ГЕОДЕЗІЯ ТА ЗЕМЛЕУСТРІЙ. ГЕОІНФОРМАЦІЙНІ ТЕХНОЛОГІЇ МОДЕЛЮВАННЯ СТАНУ ГЕОСИСТЕМ

GEOSPATIAL DATABASE USE FOR LAND CONSOLIDATION OBJECTIVES IN UKRAINE

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Abstract. *The issue of geospatial database provisioning for land consolidation objectives in Ukraine has been scrutinized in the article. The thematic justification is predefined by the increasing need for land consolidation and the need for the provision of the land consolidation process with the updated, full and valid data. The goal of the research is the substantiation of a set of the subject geospatial data as a constituent of the national infrastructure needed for managerial decisions on agricultural land consolidation and the respective land management plan development. Basic geospatial data sets predefined by the legislation in effect have been examined from the prospect of land consolidation. Thematic geospatial data sets have been suggested.*

The use of the suggested geospatial data sets in the course of the key stages of land consolidation has been analysed. The use of geospatial data at the implementation of a land consolidation project using the land reallotment optimization model has been examined. The research results can be used at the land consolidation decision making support, land resources management, development of specialized geoportals, in the following scientific researches on the development of the national geospatial data infrastructure, land consolidation in Ukraine.

Keywords: *geospatial data, land consolidation, agricultural land, agricultural land market, land reform.*

Rationale.

Land consolidation is one of the foreground land management tasks at the current stage of land relations especially with the prospect of the agricultural land market. Agricultural land market does create new opportunities for land consolidation by land plot bying and selling, however, according to Food and Agriculture Organization of the United Nations, it develops preconditions for land fragmentation [1].

At the moment, the issues of the economic, technical substantiation, and the effectiveness evaluation of land consolidation are being carefully scrutinized. Information provision is one of the most important land consolidation aspects to be examined.

In the international practice, a great attention is paid to the formation of approaches to the development of GIS web platforms to display the agricultural land use status [2], land use restrictions, recommendations on the agricultural land tenure planning [3], GIS models to support the agricultural land tenure planning and land consolidation development [4], the evaluation of data needed to be added to information systems for land consolidation [5], current transformations monitoring.

Relations arising due to the creation, functioning and development of geospatial data infrastructure in general and metadata, geoportals, geoinformation systems as its constituents are covered by the Law of Ukraine on the National Geospatial Data Infrastructure [6]. Geospatial data sets (types) are defined by the legislation of Ukraine.

The formation of geospatial data infrastructure is currently a widely considered issue [7]. Especially, the issues of creation, functioning and the perspectives of the national geospatial data infrastructure development and the formation of sector-specific land and property registration systems on its basis, the improvement of legal aspects are reflected in the scientific research activities [8, 9]. However, at the moment, there are no researches on how the composition and demands to geospatial data satisfy the needs of land consolidation in Ukraine.

The goal of the research is the substantiation of a set of the subject geospatial data as a constituent of the national infrastructure needed for managerial decisions on agricultural land consolidation and the respective land management plan development.

Research methods and materials.

According to FAO, land consolidation is aimed at a more effective multifaceted rural area use through balancing the needs of agricultural industry, landscape planning, environment protection, recreation and transport [1], provides for merging and improvement of land plots [10]. Land consolidation should be carried out taking into consideration the land natural properties, economic and social conditions, administrative and territorial units boundaries [11, 12, 13]. According to the draft Law of Ukraine [14], which will regulate land consolidation issues, land survey projects on land plots consolidation will include:

- basis of land survey project;
- explanatory note;
- geodetic surveying and land surveying project data (in case land plots are formed);
- land plot area calculation details (in case they are formed);
- details on real estate units placed on land plots to be consolidated;
- agricultural and forestry production losses calculation (in cases envisaged by law);

- losses calculation;
- boundary marks collateral receipt (in case land plots are formed);
- boundaries staking act of protective zones, protective sanitary zones and special land use areas if present (in case land plots are formed);
- land plot use restrictions;
- graphical materials denoting the existing (actual) land plot(s) placement with the specification of ownership form, land owners and users;
- graphical materials denoting the designed land plot(s) placement with the specification of ownership form, land owners and users;
- cadastral plan;
- staking data (in case land plots are formed);
- land survey project approval data [14].

Geospatial database should provide up-to-date, correct and full information on agricultural land which allows to reallocate, merge or divide them aiming at the creation of new land tenures in accordance with the land consolidation objectives.

Key aspects which should be considered at land consolidation, are the following:

1. Land tenure shortcomings elimination.
2. Land conservation and rehabilitation, environmental deterioration prevention.
3. Fair land plots reallotment.
4. Choosing the optimal land consolidation option.
5. Separation of land plots subject to conservation or special use arrangements.

Demands to geospatial information supporting the land consolidation process should be formed according to the above mentioned aspects.

According to the Law of Ukraine On the National Geospatial Data Infrastructure [6], geospatial data are divided into basic and thematical geospatial data. Among the geospatial data basic sets (types) specified by the Law of Ukraine On the National Geospatial Data Infrastructure, the following data should be used at land consolidation: 1. Geographic names; 2. Administrative and territorial unit boundaries; 3. Addresses (in case the land plot is placed in an inhabited area); 4. Land plots boundaries and their attributive data, cadastral zoning (formed land plots and their parts, agricultural land masses, cadastral zones and blocks); 5. Transportation networks; 6. Hydrographic facilities (water features, swamps, storage reservoirs, hydrographic and hydroeconomic zoning, hydroeconomic systems; 7. Nature conservation areas and facilities; 8. Relief; 9. Terrain (land: agricultural land; bald land or land with minor green cover; forests and other land with tree cover; water; built up areas; land occupied by technical infrastructure facilities; land occupied by agricultural infrastructure facilities and other household buildings and farmyards; recreational land; land occupied by special designated use facilities); 10. Buildings and structures; 11. Soils (soil genetic types, agroproductional soil groups, natural and agricultural zoning, soil materials, stratigraphic division, glacial deposit genetic types, granulometric composition, rockiness, erosional feature, average slope, potential moisture retention capacity); 12. Land tenure types (functional zones, land category by the designated use, land and land plot designated use types); 13. Vital activity security (sanitary and epidemiological situation, influence of the environment state on the human health); 14. Monitoring data: observation and measuring the environment state results and other ecosystem parameters; 15. Industrial and logistical facilities (water intake facilities, warehouse facilities); 16. Agriculture and aquaculture facilities (agricultural facilities, including amelioration systems, greenhouses, orangeries, farmyards and buildings); 17. Population distri-

bution, demography; 18. Territorial zones, control zones, land use restrictions and accounting units (including protective zones, protective sanitary zones, special land use zones, water protection zones, coastal buffer zones, beach zones, easement areas, radioactive contamination zones, environmental disaster areas, special raw material zones foragricultural production); 19. Natural risk zones, environmental disaster areas, degraded land; 20. Biogeographical regions (natural and agricultural, eco-economic, erosion preventing and other types of zoning); 21. Mineral resources; 22. World heritage sites, their territory and buffer zones, objects of cultural heritage.

Basic data specified by Ukrainian legislation [6] are not sufficient for land consolidation, their structuring is necessary. Management decision making demands the provision of data characterizing agricultural land as the spatial basis, means of production and a natural resource and considering the land reallotment method [15].

In order to provide the effective land consolidation, local communities and land owners should be provided with accurate and up-to-date data on land reallotment among land owners and land users, existing land tenure shortcomings (strip farming, interspersing, boundaries brokenness), existing restrictions, land use regime in the restricted zones, normative monetary value, etc. It will allow to reveal the reallotment prospects and specify perspective for reallotment land tenures. Separating the stripped land plots and land tenures consisting of a number of land plots is an important task. Such approach facilitates the employment of automated reallotment models [16]. Reallotment prospects are predefined by the land use type, existing improvements and land use restrictions and encumbrances. Information on value should be indicated for each land plot.

Reallotment fairness is another important aspect [17]. This principle is compliant with «Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security. », defined by Food and Agriculture Organization of the United Nations (FAO) [18]. Fair reallotment is based on accurate and up-to-date data on land plot value, existing land use restrictions and encumbrances, etc.

The provision of data which will allow to gain the land consolidation objectives, provide information for using the key land consolidation methods and control the use of land and implementaion of land consolidation is necessary.

Research results and their discussion.

Taking into consideration the analysis, the formation of the key information blocks is suggested:
1. Basic data characterizing [6]:
   - coordinate and altitude systems,
   - state border of Ukraine,
   - water features and hydraulic facilities,
   - human settlements,
   - railways,
   - utility lines,
   - airports, sea ports and river ports,
   - geographic names,
   - digital terrain models,
   - orthophotomaps.
2. Data on land plots qualitative characteristics:
   - data on soil condition (by criteria set by standards in effect) with the following specification of land plots of especially valuable soil and land plots which need to be improved or renewed,
   - agricultural land composition,
   - date of the latest monitoring.

3. Land plot improvements data:
   - buildings and structures,
   - tree belt areas,
   - reclamation constructions,
   - roads and highways.
4. Data on land plots quantitative characteristics:
   - land plot area,
   - land tenure area (for land tenures consisting of a number of land plots),
   - agricultural land area (composition) within the land plot,
   - agricultural land mass area.
5. Placement data (of land plots and improvements) within:
   - administrative and territorial units,
   - agricultural land mass,
   - territorial community,

- cadastral division units (cadastral blocks, cadastral zones) the cadastral number is indicated,
- within the natural and agricultural zoning: natural and agricultural zones, provinces, counties, districts, mountain natural and agricultural areas,
- environmental and economic zoning,
- erosion preventing zoning,
- environmental zoning,
- territory evaluating zoning.

6. Distribution among land owners and land users data:
   - owner,
   - form of ownership,
   - user,

1. Data use analysis at land consolidation

Data type	Data according to the project[19]	Data use
Data on the distribution among land owners and users	Eighteen private land owners were involved in the reallotment within the project territory, whose land tenures were formed with the stripped land plots (2 to 4).	Preparation: initialization, land consolidation possibilities and practicability specification. Land management entities, employers, the order of development, endorsement, and approval of the project are defined by the data. The data are used at the stage of the reallotment methodology and development substantiation [19].
Placement data (of land plots and improvements).	Land plots are situated in the Kyiv Region in three adjacent agricultural land masses.	The data are included in the initial data at the preparation. Placement is considered at the stage of the reallotment methodology and development substantiation (for example, placement within an agricultural land mass is considered at the optimization model development [20]).
Data on land plots quantitative characteristics	Land consolidation project is implemented for eighteen land owners with the average land tenure area of 2.5 ha. Land tenures are formed from 2 to 4 land plots of cropland. Reallotment is implemented within a project territory of the total area of 43.2 ha.	The data are included in the initial data. The data are used at the stage of the reallotment methodology and development substantiation. The data are considered at the land consolidation project results evaluation.

Data on the qualitative characteristics	The project territory includes soil of a number of soil suitability groups: soddy podzolic and soddy non-gley and gleysolic clayed sand on sandy deposits; and soddy podzolic non-gley gleysolic on sandy loam deposits	The data are included in the initial data (land composition and soil quality predefines the possibility of reallotment). The data are used at the stage of the reallotment methodology and development substantiation [19].
Land use restrictions and encumbrances data	Restrictions and encumbrances are absent	The data are included in the initial data (they predefine the possibility/ impossibility of including the land plots into reallotment); The data are used at the stage of development. The data can be used at the land consolidation project results evaluation (for example, if the restrictions are successfully lifted as the result of the spatial improvement).
Land plot improvements data: buildings and structures, forest belts, reclamation constructions, highways and roads	Improvements on land plots are absent. The project territory includes three agricultural land masses bordered by general roads and afforestation belts	The data are included in the initial data. The data are used at the stage of the reallotment methodology and development substantiation. The data are considered at the land consolidation project results evaluation. The existence of improvements predefines the possibility of land reallotment (according to the methodology [21] land plots with improvements are not involved or involved in the last turn). The existence of improvements predefines the need for the improvement value reimbursement. The placement of improvements predefines the project masses characteristics [21].
Economic activity data: land plot use type, land plot designated use, buildings and structures functional use.	Land plots, involved into the reallotment, had been granted to private individuals for personal agriculture	The data are included in the initial data at the preparation. The data are used at the stage of the reallotment methodology and development substantiation. The data are considered at the land consolidation project results evaluation.
Land valuation data	The value of land plot before and after land consolidation has been specified	The data are included in the initial data at the preparation. The data are used at the stage of the reallotment methodology and development substantiation. The data are considered at the land consolidation project results evaluation.

- use type,
- use time.

7. Economic activity data:
   - land plot use type,
   - land plot designated purpose,
   - buildings and structures pragmatic use.
8. Land use restrictions and encumbrances data:
   - restriction or encumbrance type,
   - restriction causing object type,
   - beneficiary.
9. Land evaluation data:
   - normative,
   - expert,
   - land judgment.

The provided data blocks are basic for land consolidation objectives and are supported by regulatory legal acts and standards in effect.

Land consolidation implementation differs depending on the initial data, aims and methodologies used. The following principal stages can be singled out at the land consolidation implementation:

1. Preparation: initialization, land consolidation possibility and practicability evaluation;
2. Choosing and substantiation of the land consolidation methodology; design;
3. Results evaluation, options comparison (if predefined by the methodology).

We can analyse the provision with the necessary data on every stage (Table 1) on the example of land consolidation, implemented by the exchange of land plots using the reallotment optimization model [19].

As we can see, for a land consolidation project, a set of the thematic geospatial data which complement the basic sets, is very important at every project development stage.

Conclusions and prospects.

According to the examinations that have been carried out, necessity for the use of a set of thematic geospatial data at land consolidation has been substantiated. It has been suggested to complement the basic geospatial database with the extended data on the qualitative land plot characteristics, data on land improvements, quantitative characteristics, placement of land plots and improvements, distribution among land owners and users, economic activity, existing restrictions and encumbrances, and land valuation data. Thus, the initial stage is provided with data: initialization, land consolidation possibility and practicability substantiation; land consolidation methodology choice and substantiation; results evaluation, options comparison (if predefined by the methodology/project). The presented research is a basis for further examination on the optimization and automatization of the land consolidation process and the development of specialized geoportals.

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ЗАСТОСУВАННЯ БАЗИ ГЕОПРОСТОРОВИХ ДАНИХ ДЛЯ ЗАВДАНЬ КОНСОЛІДАЦІЇ ЗЕМЕЛЬ В УКРАЇНІ

Анотація. *У статті розгляд а ється питання застосування бази г еопросторових даних для завдань конс о лідації земель в Україні. Актуальність досл і дження обумовлена зростаючою необхідніст ю консолідації земель, необхідністю забез п ечення процесу консолідації земель актуал ь ними, повними та достовірними даними. Мета дослідження полягає в обґрунтуванні набору тематичних геопросторових даних у скл а ді національної інфраструктури, необхідних для прийняття управлінських рішень щодо к онсолідації сільськогосподарських земель т а розробки відповідних проектів землеустрою. Досліджено базові набори геопросторов и х даних, визначені чинним законодавством , на предмет використання при консолідації земель. Запропоновані набори тематичних геопросторових даних. Проаналізовано в икористання запропонованих наборів геопросторових даних на принципових етапах конс о лідації земель. Досліджено використання ге о просторових даних при реалізації проект у консолідації земель із використанням оптимізаційної моделі перерозподілу земель. Результати дослідження можуть бути використані при підтримці прийняття рішень щодо консолідації земель, управлінні земельних ресурсів, створенні спеціалізованих геопорталів, у наступних наукових дослідженнях, пов'яза них із побудовою національної інфраструктур и геопросторових даних, проведенням консолідації земель в умовах України.*

Ключові слова: *геопросторові дані, консолідація земель, сільськогосподарські землі, ринок сільськогосподарських земель, земельна реформа.*

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ИСПОЛЬЗОВАНИЕ БАЗЫ ГЕОПРОСТРАНСТВЕННЫХ ДАННЫХ ДЛЯ ЗАДАЧ КОНСОЛИДАЦИИ ЗЕМЕЛЬ В УКРАИНЕ

Аннотация. *В статье рассматривается вопрос наполнения базы геопространственных данных для задач консолидации земель в Украине. Актуальность исследования обусловлена растущей необходимостью консолидации з емель, необходимостью обеспечения п роцесса консолидации земель актуальными, полными и достоверными данными. Це л ь исследования заключается в обосно в ании набора тематических геопростра н ственных данных в составе националь н ой инфраструктуры, необходимых для принятия управленческих решений по к онсолидации сельскохозяйственных земель и разработки соответствующих проекто в землеустройства. Исследовано баз о вые наборы геопространственных данных, определенные действующим законодате л ьством, на предмет использования при консолидации земель. Предложенные н аборы тематических геопространственн ы х данных. Проанализировано использов ание предложенных наборов геопростран с твенных данных на принципиальных э т апах консолидации земель. Исследов а но использование геопространственных д анных при реализации проекта консолид ации земель с использованием оптимизационной модели перераспределения земель. Результаты исследования могут быть ис п ользованы при поддержке принятия реше ний по консолидации земель, управлении земельными ресурсами, создании специа л изированных геопорталов, в последующих научных исследованиях, связанных с п о строением национальной инфраструктур ы геопространственных данных, проведением консолидации земель в условиях Украины.*

Ключевые слова: *пространст венные данные, консолидация земел ь , сельскохозяйственные земли, рынок с е льскохозяйственных земель, земельная реформа.*