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Land Consolidation Considering Natural Afforestation

Abstract: The article highlights the problem of natural agricultural-land afforestation with insufficient forest cover of the area. The article purports to substantiate land consolidation aimed at the rationalisation of agricultural and forest land management in such conditions. The authors identify the main approaches to the issue of natural agricultural land afforestation. The afforested areas of agricultural land are suggested for redesignation as a forest resource as a result of a swap and reallocation of land plots. As an example, consolidation of available land, in the conditions of natural afforestation, has been accomplished based on a number of land masses in Chernihiv Oblast', Ukraine. Resulting from the project implementation, better configuration and improved layout of agricultural land plots have been achieved, while the length and placement of country lanes have been optimized. The reforested agricultural areas within the specific land mass have been redesignated as a forest resource. The advantages and disadvantages of natural afforestation in land consolidation are identified in contrast to alternative approaches. The research findings can be used by territorial communities in the upgrade of land management practices, laying out and redesign of landscape parks and other nature conservation areas that include areas of business activity.

Keywords: agricultural land, land consolidation, natural afforestation, land reallocation, land exchange

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1. Introduction

Land consolidation is an important constituent of sustainable regional development [1, 2]. For Eastern Europe, land consolidation objectives are shifting from those of agricultural production to the formation of environmental and infrastructural facilities. An increasing importance is being attached to multifunctional land consolidation. Owing to the wide range of objectives, we distinguish between various land-consolidation types: rural, forestry, urban, regional and environmental. The consolidation of each type usually addresses the spatial improvement of lands in accordance with their specific designation.

Demetriou et al. [3] singles out possible combinations of various land consolidation types within one project. The design of such projects is less well described in the literature and there are fewer implementation cases. This is explained by the complexity of correlating the purposes and land reallotment justification. At the same time, the prospects of such approaches are especially discernible, when the land-use type alteration is prompted by external natural or anthropogenic factors [4].

Land consolidation of agricultural land masses with partial natural afforestation has been addressed in this study. This involves the optimization of land use, where the plots, although they border on woods or reforested areas, have been out of use for a protracted period and afforested. Such processes are one of the most relevant issues affecting agricultural production [5], entailing extra costs for agricultural rehabilitation. For naturally afforested land tenures, the following issues arise: evaluation of afforestation productivity [6], practicability of the land redesignation and its inclusion into the forest resource [7]. Forest land consolidation targets privately-owned forest land fragmentation [8, 9] particularly old forests [10]. Forest land consolidation of young forests is not addressed.

This issue is urgent for the agricultural land management of Ukraine, together with the challenges of fragmentation, irrational configuration and placement [11]. We suggest resolving the issue of natural agricultural land afforestation in the course of land consolidation.

The working hypothesis is that the following issues can be comprehensively resolved by means of land reallotment in the course of land consolidation: 1) optimization of overall dimensions and placement of agricultural land plots; 2) retention of afforested land plots and their inclusion into the forest resource.

The purpose of this paper is to substantiate land consolidation aiming at the rationalisation of agricultural and forest land management in the environment of natural agricultural land afforestation.

2. Analysis of the Problems

Cases of natural afforestation are widespread in Ukraine. According to expert estimates, there are 3,000 to 5,000 km² of young forests in Ukraine [12].

Based on experts' commentaries, most of the unaccounted forests in Ukraine are situated on government and communally-owned land. However, the greatest management challenge is presented by significant afforested privately-owned land tenures. Over the course of land relations reform, the land, previously in the ownership of collective farms or government-owned, was handed over to private individuals in equal shares [13, 14]. To date, a significant number of current landowners (the heirs/heiresses of former agricultural enterprise workers) are unwilling or cannot engage in farming, other landowners are deceased, still others never came into their ownership right. Due to the absence of farming activity on those allotments, the said land plots are becoming subject to natural afforestation. The start of agricultural-land market in Ukraine creates new prospects for such land plots' better management.

Any solution to the issue of agricultural land afforestation needs to take into account uncontrolled wood logging [14], and the optimal proportion of forest land. The optimal percentage of forest land (per cent of the total land area) of Ukraine is only 16.7%. This index is much lower than the EU average (39.7%), or Europe & Central Asia (38.5%) [15]. According to the State Forest Resources Agency of Ukraine, the optimal percentage of forest land should be 20% [16].

Nowadays, forest clearing for agricultural use is an urgent global issue, and the possibilities of preventing this by providing alternative land are considered [17].

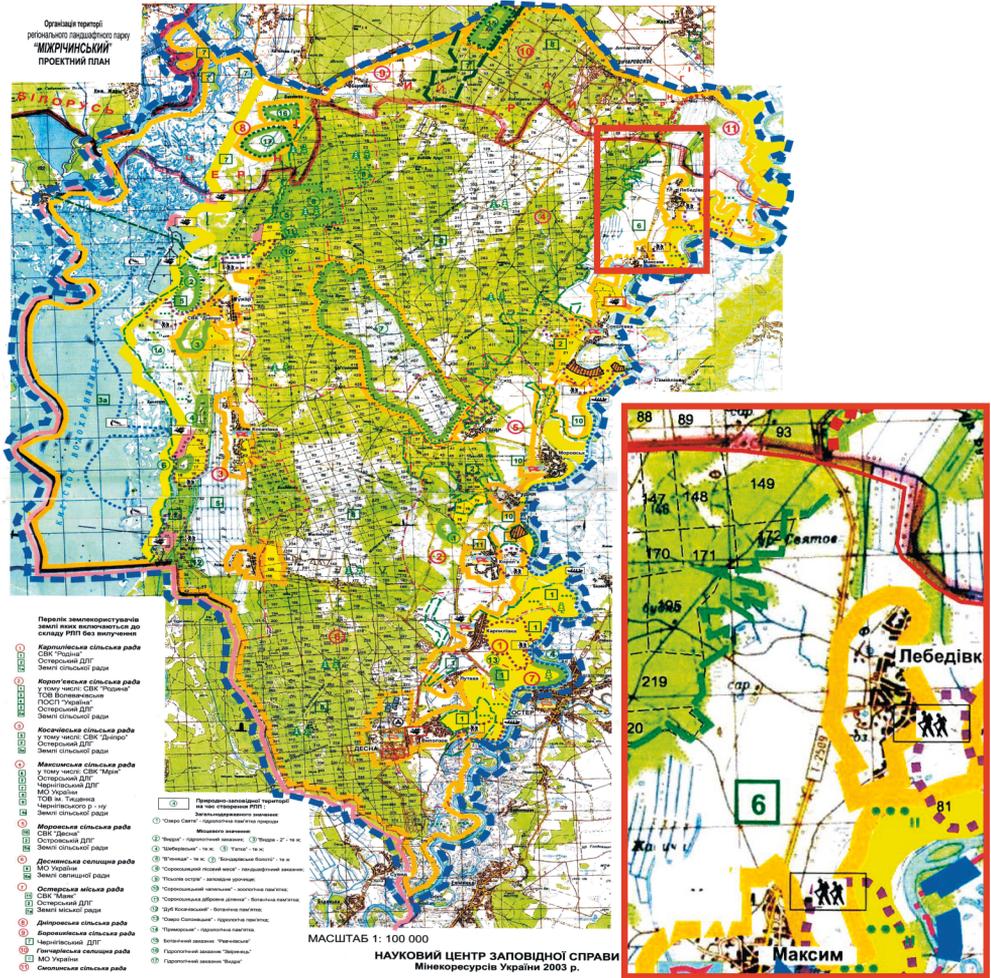
3. Materials and Methods

3.1. Study Area

The research has been carried out in the Mizhrichynskyi Regional Landscape Park (hereinafter referred to as the Landscape Park). The total area of the Landscape Park is about 78,754 mln m², it is the largest landscape park in Ukraine. The Landscape Park is situated in the interfluvium of the Dnipro and Desna rivers on the territory of Cozeletskyi and Chernihivskyi districts. Under the law of Ukraine [18], the Landscape Park is designated as a nature reserve of Ukraine, designed to conserve endemic or unique natural habitats and natural monuments in the natural environment, and to offer a place for recreation.

According to the regulations, the territory of the Landscape Park is divided into zones of various use. The zone of economic activity is situated in the north-east of the Landscape Park (Fig. 1). Within the economic zone, there are agricultural land plots, rural communities, communal infrastructure facilities, etc. The land consolidation project has been implemented on the area of 6,908,450 m² within the economic zone.

The land consolidation project included privately owned agricultural land, previously added to the territory of the Landscape Park. The land plots have been leased to the Mriya Agricultural Production Cooperative, specializing on cereals and technical crops.



- Regional Landscape Park boundaries
- Administrative region boundaries
- - - Village and settlement council boundaries
- The boundaries of land, included into the Regional Landscape Park without expropriation from land users
- 4 Maxim Village Council

- 6 Mriya (Dream) agricultural production cooperative
- 10 Forest compartment boundaries and number
- 10 Nature reserve zone
- 10 Controlled recreation zone
- 10 Permanent recreation zone
- 10 Economic activity zone
- A B Forest cover area
- Hayfields, pasture fields, fallow and plowed fields

- Water-logged land
- Rivers, lakes
- Regional highways
- District highways
- Tourist hiking routes
- Village council
- Village built-up areas
- Recreation and tourism locations
- Ponds, drainage amelioration canals

Fig. 1. Mizhrichynskiy Regional Landscape Park sketch map

Source: [19]

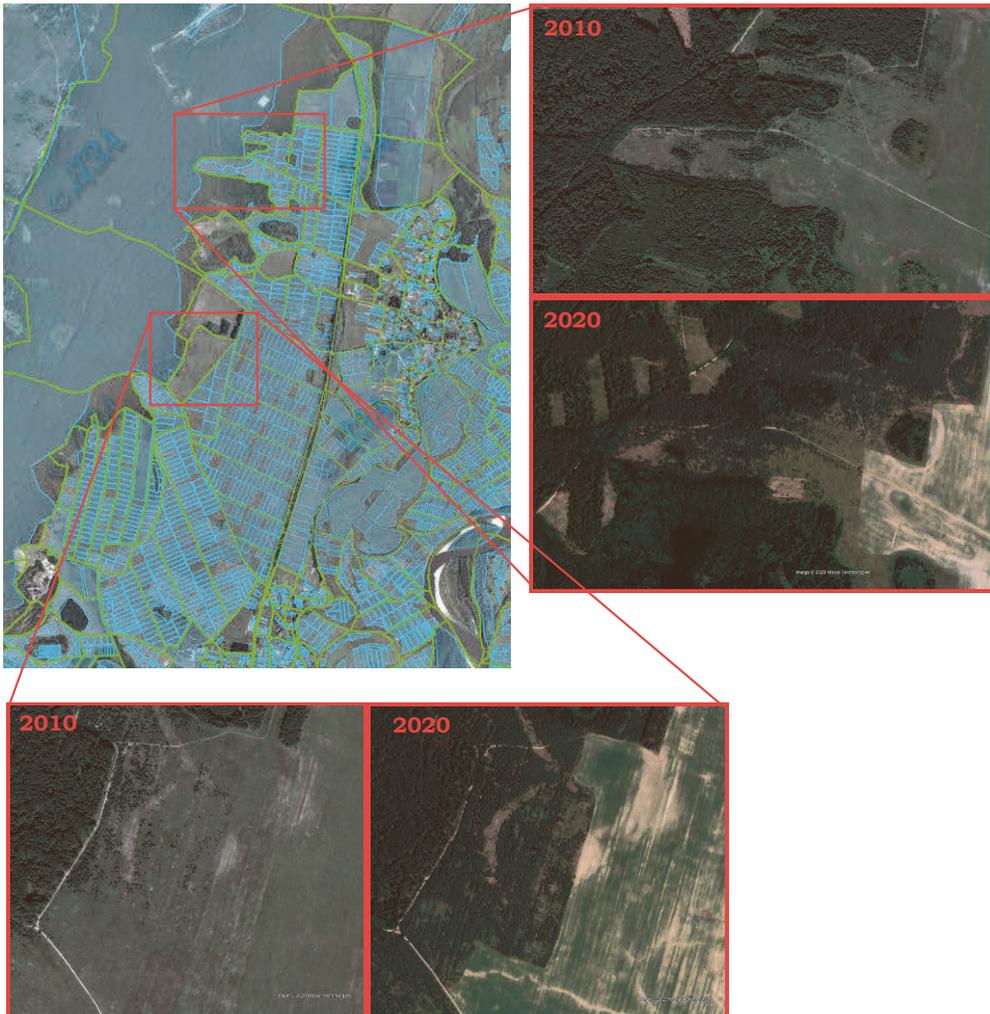


Fig. 2. Land plot vegetation cover development history

Source: authors' own elaboration based on data from the Public Cadastral Map [20] website; created using the Google Earth Pro 7.3.4 software (based on images by Maxar Technologies (photo survey from 9.10.2010); Maxar Technologies, CNES/Airbus (photo survey from 4.06.2020))

The project territory includes 415 land plots established after the collective farm closed down. Ten land plots were left in government ownership as a land reserve. The rest of the land plots, with an average area of 4,371 m² to 19,777 m², were privatized. The project territory borders on the government-owned forest land and encompasses randomly scattered wooded outlines. As we can see in Figure 2, land plots bordering on wooded areas (forests and afforested outlines) have been afforested over the last few decades. Historical data was analysed using the Google Earth Pro 7.3.4 software.

At the moment, these land plots are covered with young forest, mostly pine, and are uncultivated. Over a ten-year period, the land area used for agricultural production has decreased by almost 2,470,000 m² (Fig. 3). Afforestation has reached a point that prevents agricultural production without clearing.



Fig. 3. Project territory vegetation cover development history

Source: created using the Google Earth Pro 7.3.4 software (based on images by Maxar Technologies (photo survey from 9.10.2010); Maxar Technologies, CNES/Airbus (photo survey from 4.06.2020))

3.2. Approaches to the Issue of Natural Land Afforestation

The issue of natural agricultural land afforestation can be resolved in several ways. The writers suggest a classification presented in Figure 4. In most cases, the afforested agricultural land plots are cleared.

The transfer of afforested land plots to forest resource, i.e., redesignation of land use type, is another option. Such an alternative is extensively considered, and creation of jointly-owned forests is substantiated [9, 21]. As an example, the afforested land plots in communal and government ownership are planned for transfer to forest resource to improve the national percentage of forest land of Ukraine [22].

For private land plots, the repurposing of land use type should be initiated by the owner of the land plot. Based on existing research data, landowners do not demonstrate much interest in the said redesignation [23]; and initiatives on private forest formation in Ukraine are now at the stage of discussions [24], while initiatives on joint ownership are so far absent.

Another alternative to naturally afforested agricultural land conservation is buying out afforested land plots from their owners. This approach is risky at the stage of sale negotiation and defining the redemption price. The key issue in the transaction is the landowner's commitment to selling their land plot.

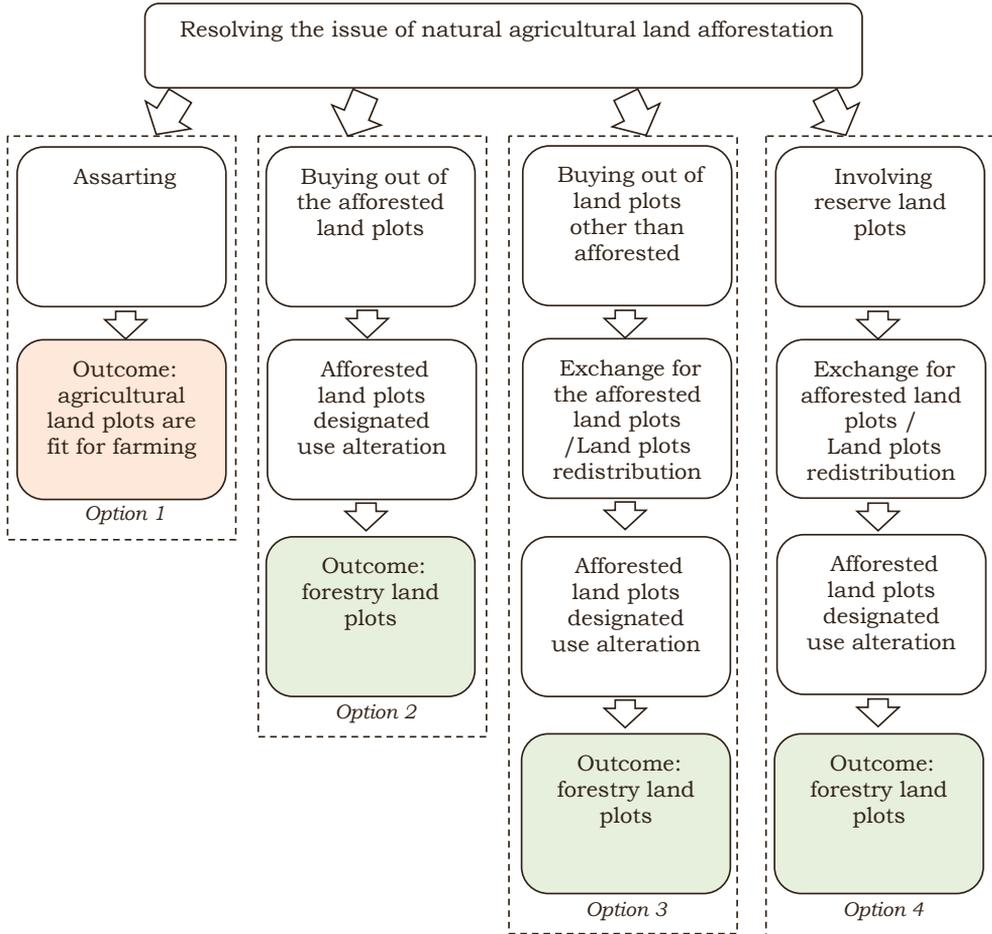


Fig. 4. Basic approaches to the issue of natural agricultural land afforestation

There are two other currently most beneficial approaches to land consolidation, aimed at conservation of naturally afforested land plots and their redesignation to forest resource. These approaches are based on land reallocation. They are as follows:

- afforested land plots are exchanged for non-afforested land plots, previously bought out by the territorial community,
- afforested land plots are exchanged for non-afforested land plots, created on reserve area.

The final stage involves land reallocation. As a result, the designated use of afforested communal land plots is altered to forest land.

Taking into consideration the importance of the project territory for nature conservation, keeping young forest on the afforested agricultural land is rational.

General reallocation methodology has been adjusted to conform to this [25]. However, the conservation of trees on afforested land plots is not the only goal of the land consolidation project. It also suggests developing a joint consolidated land mass, improving the configuration of land plots (the formation of land plots in the form of a rectangle and rectangular trapezoid is suggested), as well as optimizing the road network. A preliminary plan is developed according to the objectives of reallocation, where forest and agricultural project land masses are formed. At the following stage, buying out of afforested land plots, with owners' consent, is initiated, reserve territories are involved and buying out of non-afforested land plots is carried out.

Reallocation modeling based on the heuristic method is carried out [25]. The implementation of reallocation should meet the requirements [26], predefined by the formula (1):

$$\sum_{i=1}^n K_{ij} B_{ij} x_{ij} = \sum_{k=1}^l K_{kj} B_{kj} S_{kj}, \quad j = 1, 2, \dots, m \quad (1)$$

where K_{ij} is the coefficient characterizing the combined impact of qualitative and spatial and technological characteristics of the land plot after readjustment; B_{ij} is the coefficient characterizing the land plot soil quality by natural and acquired properties from the point of view of growing basic crops ("ball-bonitet" in Ukraine) after readjustment; x_{ij} is the area of land plot formed after readjustment; K_{kj} is the coefficient characterizing the combined impact of qualitative and spatial and technological characteristics of the land plot before readjustment; B_{kj} is the coefficient characterizing the land plot soil quality by natural and acquired properties from the point of view of growing basic crops before readjustment; S_{kj} is the area of the land plot k belonging to the owner j before readjustment; l is the quantity of land plots belonging to the owner j before readjustment; n is the quantity of blocks involved in the project; m is the quantity of landowners involved in the project.

At the final stage, the characteristics of reallocated land plots – area, configuration, and placement – are defined, the formation of land plots in the project land mass is carried out – the final plan is formed.

In this scenario, reserve areas involved in the land consolidation project are of crucial importance.

4. Reserve Areas

It suggests involving land which can be defined as reserve areas. It is about the existing land reserves within land masses, and reserve areas, which will appear in the course of the reallocation while optimizing land tenure, e.g., optimizing the road network. Government-owned land reserves, which are the land of the Soviet-era collective farms that was transferred to government over the course of privatization, fall into the existing land reserves. Not owned or used land plots are also considered

to belong to the existing land reserves. These land plots are defined as land shares without proper registration of ownership rights and escheated inheritance.

The process of the privatization of Soviet state and collective farms included a few stages. During the first stage, individuals were granted land shares of the farm land, and respective land plots were demarcated at the following stages.

A land share without proper registration of ownership rights is a land share with no document of title issued or a land share without ownership right acknowledged in accordance with the legislation in effect [27]. Land plots of escheated inheritance are land plots, whose owners are deceased and there are no heirs/heiresses or the latter are either deprived of the right of inheritance or did not accept succession. This status is determined through court decision [28].

Escheated inheritance and land shares without proper registration of ownership rights make up a significant share of agricultural land (Fig. 5). According to expert estimates [29], escheated inheritance comprises about 10–15% of land plots of each agricultural land mass, circa one billion square metres in total. Chernihiv Oblast' (oblast' is the main unit of administrative division in Ukraine), where the land consolidation project took place, has one of the largest land reserves of this type (Fig. 5).

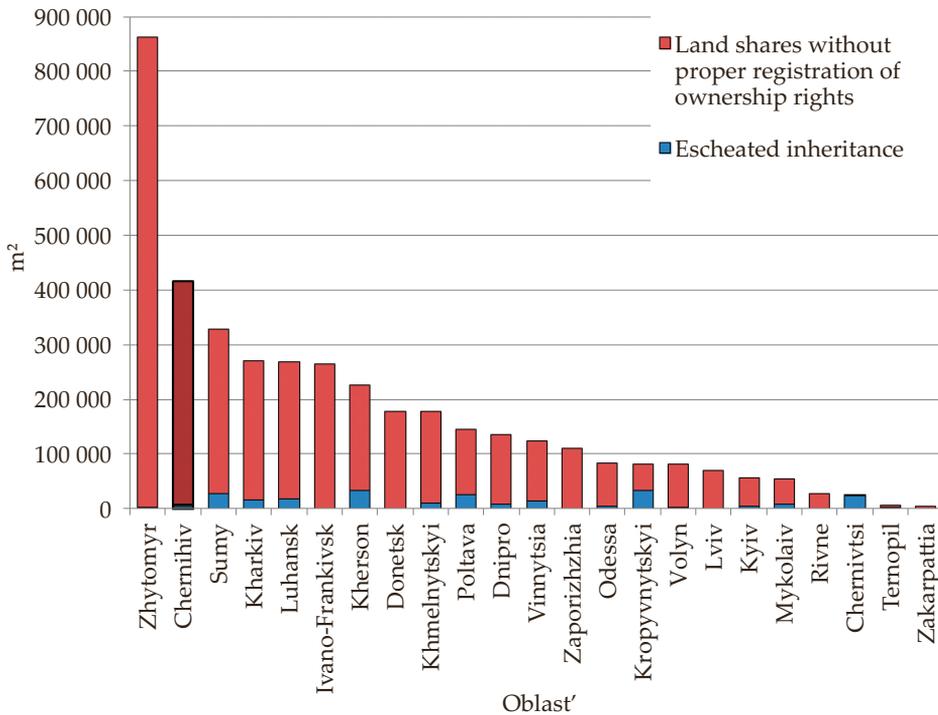


Fig. 5. Escheated inheritance and land shares without proper registration of ownership rights in Chernihiv and other oblast's of Ukraine [m²]

Source: authors' elaboration based on available data [29, 30]

Under the Civil Code of Ukraine [28], land plots found escheated inheritance by the court, become the ownership of local territorial community. At the moment, according to official data, circa 49% of land defined as escheated inheritance, is leased.

According to the latest version of the Law of Ukraine on the Order of Land Plot Demarcation for the Owners of Land Plots (Shares) [27], it specifies that in case the owner of a land share without proper registration of ownership rights or their heirs/heiresses do not register title in their land plot before 1 January, 2025, they will be deemed to have given up their right for the acquisition of the land plot.

A land share without proper registration of ownership rights is granted to the local territorial community under an established procedure after it has been demarcated as a land plot. In the space of 7 years from the date of state registration of the communal ownership right, such land plots may not be privatized except by the owner of the land share or their heirs/heiresses [28].

5. Results and Discussion

Land reallocation within the project territory was complicated by the existing network of land reclamation canals. The afforested land plots were exchanged for reserve areas and land plots which had been bought out. Subsequently, land reallocation was carried out. The owners of afforested land plots got peer agricultural land plots within the project territory. The forest land area was enlarged due to an exchange of afforested land plots for reserve land plots and the redistribution of land plots.

Over the course of reallocation (Fig. 6):

- the configuration and placement of land plots were improved;
- the placement of country lanes was optimized and their length within the project territory was minimized by 2,410 m;
- 2,470,222 m² of afforested agricultural land was added to the forest resource.

The reallocation involved: 356 land plots in private ownership; 10 reserve government-owned land plots with an area of 1,379,639 m²; 48 land plots falling under the category of escheated inheritance and land shares without proper registration of ownership rights with a total area of 416,988 m²; a previously bought out land plot with an area of 19,776 m².

The suggested approach is most rewarding when there is a sufficient supply of land plots for sale, including the non-afforested ones, or reserve government-owned and communal land. The conservation of natural afforestation is one of the most essential advantages. Owners willing to cultivate land, get peer land plots for their agricultural activities. Other options provide either selling by such landowners or redesignation of land plots as forest land.

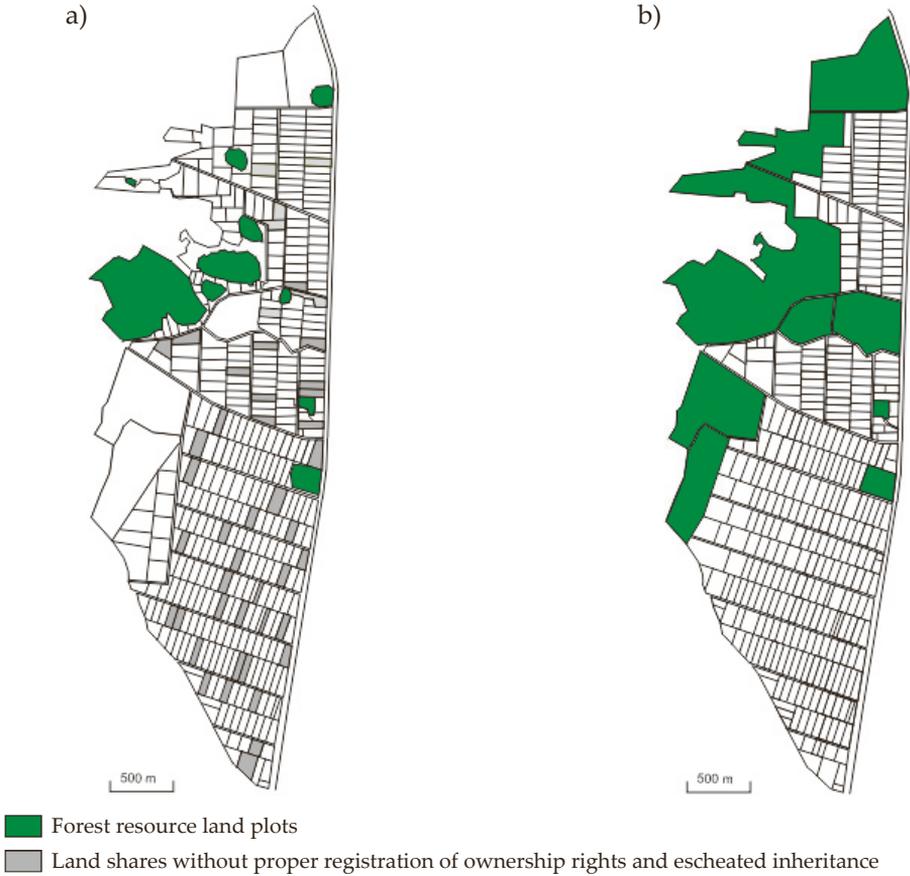


Fig. 6. Project territory land consolidation project:
 a) before land consolidation; b) after land consolidation

In comparison with other approaches to forest land consolidation [9], the suggested approach has an advantage: land plots redesignated as forest reserve during the project implementation, are already covered with young forest and there is no need for reforestation; natural forest is more resilient than planted [23], as its biocenosis is already in place. It is especially important for nature conservation areas, landscape parks in particular [18]. The suggested approach is applicable in cases where private forests are not stipulated by legislation or only rarely.

At the same time, such reallocation measures require legal regulation. Only now is a draft law on land consolidation being discussed in Ukraine [31]; issues of afforestation and undocumented/unaccounted forests are not regulated by legislation. The priority of agricultural land is defined by legislation of Ukraine [32], marginal and degraded land shall be subject to afforestation [33]. The said provisions should be revised for nature conservation areas.

The authors suggest amending the current legislation with regulations on the redesignation of afforested agricultural land plots to forest reserves in the course of land consolidation. At the first stage, this regulation should be provided for nature conservation areas. In the future, legislation should stipulate land reallocation providing peer agricultural land plots to those owners of afforested land plots that are not willing to sell or alter the designated use of their land plots.

6. Conclusion

The insufficient percentage of forest land, fragmentation, irrational configuration of agricultural land as well as the natural afforestation of agricultural land are priority issues for Ukraine. We have considered land consolidation aiming at the rationalisation of agricultural and forest land tenure.

The authors consider the enlargement of forest land area through the exchange of afforested land plots for reserve land plots and reallocation of land plots. Land tenure in the economic zone of nature conservation area has been chosen for approval. For such territories, the conservation of young forest is of special importance, because it is connected to the conservation of biocenoses, developed on the afforested land.

The land consolidation project has been implemented for two land masses in Chernihiv Oblast'. The key results are: the improvement of the configuration and placement of agricultural land plots, the optimization of country lanes placement and the reduction of their length by 2,410 m. Afforested agricultural land has been redesignated as forest resource.

The project demonstrates that in case there is a sufficient supply of land plots for sale, including non-afforested ones, or reserve government-owned and communal land, this algorithm has advantages as compared to alternative approaches. The article considers the challenging issues of legislative regulation, which can arise at the implementation of the suggested approach. Subsequent research should look into the justification of forest consolidation involving naturally afforested land with an application of the suggested approach.

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