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UPDATING THE STATISTICAL REGISTER OF HOUSING IN THE REPUBLIC OF MOLDOVA USING OPEN-SOURCE GIS TECHNOLOGIES

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Abstract. This article describes the possibilities of promoting and implementing open-source geoinformation technologies in the field of statistical activity in the Republic of Moldova, which will simplify and streamline the process of analysis, collection, systematization of data, as well as their dissemination. Since 2019, the National Bureau of Statistics of the Republic of Moldova, according to the recommendations of the United Nations, has proposed the creation of the geo-coded Statistical Register of Housing (SRH). With the creation of the National Spatial Data Infrastructure (NSDI), this goal can be achieved, as SRH will form the basis of the Population and Housing Census (PHC) from the 2020 round. The geospatial data from SRH will be used to delimit the census enumeration areas, and the reviewed population will be attached to the geographical coordinates of the dwelling. These enumeration areas will cover the entire territory of the Republic of Moldova and will serve to plan human resources, organize field activities and ensure the full coverage of census units (for people, households and dwellings).

Rezumat. Articolul descrie posibilitățile de promovare și implementare a tehnologiilor de geoinformație open-source în domeniul activității statistice în Republica Moldova, care vor simplifica și eficientiza procesul de analiză, colectare, sistematizare a datelor, precum și difuzarea acestora. Din 2019, Biroul Național de Statistică al Republicii Moldova, conform recomandărilor Națiunilor Unite, a propus crearea Registrului Statistic al Locuințelor (SRH) geocodat. Odată cu crearea Infrastructurii Naționale de Date Spațiale (NSDI), acest obiectiv poate fi atins, întrucât SSR va sta la baza Recensământului Populației și Locuințelor (PHC) din runda 2020. Datele geospațiale de la SRH vor fi utilizate pentru delimitarea zonelor de enumerare a recensământului, iar populația revizuită va fi atașată la coordonatele geografice ale locuinței. Aceste zone de enumerare vor acoperi întreg teritoriul Republicii Moldova și vor servi pentru planificarea resurselor umane, organizarea activităților de teren și

asigurarea acoperirii integrale a unităților de recensământ (pentru persoane, gospodării și locuințe).

Cuvinte cheie: *Registrul Statistic al Locuințelor (SRH), Sisteme Informaționale Geografice (GIS), Recensământul Populației și Locuințelor (PHC), QGIS, QField.*

Introduction

Numerous real-world examples, with clear explanations of the methodology, demonstrate the usefulness of geographic information systems (GIS) for solving practical problems in various fields of activity [1, 2].

In the field of statistics, high quality data are of particular importance for a contemporary country. They are essential for solid decision-making, which will affect the daily lives of citizens. The implementation of geo-informational technologies in statistics will simplify and streamline the data collection process as well as their dissemination [3, 4].

Given that the update of the Statistical Register of Housing (SRH) in the Republic of Moldova is a very important database for the future census in 2023, the use of GIS technologies, especially open-source, are welcome. SRH is a database of all dwellings, regardless of the form of ownership, including specialized houses (dormitories, boarding houses, penitentiaries and others), apartments, service rooms and other houses in other useful constructions for living. Until 2019 there was no such register, an alternative used being the Lists of Buildings and Housing (LBH), prepared by the Local Public Authorities (LPA) together with the Territorial Statistics Offices (TSOs). These lists were difficult to use because not all dwellings had an address, and even if they did, they were not standardized [5].

According to the recommendations of the United Nations, our country has proposed the creation of the geo-coded Statistical Register of Housing (each dwelling must have x and y coordinates).

In this sense, in order to achieve the proposed goal, the following objectives have been outlined:
- analysis, collection and systematization of housing data, from official sources of administrative data;
- presenting the structure of the SRH layers and explaining the variables;
- choosing and establishing methods for collecting and storing data in a database, using the open-source applications QGIS [6,7] and QField [8];
- populating, validating and processing housing data in SRH.

Data collected and structuring of SRH layers

When updating the SRH for the study area were served the following sources of geospatial data:
- Real Estate Register (RER), managed by the Public Services Agency (ASP) [9];
- State Register of Administrative-Territorial Units and Addresses (SRATUA), Public Services Agency (ASP) [9];
- Linear Map 2017, State Enterprise Institute of Geodesy, Engineering Research and Cadastre "INGEOCAD" under the coordination of the Agency for Land Relations and Cadastre of the Republic of Moldova (ARFC) [10];
- Orthoimages (Orthophoto) 2007/2016/2020, State Enterprise Institute of Geodesy, Engineering Research and Cadastre "INGEOCAD" under the coordination of the Agency for Land Relations and Cadastre of the Republic of Moldova (ARFC) [10];

For areas that were not covered by the geospatial data listed above or whose source is obsolete, field data were collected.

The database that will contain the homes which we are going to update will be of the *SpatiaLite* type [11] and will be called *"ActRSL_Ialoveni"*. It will consist of the *"Buildings"* layers, of point type (Table 1) and *"Dwellings"*, of table type (Table 2) [5, 12].

Table 1

Structure of the "Buildings" layer

No.	Name	Type	Description	Values
1	Commune	Text, 150 char.	Commune name	
2	Locality	Text, 150 char.	Locality name	
3	ID_ea	Text, 12 char.	Enumeration area code	
Address data				
4	ID_Entry	Integer, 3 char.	Building entry ID	
5	CODE_ Building	Integer, 3 char.	Building code	
6	JID_ Entry	Text, 20 char.	Building-entrance code	
7	Street_ type	Text, 15 char.	Street type	1) Street; 2) Stradella; 3) Boulevard; 4) Road; 5) City Square; 6) Blind alley; 7) Other.
8	Street	Text, 150 char.	Street name	
9	Number	Integer, 3 char.	Building number	
10	Slash	Text, 10 char.	Slash	
11	Stair	Integre, 2 char.	Stair number	
Building data				
12	Build_Cond.	Text, 150 char.	Building condition	1) With all structural components 2) Under (re)construction 3) Damaged / ruined 4) Demolished

Continued Table 1

13	Build_Use.	Text, 150 char.	Building use	1) For residential purposes only 2) Residential and other purpose 3) Non-residential
14	Build_Type.	Text, 150 char.	Building type	1) Detached house 2) Row house 3) Apartment building 4) Collective living quarter 5) Accessory building for the main building 6) Industrial 7) Commercial 8) Educational 9) Health 10) Institutional 11) Others
15	Nr_ Floors	Integer, 2 char.	Total number of floors in the building	
16	Nr_ Dwell.	Integer, 3 char.	Total number of dwellings in the building	
17	List_ Dwell.	Text, 254 char.	Dwelling list	
18	Notes	Text, 254 char.	Notes	

Table 2

Structure of the "Dwellings" layer

No.	Name	Type	Description	Values
1	ID_ Dwell.	Integer, 3 char.	Dwelling ID	
2	CODE_ Entry	Text, 20 char.	Building-entrance code	
3	Floor	Integer, 2 char.	Floor number	
4	Apartment	Text, 10 char.	Apartment number	
5	DirectAccess	Text, 2 char.	Presence of a direct access from outside the building	1) Yes 2) No

Continued Table 2

6	Type Dwelling	Text, 15 char.	Dwelling type	1) Conventional dwelling 2) Unconventional dwelling 3) Collective living quarter 4) Business unit 5) Unit for Institutional or cultural use 6) Unit used as accessory of the building 7) Ruined unit 8) Others 9) Non-existent
7	Notes	Text, 254 char.	Notes	

Results - Case study

For the case study, two pilot enumeration area from the Republic of Moldova were chosen, namely from Ialoveni district:

– 552000002061 from the village of Milestii Mici [13] (Figure 1 (a)), where it took place massive primary real estate registration, and in the Population and Housing Census (PHC-2014) 126 dwellings were identified [14];

– 552300004023 from the village of Pojareni [13] (Figure 1 (b)), where it did not take place massive primary real estate registration, and at PHC-2014, 87 dwellings were identified [14].
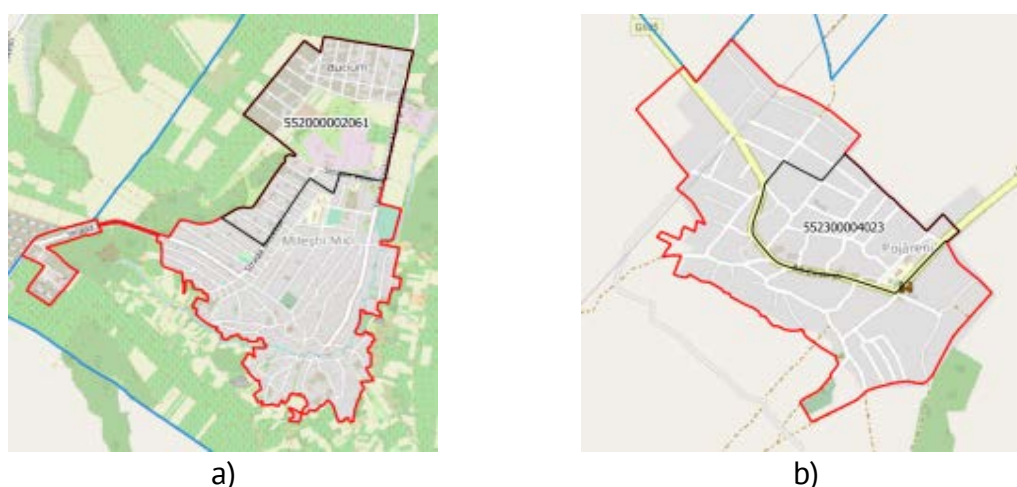

a)   b)

Figure 1. Excerpt from the enumeration area boundaries:
a) 552000002061 Milestii Mici; b) 552300004023 Pojareni
Source: [5].

The process of updating the SRH will include three stages: population of the register; data validation; data processing.

Population of the register.

In the first stage, using the open-source application QGIS, SRH was populated based on administrative data and orthophoto images, as follows:

− Pilot enumeration area of the Population and Housing Census (PHC) - 2014, defined the work area [14];
− Address point of the building from SRATUA, was used to complete the variables for the address;
− Land and buildings from Real Estate Register, were needed to define the boundaries between the properties and to identify the buildings and their use;
− Roof Area from the Linear Map 2017, completed the *Buildings* layer, especially in the areas where it did not take place massive primary real estate registration;
− Orthophoto images have completed the *Buildings* layer and Roof Area, especially in high-speed construction areas.

The database in QGIS will contain the dwellings to be updated and will be named "ActRSL_Ialoveni", which will consist of the *Buildings* layer, of point type and *Dwellings* of table type (Tables 1 and 2).

Following this stage, there were obtained a total of 917 buildings: 613 in the enumeration area 552000002061 from Milestii Mici (Figure 2 (a)) and 304 in the enumeration area 552300004023 from Pojareni (Figure 2 (b)).
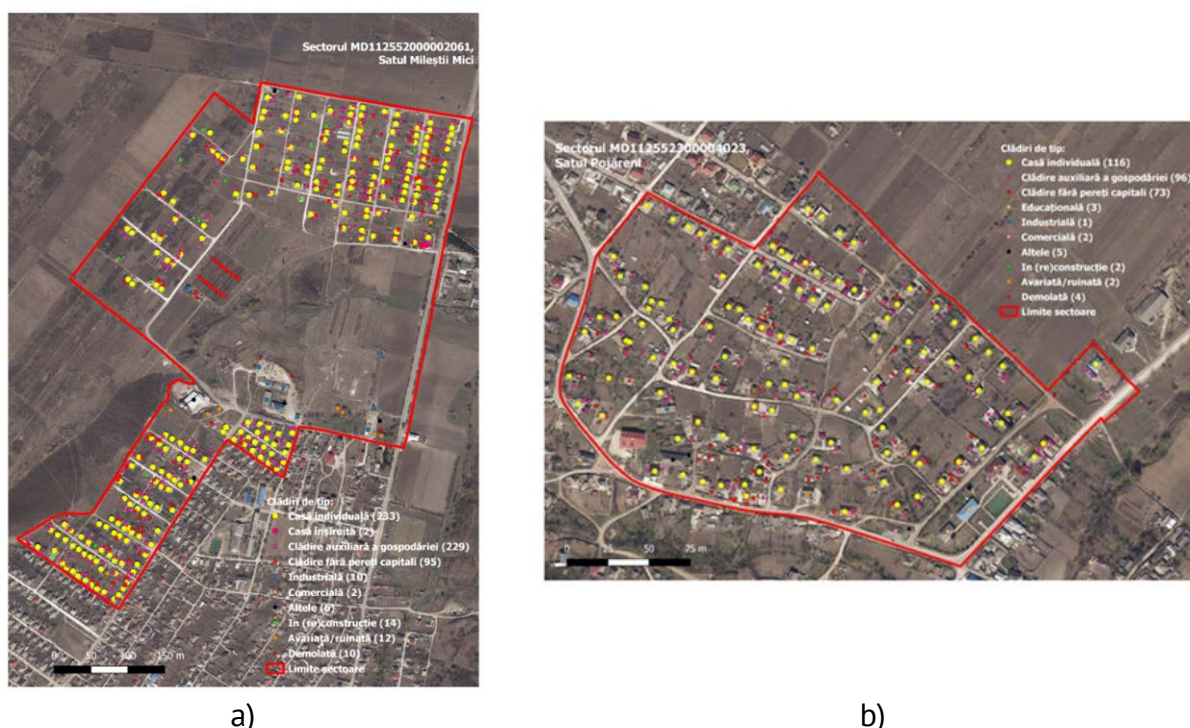

a)   b)

Figure 2. Excerpt from the distribution and classification of buildings after the population of the SRH from administrative data and orthophoto images:
a) 552000002061 Milestii Mici; b) 552300004023 Pojareni
Source: [5].

In the village of Pojareni 97% of the buildings are with all the structural components, of which 38% are used only for residential purposes and another 59% for non-residential purposes. 100% of the residential buildings are of the individual house type, and in the

category of non-residential buildings 53% are auxiliary buildings of the household and another 40% are buildings without capital walls.

In the village of Milestii Mici 94% of the buildings are with all the structural components, of which 38% are used only for residential purposes and another 56% for non-residential purposes. 99% of the residential buildings are of the individual house type, and in the category of non-residential buildings 62% are auxiliary buildings of the household and another 32% are buildings without capital walls.

Data validation.

Given that administrative data, used in the SRH population, is not always current and it is necessary to go to the field and validate the data obtained directly from the source.

The QField open-source mobile application was used to accomplish this step. The QField application uses the same graphical editing controls as the QGIS desktop [8].

To create a project in the QField application, we will use the *"QFieldSync"* plugin, which will help us to prepare and package QGIS projects for QField. The QField project will be based on the QGIS project *"ActRSL_Ialoveni"*

In this case, a copy of this project will be created with the name *"ActRSL_Ialoveni_QField"*, where only the necessary layers from the field will be kept.

Thus, in the QGIS platform, this project was created for data collection in the QField application (Figure 3).
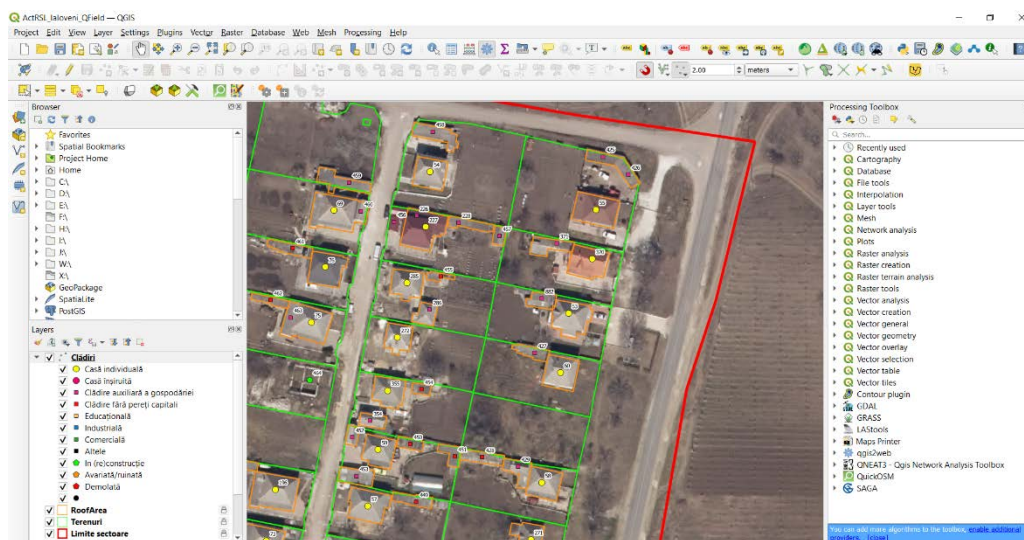

Figure 3. Creating the project for collecting data from the field.
Source: [5].

This project is exported and uploaded to the mobile device via a USB. To open the project in the QField application, will be performed the following steps from Figure 4: (1) *„Open local file"*; (2) choosing the location of the file; (3) opening the project with the terminations *"qgs"*.

With the help of the tools for enlarging, reducing and finding the user's location, the pilot area will be navigated. So, when we are in the field, we will visit each building and check the correctness of the classification using the QField application (Figure 5).

To view the data of a building, is accessed the geometry of the building (1), and from the *"Features"* window (2) is selected from the list the desired building, based on the code *"pkuid"* (3). To edit the existing data, go to the *"Enable editing"* button (4), and from the list (5) you will find the move buttons *"Move Feature"* (6), move duplication *"Duplicate Feature"* (7) or

delete the object *"Delete Feature"* (8). And by accessing the check mark (9) we will save the created changes.
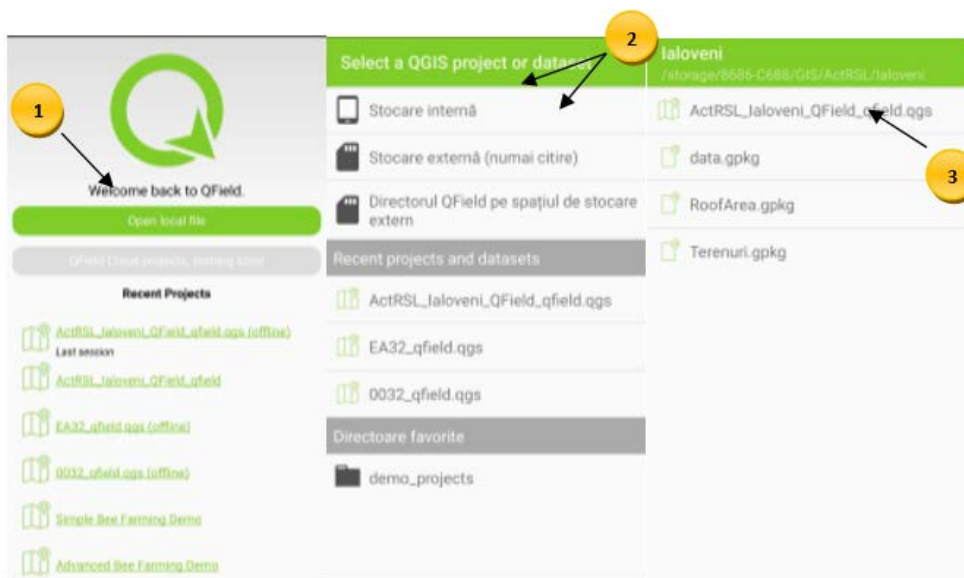

Figure 4. Opening of the *"ActRSL_Ialoveni_QField"* project.
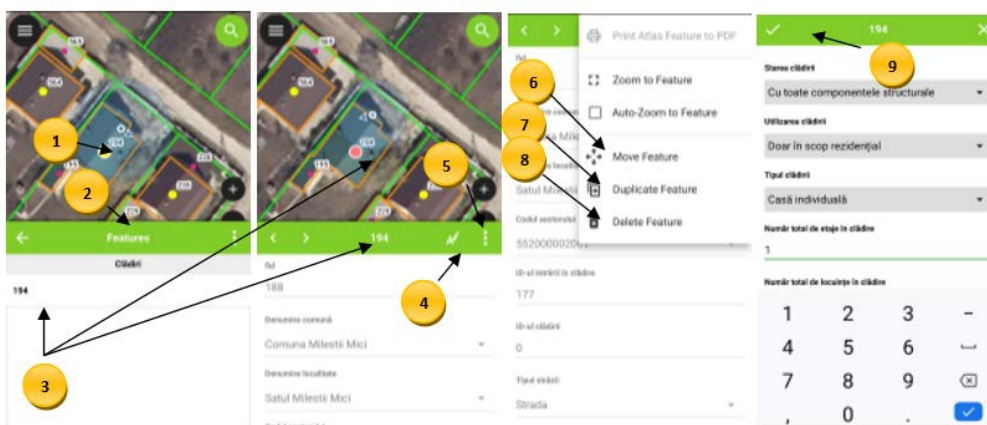*Source: [5]*

Figure 5. Visualization, editing and saved an object in QField.
Source: [5].

Data processing.

After the field verification, we move on to the third stage, that of data processing. The data processing step involves downloading the data collected in the field, from the mobile device to the computer, with their repeated verification and uploading as a final variant in the SRH database.

Following the data analysis, were obtained a total of 916 buildings: 615 in the 552000002061 enumeration area in Milestii Mici (Figure 6 (a)) and 301 in the 552300004023 enumeration area in Pojareni (Figure 6 (b)).

In Pojareni village 92% of the buildings are with all the structural components, of which 39% are used only for residential purposes and another 53% for non-residential purposes. 100% of the residential buildings are of the individual house type, and in the category of non-residential buildings 54% are auxiliary buildings of the household and

another 40% are buildings without capital walls. At the same time, 1% of the buildings are in (re) construction, 6% are damaged and 1% are demolished.
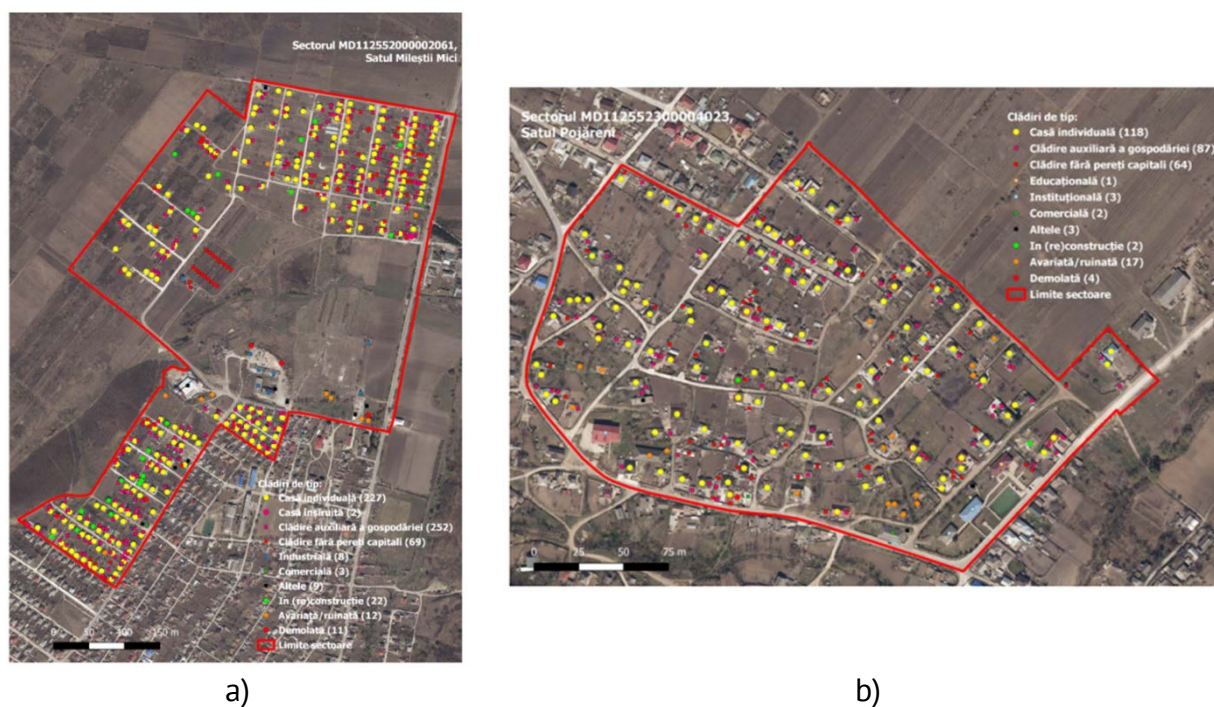

<div align="center">a)   b)</div>

Figure 6. Excerpt from the distribution and classification of buildings according to the field data validation process: a) 552000002061 Milestii Mici; b) 552300004023 Pojareni.
Source: [5].

In the village of Milestii Mici, 93% of the buildings are with all the structural components, of which 37% are used only for residential purposes and another 55% for non-residential purposes. 99% of the residential buildings are of the individual house type, and in the category of non-residential buildings 74% are auxiliary buildings of the household and another 20% are buildings without capital walls. At the same time, 4% of the buildings are in (re) construction, 2% are damaged and 2% are demolished.

Conclusions

Comparing the number of dwellings registered at PHC-2014 with those collected in this paper, there is an increase of 26% in the case of Pojareni village, from 87 dwellings registered at PHC-2014 to 118 recently identified. And in the case of the village of Milestii Mici, an increase of 45%, from 126 dwellings in the PHC-2014 to 229 recently identified.

The increase in the number of dwellings is largely influenced by two factors: the first factor would be the spatial mismatch of the dwellings in the census enumeration area in the spatial base with those in the database collected at the census. And the second reason is due to a positive dynamics of various constructions in the localities near the municipality of Chisinau.

The implementation of open-source GIS technologies are recommended in the field of statistical activity in the Republic of Moldova. Their use will lead to an increase in the quality of data collected and disseminated, will reduce the team involved in data collection and monitoring, while reducing the cost of statistical work.

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