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IDENTIFICATION OF LAND PAYMENTS RISK ZONES IN ESTABLISHING TERRITORIAL COMMUNITY BOUNDARIES USING GIS

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Abstract. *The article is dedicated to the concept of "tax risk zones," their identification using Geographic Information Systems (GIS), and the role of these zones in the process of establishing territorial community boundaries. The authors examine the impact of the administrative-territorial reform carried out in Ukraine on the spatial identification of land parcels as tax objects. One of the main issues arising*

during the process of establishing territorial community boundaries is the emergence of tax uncertainty zones and the potential for land disputes between neighboring communities. In such zones, territorial communities risk losing land tax revenue due to uncertainty about the ownership of land parcels by one community or another. The article emphasizes the need for accurate data on land parcels to effectively shape tax policies at the local level. The use of GIS allows the identification of these tax risk zones and provides tools for decision-making regarding the optimization of community boundaries. The article provides examples of the application of GIS for the analysis of spatial data on territorial boundaries and land parcels, as well as an assessment of potential local budget losses due to uncollected land tax and rental payments.

Keywords: *Tax map of Ukraine, land tax, rental payment, compliance risk, CATUTTC, land management, COATSU, land management documentation.*

Relevance. Land payments, collected in the form of land tax or rent for land parcels, are one of the revenue sources for local budgets of territorial communities in Ukraine. According to the Land Management Institute of NAAS of Ukraine, under the current level of land parcel registration within community territories, the share of land payments in local budgets can range from 5% to 20%, depending on various factors [1,30]. However, the administrative-territorial (decentralization) reform conducted between 2014 and 2020, along with the formation of new territorial communities—many of which lack registered boundaries in the State Land Cadastre—has revealed several issues in the spatial identification of land parcels as taxation objects.

Territorial communities can collect land payments only within their jurisdiction, defined by established community boundaries. Unclear boundaries lead to tax compliance risks, which include the potential failure of taxpayers to meet tax or rent payment obligations for specific communities, ultimately resulting in reduced land revenue for local budgets. Boundary uncertainty also creates land disputes between neighboring communities, particularly in areas adjacent to projected boundaries

during the development of land management projects. This is especially problematic when there are no approved projects, as disputes become more prevalent.

In Ukraine, the objects of land payments are land parcels registered in the State Land Cadastre [2]. A parcel is considered formed (registered) once it is assigned a cadastral number. However, the implementation of the new Codifier of Administrative-Territorial Units and Territories of Territorial Communities of Ukraine (CATUTTC) [3] is not reflected in cadastral numbers, which serve as identifiers. The structure of cadastral numbers still includes the code according to the Classification of Objects of the Administrative-Territorial System of Ukraine (COATSU). Extracts from the State Land Cadastre confirming community boundary registration also lack the CATUTTC code.

Our work focuses on uncovering these issues and finding solutions through Geographic Information Systems (GIS).

Analysis of Recent Studies and Publications. According to Emiko Guthe, utilizing GIS tools to create a functional tax register will provide municipalities with a critical first step in the tax cycle; enabling each municipality to invoice its tax base. Property tax is based upon geographic features that exist on the earth's surface—buildings, parcels, agricultural land, etc.—and thus can be mapped in a GIS. Using GIS for property tax purposes allows municipalities to collect data about what exists on the ground, manage spatially referenced data in a database and then utilize this information for analysis, reporting, transparency and decision making [4].

We believe that the spatial identification of land parcels as taxation objects is inherently tied to the establishment of community boundaries. This process defines the jurisdictional boundaries of local governments and ensures the proper collection of land payments to the budget of the specific community where the parcels are located.

As noted in the works of O. Dorosh, R. Kharytonenko, A. Dorosh, R. Derkulskyi, Yu. Ryabova, A. Barvinskyi, I. Kupriianchyk, and Ye. Butenko, during the establishment of community boundaries, it is important to analyze settlement boundaries, land parcels registered under COATSU in the State Land Cadastre, and

included in the community's territory, as well as CATUTTC and other relevant data [5]. Additionally, the boundaries of adjacent communities and parcels previously attributed to neighboring communities based on cadastral numbers and COATSU codes must be considered [6].

Risks Arising from Boundary Uncertainty. When community boundaries are unclear, land payments risk zones often emerge in areas adjacent to projected community boundaries. These zones create challenges such as:

1. Both adjacent communities claim ownership of certain land parcels, leading to land disputes.
2. Neither community recognizes a parcel as part of its jurisdiction.

Understanding which specific parcels belong to a community is critical for justifying land tax rates and rental fees for municipal lands based on their designated use. This issue should be considered in the context of community development strategies and local economic priorities. For example, if a community aims to support industrial producers, it can set reduced land tax rates or rental fees for industrial land, as regulated by local legislative acts. Similar incentives can be applied to agricultural, residential, or public lands. However, accurate spatial data on land parcels, their areas, and the overall land use structure within a community's jurisdiction are essential for effective local tax policy.

Z. Yang attempted to investigate empirically the effect of land value taxation on the value of land and explored the differential effects across various types of land use. He used panel data for Pennsylvania municipalities in which a two-rate property tax is applied. A two-rate property tax means that the land value and the value of buildings on the land are taxed at different rates. Yang showed that increasing the tax rate on land while lowering the tax rate on buildings leads to an increase in assessed land value per acre. Further, the impact of the tax change differs between residential land and commercial and industrial land. It appears that residential land is more responsive to changes in the tax differential than commercial and industrial land [7].

J. Janoušková & Š. Sobotovičová empirically assessed the impact of legislative changes of land taxes and land value on land tax revenues in the Czech Republic.

They concluded that the low tax revenue of Czech municipalities in comparison to other municipalities in the European Union is due to the method used by the tax administration to calculate the value of land [8].

The above analysis indicates that the highlighted issue is relevant not only for Ukraine but also internationally. However, the situation in Ukraine is further complicated by the decentralization reform and its subsequent impacts on taxation, as well as the introduction of the new Codifier of Administrative-Territorial Units and Territories of Territorial Communities of Ukraine (CATUTTC).

Research Objective. The aim of the study is to identify and analyze land payments risk zones in the process of establishing territorial community boundaries, estimate the total value of land parcels potentially located within such zones, and assess the possible revenue from land payments to local budgets for parcels located in these zones.

Materials and Methods. The study employs general scientific methods, including monographic analysis, forecasting, generalization, and the abstract-logical method. A monographic analysis was applied to review scientific publications by Ukrainian and international scholars on land management and local tax policies (specifically land payments).

The GIS system QGIS was utilized to compare data from various sources on the boundaries of territorial communities formed in Ukraine during the decentralization reform and the land parcels located within or adjacent to these communities. Data on territorial community boundaries were sourced from the online platform "Tax Map of Ukraine" (https://map.tax.gov.ua/main), an official platform provided by the State Tax Service of Ukraine. This interactive map contains comprehensive information on the country’s tax infrastructure and aims to enhance transparency and accessibility of tax revenue data. In connection with the administrative-territorial reform in Ukraine and the formation of territorial communities, data aggregation on tax revenues to local budgets is carried out according to the CATUTTC.

Additionally, SHP files of community boundaries established according to approved land management projects developed by the Institute of Land Management

of the National Academy of Agrarian Sciences of Ukraine were imported into QGIS. As an example, data on land parcels and boundaries of the Hleiuvatka Rural Territorial Community (CATUTTC code UA12060050000031212, Dnipropetrovsk region) were included.

Since land parcels are the taxable objects under current legislation, data on registered parcels were retrieved from the kadastr.live website, which provides open data from the State Land Cadastre of Ukraine, including parcel boundaries and cadastral numbers.

Using generalization and abstract-logical methods, conclusions were formulated regarding the identification of land payments risk zones during the establishment of territorial community boundaries using GIS.

Results and Discussion. Through the spatial overlap of various polygons representing the boundaries of the Hleiuvatka Rural Territorial Community, the following were identified:

1. A polygon showing the boundaries of Hleiuvatka Rural Community according to official data from the State Tax Service of Ukraine's Tax Map of Ukraine.

2. A polygon showing boundaries obtained from the State Scientific and Production Enterprise "Cartography" and the United Nations Office for the Coordination of Humanitarian Affairs [9].

3. A polygon showing the projected boundaries according to the land management project for establishing the boundaries of the Hleiuvatka Rural Territorial Community.

During the study, zones were identified where land parcels, as per the Tax Map of Ukraine, were not included within the boundaries of the territorial community. These potential "land payment risk zones" (marked in yellow) indicate that excluding such parcels from the community boundaries could result in the community's local budget missing out on land payment revenues (Fig. 1).

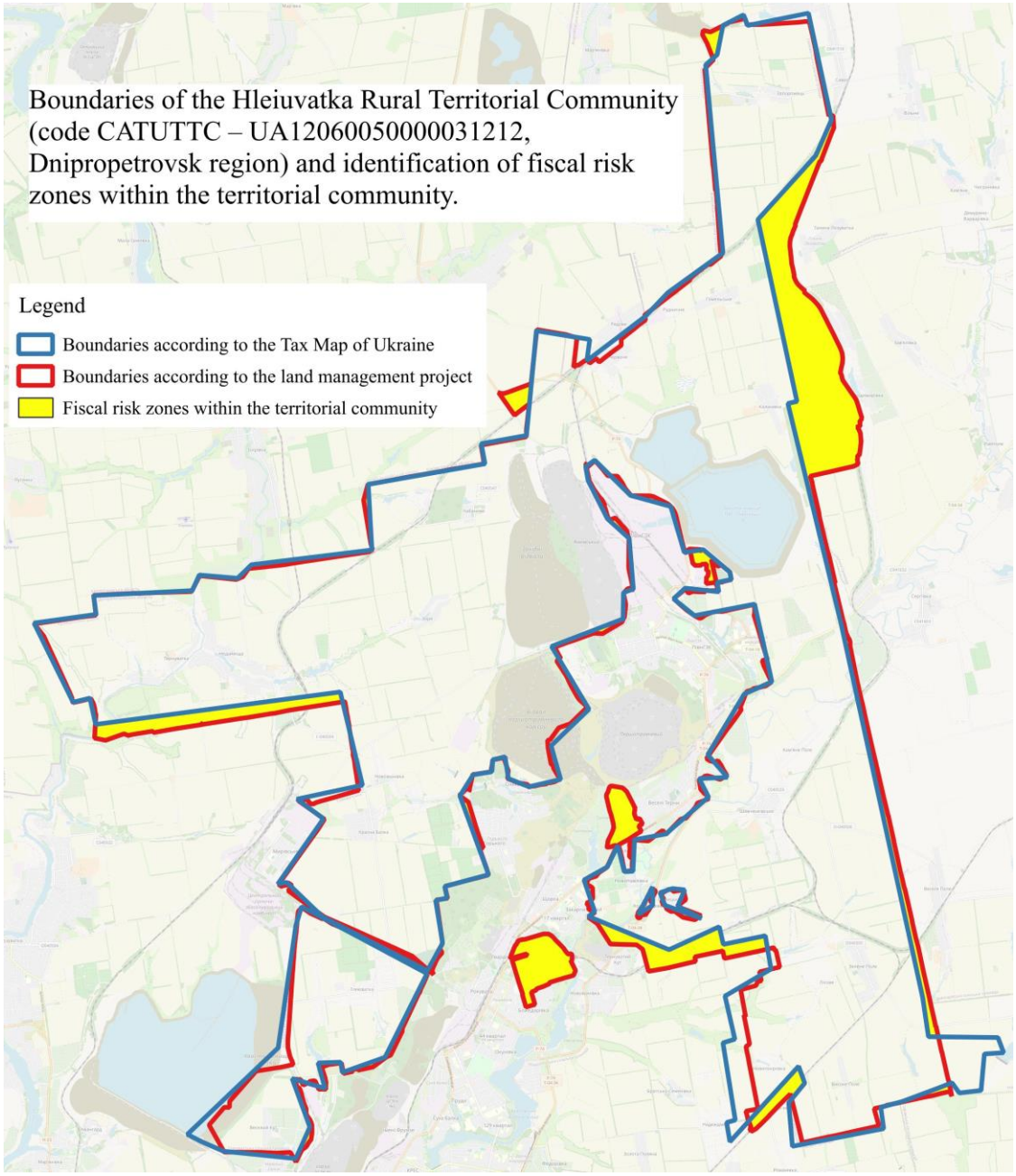

Fig. 1. Identification of land payments risk zones in QGIS for the studied territorial community

**Developed by the authors*

Accordingly, the information on tax revenues in the community (data aggregated by CATUTTC), provided by the State Tax Service, may be inaccurate. One of the reasons for this is that extracts from the State Land Cadastre and cadastral numbers do not include information about the CATUTTC to which the land parcel belongs or the identification of land parcels in relation to specific CATUTTC codes.

The structure of the cadastral number, which serves as the identifier of a land parcel, is as follows:

NCZ : NCQ : NLP, or XXXXXXXXXX:XX, where:

- **NCZ**: A twelve-digit number for the cadastral zone (maximum 999999999999), where the last two digits are separated from the first ten by a colon, e.g., XXXXXXXXXX:XX

. The first 10 digits represent the code according to COATSU, which was used before the administrative-territorial reform and has been replaced by CATUTTC.

- **NCQ**: A three-digit number for the cadastral quarter within the cadastral zone (maximum 999 cadastral quarters within a cadastral zone).
- **NLP**: A four-digit number for the land parcel within the cadastral quarter (maximum 9999 land parcels within a cadastral quarter) [10].

It should also be noted that not only do extracts from the State Land Cadastre about land parcels lack information about CATUTTC, but extracts concerning land within the territory of a territorial community—which include details on materials used to establish community boundaries and are formed after boundary registration in the State Land Cadastre—also do not contain CATUTTC.

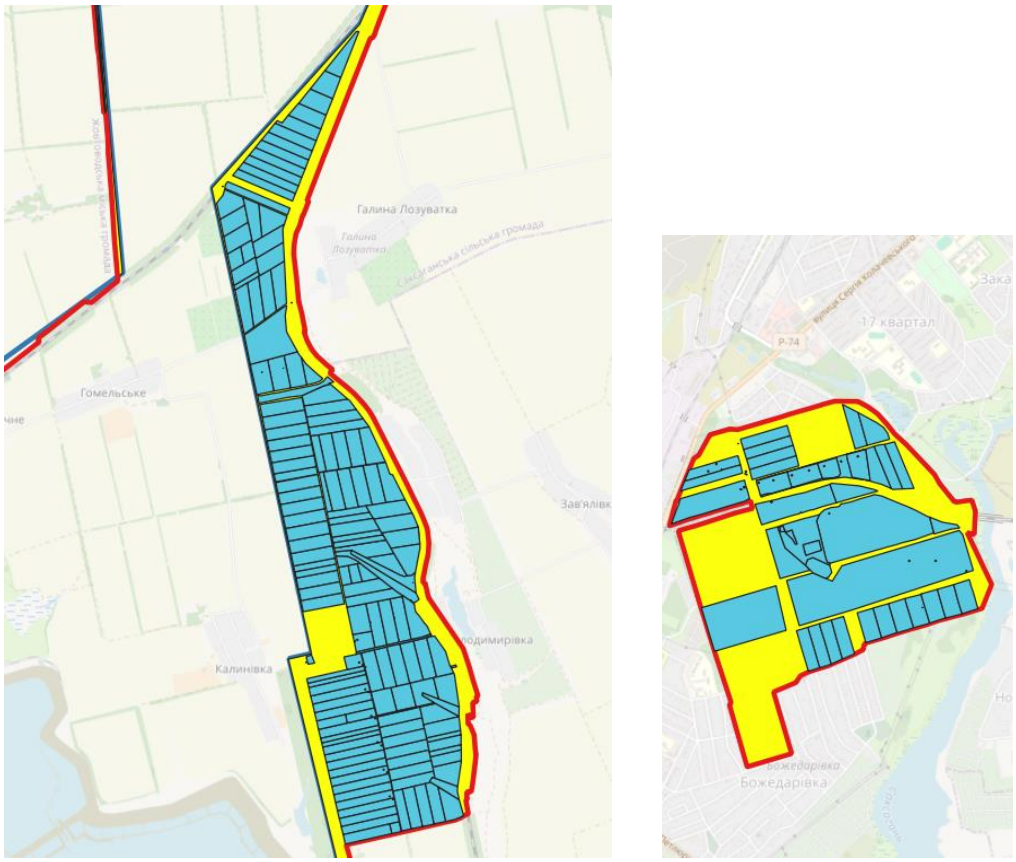

Fig. 2-3. Land parcels fully located within land payments risk zones

Fig. 4. Land parcels fully located within land payments risk zones

**Developed by the authors*

In the course of the study, we calculated the total normative monetary valuation of land parcels located within the land payments risk zones of the territorial community, as shown in Figures 2–4. It is important to note that only those land parcels that are spatially fully located within the tax risk zones were included in the

calculation. Consequently, the total normative monetary valuation of the land parcels in these zones amounts to **31,766,944 UAH (as of August 9, 2024).**

Based on the decision of the Hleiuvatka Village Council dated July 13, 2023, No. 1902-XXII/VIII, "On Establishing Land Payment Rates and Exemptions from Land Tax in the Hleiuvatka Village Council Territory for 2024," we estimated the potential total land tax revenue from the land parcels located within the identified tax risk zones. The estimated revenue amounts to **323,683 UAH.**

Conclusions and Prospects. The study revealed that using Geographic Information Systems (GIS) to identify land payments risk zones during the establishment of territorial community boundaries is an effective tool for addressing issues related to the spatial uncertainty of land parcel affiliation. A major problem identified is the emergence of tax uncertainty zones, which can lead to revenue shortfalls for local budgets. Spatial identification of land parcels as taxable objects is a critical condition for ensuring the accuracy of tax and rental payments to local budgets. It is evident that, on a national scale, the number of land parcels does not change; however, land payments are considered at the local level in this context. The inclusion of land parcels in these "land payments risk zones" can shift them into the territory of one or another adjacent territorial community. Additionally, variations in land tax rates and exemptions across communities mean that landowners and users may pay more in one community and less in another.

The study established that the administrative-territorial reform in Ukraine has resulted in many newly created communities having unregistered boundaries in the State Land Cadastre, complicating land taxation and rental assessments. Furthermore, the lack of updates to cadastral numbers to align with the new Codifier of Administrative-Territorial Units and Territories of Territorial Communities (CATUTTC) creates additional barriers to effective tax accounting.

Accurate spatial information about land parcels and their legal status is crucial for local tax policy, as it directly impacts the calculation of land taxes and rental payments. Land revenue depends significantly on how community boundaries are projected in relation to land payments risk zones and whether land parcels within

these zones become part of one community or another during the development of land management projects for boundary establishment. Such zones could potentially become the subject of land disputes between adjacent communities, both before and after land management projects are approved (including in court proceedings). Identifying these zones is essential and lies at the intersection of land management, administrative-territorial structure, taxation, and statistics.

The study also highlights the need to amend the Procedure for Maintaining the State Land Cadastre, approved by the Resolution of the Cabinet of Ministers of Ukraine No. 1051 of October 17, 2012. These amendments should include updates to extracts from the State Land Cadastre to incorporate CATUTTC codes and integrate CATUTTC information into extracts regarding land parcels. Such measures would help reduce tax risks, enhance transparency, and improve the efficiency of local tax policy.

The findings can contribute to further improving land tax policy and land management at the territorial community level, particularly under decentralization conditions.

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References

1. Tsilova prohrama okhorony ta vykorystannia zemel Perechynskoi miskoi terytorialnoi hromady na 2024 – 2026 roky. [Target Program for the Protection and Use of Land in the Perechyn Municipal Territorial Community for 2024–2026].

(2024). URL: https://pmr.gov.ua/wp-content/uploads/2024/04/TSilova-programa.-Perechyns-TG.pdf

2. Verkhovna Rada of Ukraine (2010). Tax Code of Ukraine. Official Website of the Parliament of Ukraine. Available at: https://zakon.rada.gov.ua/laws/show/2755-17?lang=en

3. President of Ukraine. (2021). Decree of the President of Ukraine No. 180/2021: On the decision of the National Security and Defense Council of Ukraine dated April 15, 2021, "On measures of state regional policy to support decentralization of power". Official Internet Representation of the President of Ukraine. Available at: https://www.president.gov.ua/documents/1802021-38825

4. Guthe, E. (2015). Utilizing GIS to support municipal tax collection. Planning and Local Governance Project (PLGP) in Albania. Available at: https://pdf.usaid.gov/pdf_docs/PA00N1ZC.pdf

5. Dorosh, O., Kharytonenko, R., Dorosh, A., Derkulskyi, R., & Riabova Y. (2023). Geographic Information Systems and Technologies in Establishing the Boundaries of Territorial Communities in Practical Terms. DOI: https://doi.org/10.3997/2214-4609.2023520058

6. Kharytonenko, R., Barvinskyi, A., Derkulskyi, R., Kupriianchyk, I. & Butenko, Y. (2022). Study of Problematic Issues in Establishing the Borders of Territorial Communities and Entering Data About Them into the State Land Cadastre. DOI: https://doi.org/10.3997/2214-4609.2022590036

7. Yang, Z. (2018). Differential effects of land value taxation. Journal of Housing Economics, 39, 33–39. DOI: https://doi.org/10.1016/j.jhe.2017.11.002

8. Janoušková, J., & Sobotovičová, Š. (2019). Fiscal autonomy of municipalities in the context of land taxation in the Czech Republic. *Land Use Policy*, *82*, 30–36. DOI: https://doi.org/10.1016/j.landusepol.2018.11.048

9. Ukraine - Subnational Administrative Boundaries - Humanitarian Data Exchange. (2024). Humdata.org. Available at: https://data.humdata.org/dataset/cod-ab-ukr

10. Pro zatverdzhennia Poriadku vedennia Derzhavnoho zemelnoho kadastru: Postanova Kabinetu Ministriv Ukrainy vid 17 zhovtnia 2012 r. № 1051. [On Approval of the Procedure for Maintaining the State Land Cadastre: Resolution of the Cabinet of Ministers of Ukraine dated October 17, 2012, No. 1051.] (2012). Available at: https://zakon.rada.gov.ua/laws/show/1051-2012-%D0%BF#Text

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ІДЕНТИФІКАЦІЯ ЗОН ПОДАТКОВИХ РИЗИКІВ ПРИ ВСТАНОВЛЕННІ МЕЖ ТЕРИТОРІЙ ТЕРИТОРІАЛЬНИХ ГРОМАД ІЗ ЗАСТОСУВАННЯМ ГІС

Анотація. *Стаття присвячена розкриттю поняття «зони податкових ризиків», їхній ідентифікації із застосуванням геоінформаційних систем (ГІС) та ролі таких зон у процесі встановленні меж територій територіальних громад. Автори досліджують вплив адміністративно-територіальної реформи, проведеної в Україні, на просторову ідентифікацію земельних ділянок як об'єктів оподаткування. Однією з основних проблем, що виникають у процесі встановлення меж територій територіальних громад, є виникнення зон податкової невизначеності та потенційного виникнення земельних спорів між суміжними громадами. У таких зонах територіальні громади ризикують недоотримати доходи від плати за землю через невизначеність щодо приналежності земельних ділянок до тієї чи іншої громади. У статті розглянуто необхідність точних даних щодо земельних ділянок для ефективного формування податкової політики на місцевому рівні. Використання ГІС дозволяє виявляти такі зони податкових ризиків і надає інструменти для прийняття рішень щодо оптимізації меж громад. Наведено приклади застосування ГІС для аналізу просторових даних щодо меж територій територіальних громад та земельних ділянок, а також оцінку*

можливих втрат місцевих бюджетів через недоотримання земельного податку на орендної плати за земельні ділянки.

Ключові слова: *Податкова карта України, земельний податок, орендна плата, комплаєнс-ризик, КАТОТТГ, землеустрій, КОАТУУ, документація із землеустрою.*