocadastre of Ukraine). E-learning platforms, frequent workshops, and seminars can facilitate continuous professional development.
3. Leverage donor support by creating alliances with foreign organizations (such as the World Bank and FAO) to facilitate attendance at international conferences and obtain scholarship funds for programs focused on land consolidation (e.g., through the German Federal Ministry of Education and Research, DAAD).

At the national arena, strengthening the development of human capacity in the field of land consolidation can be achieved by:
1. Creating specialized educational programs that include the basics of land consolidation, emphasizing cadastral surveys, land use planning, legal framework, and integration of public infrastructure. In addition, it is possible to develop specific training modules (courses) for different purposes within the framework of land consolidation.
2. Implementing community education initiatives for local stakeholders, such as workshops for landowners through proactive collaboration with NGOs and community authorities. Conducting such activities will significantly improve public awareness of land consolidation.
3. Creating training centres at the national and regional levels for land consolidation will facilitate decentralized access to centralized training initiatives. These centres will enable local authorities, community leaders, and landowners to benefit from the proximity of knowledge acquisition.
4. Introducing programs for Ukrainian professionals to participate in peer exchange with German specialists whose methods of land consolidation are well established and cooperation with professional associations to promote knowledge-sharing activities.

CONCLUSIONS

Adhering to the above-mentioned approaches in the international and national arenas, Ukraine can create a structure that would contribute to the strategic development of large public infrastructure projects, the optimal use of land resources, and protect the rights of landowners. In turn, this will allow for the formation of a land consolidation strategy to implement large public infrastructure projects, which will allow structured and planned land re-allotment, combining the goals of such projects with sustainable land use and preservation of land ownership rights. Creating such a mechanism of land consolidation will be crucial for the post-war recovery of Ukrainian territories affected by warfare.

The procedures currently used in Ukraine for public infrastructure projects, land expropriation, and land purchase are characterized by delays and inefficiency. Creating a comprehensive framework for land consolidation, adapted to the specific requirements of large public infrastructure projects and war reconstruction, can effectively solve existing problems. With the successful German instrument "Unternehmensflurbereinigung," Ukraine can establish a more straightforward and fair process for purchasing and expropriating land for public needs. Ukrainian land consolidation for large public projects should balance public and private interests, prevent unjustified land loss, encourage voluntary participation, and ensure fair compensation. The government can establish a transparent, effective, and equitable land reallotment process through capacity-building programs, streamlined processes, and legislative reforms aimed at public consultations. By adopting the German model's experience, Ukraine can reduce landowner violations, promote sustainable land use practices, speed up the development of agricultural and rural infrastructure, and aid in post-war recovery efforts by implementing land consolidation for major public infrastructure projects.

LIMITATIONS AND OUTLOOK

This article is based on the scientific approach of a case-by-case comparison, here Germany and Ukraine. The authors want to use the article to stimulate further discussion among experts. If the article contributes to initiating an international

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discussion on the use of land reallocation procedures that mitigate expropriation procedures for those affected by expropriation, this would create further scientific added value.

This would then also require an analysis of the legal regulations on expropriation in other European countries, or better still an international comparison. A book with authors from the individual countries would be a sensible approach for this.

This article does not provide an in-depth analysis of the legal and organizational implementation of the idea of "Unternehmensflurbereinigung" in Ukraine. Rather, this article has only described the idea of using "Unternehmensflurbereinigung" and discussed initial framework conditions. This study is an attempt to draw attention to this issue. For a more in-depth analysis of a possible implementation of the approach in Ukraine, further research is needed to provide a comprehensive feasibility study with engaging the relevant institutions in Ukraine. The authors would be pleased if they had provided an impetus for this and are available for further technical discussions.

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REFERENCES

Agribusiness of Ukraine. (2024). *Agribusiness of Ukraine MY 2023/2024: 11th edition of the infographic report*. https://agribusinessinukraine.com/the-infographics-report-ukrainian-agribusiness-2024-eng/

AgroPolit & Feodal. (2020). *Land Guide of Ukraine: Infographics*. https://mailchi.mp/latifundistmedia.com/zemelyniy-dovidnyk-ukrainy-2020-en

Anton, Ch., Mengel, J., Mupepele, A-Ch., & Steinicke, H. (2020). *Biodiversität und Management von Agrarlandschaften – Umfassendes Handeln ist jetzt wichtig* [*Biodiversity and management of agricultural landscapes – Comprehensive action is important now*]. National Academy of Sciences Leopoldina, German Academy of Science and Engineering, & The Union of the German Academies of Sciences and Humanities. https://www.leopoldina.org/uploads/tx_leopublication/2020_Akademien_Stellungnahme_Biodiversita%CC%88t.pdf

Berens, W., Mosiek, T., & Siemes, A. (2005). *Wirkungsorientiertes Controlling: Gesamtwirtschaftliche Wertschöpfungsanalyse von Bodenordnungsverfahren der Verwaltung für Agrarordnung am Beispiel der Bodenordnung nach § 87 FlurbG (Unternehmensflurbereinigung)* [*Impact-oriented controlling: Macroeconomic value added analysis of land readjustment procedures of the Administration for Agricultural Organisation using the example of land readjustment according to § 87 FlurbG (Unternehmensflurbereinigung)*]. https://www.landentwicklung.de/fileadmin/sites/Landentwicklung/Dateien/Aktuelles/Abschlussbericht_WS_BO_NRW.pdf

Berens, W., Mosiek, T., & Siemes, A. (2008). *Wirkungsorientiertes Controlling: Entwicklung und Einführung eines Konzeptes zur Wirkungsanalyse und Prognose für Bodenordnungsverfahren in Rheinland-Pfalz* [*Impact-oriented controlling: Development and implementation of a concept for impact analysis and forecasting for land consolidation procedures in Rhineland-Palatinate*]. Landentwicklung [Land Development]. https://www.landentwicklung.de/fileadmin/sites/Landentwicklung/Dateien/Aktuelles/NKLV_SO_21.pdf

Bundesgerichtshof (BGH). (1964). *Urteil vom 12.3.1964 – III ZR 209/62* [*Judgement of 12 March 1964 – III ZR 209/62*]. *BGHZ*, 41, 354.

Bundesministerium für Ernährung und Landwirtschaft (BMEL). (2024). *Neuordnung des ländlichen Grundbesitzes und Gestaltung des ländlichen Raums 2023* [*Reorganisation of rural land ownership and shaping of rural areas 2023*]. http://www.bmel-statistik.de/landwirtschaft/statistischer-monatsbericht-des-bmel-kapitel-a-landwirtschaft

✉hans-joachim.linke@tu-darmstadt.de, ✉andriy.popov@tsatu.edu.ua

Cabinet of Ministers of Ukraine (CMU). (2021). *Proekt Zakonu pro vnesennia zmin do deiakykh zakonodavchykh aktiv Ukrainy shchodo u sferi vidchuzhennia zemelnykh dilianok, inshykh obiektiv nerukhomoho maina, shcho na nykh rozmishcheni, yaki perebuvaiut u pryvatnii vlasnosti, dlia suspilnykh potreb chy z motyviv suspilnoi neobkhidnosti* [*On the introduction of changes to some legislative acts of Ukraine in the field of expropriation of land parcels, other real estate objects located on them, which are in private ownership, for public needs or for reasons of public necessity*]. *Draft Law of Ukraine of December 10, 2021, No. 6422* (Ukraine). http://w1.c1.rada.gov.ua/pls/zweb2/webproc4_1?pf3511=73411

van Dijk, T. (2007). Complications for traditional land consolidation in Central Europe. *Geoforum*, *38*(3), 505–511. https://doi.org/10.1016/j.geoforum.2006.11.010

European Commission. (2020). *EU Biodiversity Strategy for 2030: Bringing nature back into our lives.* https://data.consilium.europa.eu/doc/document/ST-8219-2020-INIT/en/pdf

European Parliamentary Research Service (EPRS). (2023). *Ukrainian agriculture: From Russian invasion to EU integration.* https://www.europarl.europa.eu/RegData/etudes/BRIE/2024/760432/EPRS_BRI(2024)760432_EN.pdf

Food and Agriculture Organization (FAO). (2003). *Operations manual for land consolidation pilot projects in Central and Eastern Europe.* http://www.fao.org/3/a-ai142e.pdf

Food and Agriculture Organization (FAO). (2004). *The design of land consolidation pilot projects in Central and Eastern Europe.* (FAO Land Tenure Studies No. 6). https://www.fao.org/4/y4954e/y4954e00.htm

Federal Law of the Federal Republic of Germany (BGBl). (2008). *Flurbereinigungsgesetz* [*Land Consolidation Law*]. *Federal Law Gazette I*, 19.12.2008, 2794. https://www.gesetze-im-internet.de/flurbg/BJNR005910953.html

Fehres, J. (2010). Die Unternehmensflurbereinigung – Beispiel für ein erfolgreiches Instrument zur Umsetzung von Infrastrukturmaßnahmen [„Unternehmensflurbereinigung" – an example of a successful instrument for implementing infrastructure measures]. *Zeitschrift für Vermessungswesen* [*Journal of Surveying*], *4*, 275–279.

Fehres, J. (2015). Artenschutzmaßnahmen als Anlass von Unternehmensflurbereinigungen [Species conservation measures as a reason for „Unternehmensflurbereinigung"]. *Zeitschrift für Vermessungswesen* [*Journal of Surveying*], *2*, 91–97.

Forschungsgesellschaft für Straßen- und Verkehrswesen (FGSV). (2011). *Hinweise zur Bewertung und Berechnung der Wirtschaftlichkeit von Unternehmensflurbereinigungen aus Sicht von Unternehmensträgern* [*Guidelines for assessing and calculating the economic viability of „Unternehmensflurbereinigung" from the perspective of business owners*]. FGSV Der Verlag.

Forschungsgesellschaft für Straßen- und Verkehrswesen (FGSV). (2024). *Hinweise für die Zusammenarbeit von Straßenbau und Flurbereinigung bei der Vorbereitung und Durchführung von Verfahren nach dem Flurbereinigungsgesetz – Hinweise zur Unternehmensflurbereinigung* [*Guidelines for cooperation between road construction and land consolidation in the preparation and implementation of procedures under the Land Consolidation Act – Guidelines for "Unternehmensflurbereinigung"*]. FGSV Der Verlag.

General Secretariat of the Council (GSC). (2023). *Proposal for a Regulation of the European Parliament and of the Council on nature restoration.* https://data.consilium.europa.eu/doc/document/ST-15907-2023-INIT/en/pdf

Hartvigsen, M. (2014). Land reform and land fragmentation in Central and Eastern Europe. *Land Use Policy*, *36*, 330–341. https://doi.org/10.1016/j.landusepol.2013.08.016

Hartvigsen, M. (2015). Integrated voluntary land consolidation – A third model for land consolidation in Central and Eastern Europe. *FAO Land Tenure Journal*, *1*, 9–43.

Hartvigsen, M., Versinskas, T., Vidar, M., Mitic Arsova, K., Van Holst, F., & Gorgan, M. (2019). *FAO recommendation on land consolidation legislation.* Paper presented at the *World Bank Conference on Land and Poverty*, Washington, DC, March 25–29, 2019.

Hendricks, A., & Lisec, A. (2014). Komasacije pri velikih infrastrukturnih projektih v Nemciji [Land consolidation for large-scale infrastructure projects in Germany]. *Geodetski Vestnik*, *58*(1), 46–68.

Hendricks, A., Schumann, M., Adjinski, A., Bix, D., Hindorf, M., & Weber, Th. (2019). Die europäische Wasserrahmenrichtlinie: Umsetzungsprobleme und Verbesserungsansätze durch die Flurbereinigung [The European Water Framework Directive: Implementation problems and approaches to improvement through land consolidation]. *Zeitschrift*

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für Vermessungswesen [*Journal of Surveying*], *19*(5), 284–291.

International Centre for Ukrainian Victory (ICUV). (2024). *The impact of Russia's full-scale invasion on the planted areas in Ukraine*. https://ukrainianvictory.org/wp-content/uploads/ICUV-Research-Presentation-EN.pdf

Kötter, T., Groß, B., & Pils, C. (2017). *Der Beitrag von Bodenordnungsverfahren nach dem FlurbG zur Reduzierung der Flächeninanspruchnahme und zur Steigerung der Flächeneffizienz in Nordrhein-Westfalen* [*The contribution of land consolidation procedures under the Land Consolidation Act to reducing land use and increasing land efficiency in North Rhine-Westphalia*]. Rheinische Friedrich-Wilhelms-Universität Bonn, Landwirtschaftliche Fakultät, Lehr- und Forschungsschwerpunkt Umweltverträgliche und Standortgerechte Landwirtschaft USL [University of Bonn, Faculty of Agriculture, Teaching and Research Focus: Environmentally Sound and Site-Appropriate Agriculture (USL)]. https://hdl.handle.net/20.500.11811/1282

Martyn, A., & Krasnolutskyi, O. (2011). Konsolidatsiia zemel silskohospodarskoho pryznachennia ta pravovi mekhanizmy yii zdiisnennia v Ukraini [Agricultural land consolidation and its legal mechanisms in Ukraine]. *Zemlevporiadnyi visnyk* [*Land Management Bulletin*], *5*, 16–21.

Martyn, A., Koshel, A., Hunko, L., & Kolosa, L. (2022). Land consolidation in Ukraine after land reform: Voluntary and forced mechanisms. *Acta Scientiarum Polonorum. Administratio Locorum*, *21*(2), 223–229. https://doi.org/10.31648/aspal.6702

NASA Harvest Consortium. (2023). *Farming amidst a war: Satellite data reveals productive yet challenging season for Ukraine*. https://www.nasaharvest.org/news/farming-amidst-war-satellite-data-reveals-productive-yet-challenging-season-ukraine

Nivievskyi, O., & Neyter, R. (2024). An interim assessment of the war-induced damages and losses in Ukraine's agriculture. *Ukrainian Analytical Digest*, *5*, 2–7. https://doi.org/10.3929/ethz-b-000665476

Nobis, K., Schumann, M., Lehmann, B., & Linke, H.-J. (2020). *Die Anwendung der ländlichen Bodenordnung bei der Renaturierung und naturnahen Entwicklung von Fließgewässern* [*The application of rural land consolidation in the renaturation and near-natural development of flowing waters*]. Springer Spektrum Wiesbaden. https://doi.org/10.1007/978-3-658-30253-5

Popov, A. (2015). Konsolidatsiia zemel, yak instrument staloho rozvytku silskykh terytorii [Land consolidation as a tool of sustainable rural development]. *Molodyi vchenyi* [*Young Scientist*], *11*(26), Part 2, 94–101.

Popov, A. (2018). Pererozpodil zemel v umovakh konsolidatsii: administratyvnyi i tekhnichnyi aspekty [Land reallocation in conditions of consolidation: Administrative and technical aspects]. *Science and Education a New Dimension. Humanities and Social Sciences*, *VI*(26), 34–39.

Popov, A. S. (2016). Uroky provedennia konsolidatsii zemel silskohospodarskoho pryznachennia v krainakh Tsentralnoi i Skhidnoi Yevropy [Lessons from agricultural land consolidation in Central and Eastern Europe]. *Ekonomika ta suspilstvo* [*Economy and Society*], *2*, 459–465.

Popov, A. S. (2017). Pererozpodil zemel v umovakh konsolidatsii: Pravovyi aspect [Land reallocation in conditions of consolidation: Legal aspect]. *Współpraca Europejska* [*European Cooperation*], *12*(31), 24–38.

Popov, A., Tymoshevskyi, V., & Poliakh, V. (2022). Costs, benefits and obstacles to the adoption and retention of shelterbelts: Regional perception and mind map analyses for Ukraine. *Geomatics and Environmental Engineering*, *16*(2), 157–176. https://doi.org/10.7494/geom.2022.16.2.157

Samoiliuk, M. (2025). *Ukraine war economy tracker*. Centre for Economic Strategy. https://ces.org.ua/en/tracker-economy-during-the-war/

Shvorak, A., & Yevsiukov, T. (2014). Sposoby ta metody konsolidatsii zemel silskohospodarskoho pryznachennia [Ways and methods of consolidation of agricultural lands]. *Ekonomist, 8*, 44–48.

State Forest Resources Agency of Ukraine (SFRAU). (2024). *Ukraine is the most heavily mined country in the world – according to UN estimates!* State Forest Resources Agency of Ukraine. https://forest.gov.ua/en/news/za-otsinkamy-oon-ukraina-naibilsh-zaminovana-kraina-u-sviti

Stezhensky, A. (2025). *Ukraine loses 20% of its farmland to war*. The new voice of Ukraine. https://english.nv.ua/business/ukraine-loses-20-of-its-farmland-since-start-of-full-scale-war-says-agriculture-minister-50499092.html

Stupen, M., & Dudych, H. (2015). Orenda yak forma konsolidatsii zemel [Lease as a form of land consolidation]. *Ekonomist* [*Economist*], *7*, 34–37.

Thomas, J. (2006a). Attempt on systematization of land consolidation approaches in Europe. *Zeitschrift für*

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Geodäsie, Geoinformation und Landmanagement [*Journal of Geodesy, Geoinformation and Land Management*], *3*, 156–161.

Thomas, J. (2006b). What's on regarding land consolidation in Europe? In *Proceedings of the XXIII FIG Congress: Shaping the Change* (October 8–13). Munich, Germany. http://www.fig.net/pub/fig2006/papers/ts80/ts80_03_thomas_0311.pdf

Thomas, J. (2011). Uncontrolled land consumption versus resource-saving land use in Germany. *Land Tenure Journal*, *1*, 79–99.

Thomas, J. (2024). *Handbook on rural land readjustment and land consolidation in Germany*. Lysenko Mykola.

Veršinskas, T., Vidar, M., Hartvigsen, M., Mitic Arsova, K., van Holst, F., & Gorgan, M. (2020). *Legal guide on land consolidation: Based on regulatory practices in Europe* (FAO Legal Guide No. 3). FAO. https://doi.org/10.4060/ca9520en

Verkhovna Rada of Ukraine (VRU). (2001). *Zemelnyi kodeks Ukrainy* [*Land Code of Ukraine*] (Ukraine). https://zakon.rada.gov.ua/laws/show/2768-14#Text

Verkhovna Rada of Ukraine (VRU). (2003). *Pro zemleustrii* [*On land-use planning*], *Law of Ukraine of May 22, 2003*, *No. 858-IV (as amended on December 15, 2024)* (Ukraine). https://zakon.rada.gov.ua/laws/show/858-15#Text

Verkhovna Rada of Ukraine (VRU). (2004). *Pro derzhavnu reiestratsiiu rechovykh prav na nerukhome maino ta yikh obtiazhen* [*On State Registration of Real Estate Rights and Their Burdens*], *Law of Ukraine of July 1, 2004, No. 1952-IV (as amended on November 15, 2024).* (Ukraine). https://zakon.rada.gov.ua/laws/show/1952-15#Text

Verkhovna Rada of Ukraine (VRU). (2009). *Pro vidchuzhennia zemelnykh dilianok, inshykh obiektiv nerukhomoho maina, shcho na nykh rozmishcheni, yaki perebuvaiut u pryvatnii vlasnosti, dlia suspilnykh potreb chy z motyviv suspilnoi neobkhidnosti* [*On Alienation of Land Plots, Other Real Estate Objects Located on Them, Which Are in Private Ownership, for Public Needs or Reasons of Public Necessity*], *Law of Ukraine of November 17, 2009, No. 1559-VI (as amended on November 8, 2024)* (Ukraine). https://zakon.rada.gov.ua/laws/show/1559-17#Text

Verkhovna Rada of Ukraine (VRU). (2011). *Pro Derzhavnyi zemelnyi kadastr* [*On State Land Cadaster*], *Law of Ukraine of July 7, 2011, No. 3613-VI (as amended on November 8, 2024)* (Ukraine). https://zakon.rada.gov.ua/laws/show/3613-17#Text

Verkhovna Rada of Ukraine (VRU). Committee on Agrarian and Land Policy. (2024). *Food security for Ukraine and the world in the context of the peace formula*. https://komagropolit.rada.gov.ua/news/main_news/75536.html

Weiß, E. (2008). Einige wirtschaftliche, rechtliche und technische Aspekte zum Bau der Saaletalsperre bei Hohenwarte in den Jahren 1935–1941 [Some economic, legal and technical aspects of the construction of the Saale Dam near Hohenwarte in the years 1935–1941]. *Mitteilungsheft des DVW Hessen und DVW Thüringen* [*Newsletter of the DVW Hesse and DVW Thuringia*], *2*, 2–14.

Weitkamp, A. (2011). Die Unternehmensflurbereinigung in der Praxis ["Unternehmensflurbereinigung" in practice]. In E. Hepperle, R. W. Dixon-Gough, Th. Kalbro, R. Mansberger, & K. Meyer-Cech (Eds.), *Core themes of land use politics: Sustainability and balance of interests* (pp. 149–160). vdf Hochschulverlag AG Zollikon.

World Bank. (2025). *Ukraine: The Fourth Ukraine Rapid Damage and Needs Assessment (RDNA4).* https://documents1.worldbank.org/curated/en/099022025114040022/pdf/P180174-ca39eccd-ea67-4bd8-b537-ff73a675a0a8.pdf

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