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**Vitalii Zatserkovnyi**, Doctor of Technical Sciences

National Aviation University, Kyiv, Ukraine

## USE OF GEOINFORMATION TECHNOLOGIES FOR MONITORING OF HUNTING SECTOR CONDITIONS

**В.І. Зацерковний**, д-р техн. наук

Національний авіаційний університет, м. Київ, Україна

### ВПРОВАДЖЕННЯ ГЕОІНФОРМАЦІЙНИХ ТЕХНОЛОГІЙ У МОНІТОРИНГ СТАНУ МИСЛИВСЬКИХ ГОСПОДАРСТВ

**В.И. Зацерковный**, д-р техн. наук

Национальный авиационный университет, г. Киев, Украина

### ВНЕДРЕНИЕ ГЕОИНФОРМАЦИОННЫХ ТЕХНОЛОГИЙ В МОНИТОРИНГ СОСТОЯНИЯ ОХОТНИЧЬИХ ХОЗЯЙСТВ

*The following justification is conducted: necessity of implementation of geoinformation systems (GIS) and geoinformation technologies (GIT) for hunting sector monitoring. Possibilities of the use of geoinformation systems (GIS) as one of the most promising approaches to increase monitoring effectiveness are analyzed; these are the tool for practical implementation of new approaches to monitoring on the basis of spatial mapping of objects that have a certain size and propagation in space and the tool for making effective managerial decisions. Approaches of GIS development for tasks on monitoring of hunting sector state were considered.*

**Key words:** territory, geoinformation systems (GIS), geoinformation technologies (GIT), monitoring.

*Проведено обґрунтування необхідності впровадження геоінформаційних систем (ГІС) і геоінформаційних технологій (ГІТ) у моніторинг стану мисливських господарств. Проаналізовано можливості використання ГІС як одного з найбільш перспективних напрямків підвищення ефективності моніторингу, які є інструментом для практичної реалізації нових підходів щодо управління галуззю, моніторингу на основі просторового відображення об'єктів, що мають певні розміри та поширюваність у просторі та прийняття ефективних рішень. Розглянуто загальні підходи щодо створення ГІС для задач моніторингу стану мисливських господарств.*

**Ключові слова:** територія, геоінформаційні системи (ГІС), геоінформаційні технології (ГІТ), моніторинг.

*Проведено обоснование необходимости внедрения геоинформационных систем (ГИС) и геоинформационных технологий (ГИТ) в мониторинг охотничьих хозяйств. Проанализированы возможности использования ГИС как одного из наиболее перспективных направлений повышения эффективности мониторинга, которые являются инструментом для практической реализации новых подходов к мониторингу на основе пространственного отображения объектов, имеющих определенные размеры и распространенность в пространстве, и средством принятия эффективных управленческих решений. Рассмотрены подходы создания ГИС для задач мониторинга состояния охотничьих хозяйств.*

**Ключевые слова:** территория, геоинформационные системы (ГИС), геоинформационные технологии (ГИТ), мониторинг.

**Problem definition.** The problem of territorial organization of hunting sector in Ukraine was always one of the thorny one. Today with sharp stratification of society at the background together with growth of social inequality and high corruption there is a massive acquisition of the best hunting lands by financial and political elite, as well as push of ordinary hunters to underproductive territories which very often become too expensive for majority of Ukrainian hunters.

There is a tendency observed – tendency of massive noncompliance of hunting legislation norms, including remonstrative poach, intentional damage of private hunting households functioning, those households that limit or close access to local hunters.

All that is happening at the background of noticeable weakening of state services of environmental security and resources utilization, particularly animal world that brings discredit to country status as owner of animal world.

During independence period of Ukraine hunting sector works unprofitable, quantity of hunting lands decreases, the limits of hoofed types of hunted animals are not followed, and their kill estimates by 100–200 times less than in countries of European Union. But as it comes from European countries experience, the use of state hunting fund is not profit-loss but profitable thing. Good examples in hunting household keeping show our geographical neighbors – Hungary, Poland, Czech Republic and Bulgaria. For example in Ukraine, territory id which is 604 thousand square kilometers, 1 thousand of deer is killed, as well as 6-8 thousand of wild boars and 5–7 thousand roe deer; and in neighboring Poland which territory is almost twice less (313 thousand square kilometers) they kill 39 times more of deer, 10 times more of wild boars and 17 times more of row deer [1].

Problems existence in this field demand development and scientific justification of set of tools (environment-oriented, managerial, organization-informational as well) that will improve system of hunting resources recovery, increase of use efficiency on the basis of constant development.

**Analysis of latest investigations and releases.** The development of scientific problematics connected with increase of efficiency of protection, recovery and use of nature resources potential in general and hunting sector particularly grew during past years. The following scientists contributed into its research – V.D. Baytala, I.K. Bystryakov, V.S. Bondar, P.P. Borschevskiy, V.V. Varankin, M.M. Vedmid, S.A. Hensiruk, D.S. Dobryak, S.I. Dorohuntsov and many others.

Development and establishment of GIS the society is obliged to many foreign, soviet, post-soviet and domestic scientists, among which are O.M. Berlyant, L.M. Bugaevskiy, B.S. Busyhin, G. Dangermond, O.O. Ischuk, E.H. Kapralov, Y.K. Korolyov, A.V. Koshkaryov, M. Kumbs, I.K. Lurie, M. de Mers, V.B. Mokin, V.V. Morozov, O.O. Svitslychnyi, E.S. Seredynin, V.S. Tikunov, Z.F. Tomplinson, A.M. Trofimchuk, V.D. Shypulin, V.Y. Tsvetkov anf many others.

**Emphasis on previously unsolved parts of general problem.** Among main reasons which cause inefficient keeping of hunting industry and slowdown development of hunting sector in Ukraine one can point imperfect state rules and regulations (absence of accurate order of granting into usage of hunting lands, absence of limits of kill, pass-through capacity, norms of hunting animals kill); imperfect legal regulation of activity of state regional hunting management and hunting service in the field of fight with poach; absence of operative mechanism of damage reparation done to hunting types of animals; imperfect legal regulation of administrative services delivery in field of hunting sector (issue of annual controlling swipe card on wild fowl kill and violation of hunting rules) and inefficient law enforcement by authorized public authorities of state executive government (absence of operative state control over requirements of current legislation, duplication of competences of state public authorities as well); imperfection of interpretation of hunting terminological definitions in Law of Ukraine “About hunting sector and hunting itself” and absence of efficient informational system that would provide effective functioning of modern hunting sector including development of project on internal economical set-up of hunting sector on the territory of Ukraine, based on use of modern methods of hunting arrangement and legal framework, creation of necessary package of cartographic materials, inventory and site class determination of hunting lands, analysis of hunting economic operation, planning of events on wild life conservation, as well as biotechnical, operating and inventory events.

**Main target of the publication** is grounding of GIS use necessity as efficient tool of spatial analysis of environmental factors influence on the condition of hunting sector and its visualization in process of monitoring and creation of united system of suballocated data processing, organization of scale collecting system, processing, maintenance, analysis and

provision of information about realistic condition of hunting lands with the help of modern informational technologies, first of all geoinformational technologies and Earth Remote Sensing Technologies (EDST).

**Chernihivska oblast was chosen** as the subject of investigation, **as one of the typical region of Ukraine.**

**Initial basis for investigation conducting were data of official statistics of regional statistical and environmental authorities.**

**Presentation of core material.** In process of certain hunting territory management (field) one should operate with huge data volumes, making decision on choice of development strategy (economical, ecological, environmental as well), reasonable nature- and land usage. As spatial information is often critical for field development provision, planning and management, and geoinformational technologies (GIT) ensure consistent spatial unification of such information and its mutual use, modern geoinformation systems (GIS) are world-wide recognized as one of multi-purpose integrated informational and technological tools of solving diverse regional problems [2; 3].

Current hunting sector problems carry systematic nature and lack of people resources and scientific pilot projects are the most important factors of economical growth restraint, and also decrease of economical indexes in this sphere.

For efficient management of available resources, development planning and operative management of hunting sector it is necessary to have computerized system of collection, maintenance and analysis of information appropriate for making efficient management decisions. The existence of computerized system of management (CSM) of hunting sector and its use is impossible without efficient use of geo-spatial information which contains in electronic maps, aerospace, digital orthophotoplans and other sources of information about territory, that are integrated into GIS. Undoubtedly the most efficient tools in spatial data processing today are geoinformation technologies. For the latest decade the understanding of their essence dramatically changed, and functional variety of use seriously expanded – from accomplishment of narrow geographical investigative and cadastral tasks to complicated analytic modeling and advisory managerial tasks practically in all spheres of human activity. For this reason GIS serve as the most important functional part of modern and promising CSM.

Modern GIS let to unite electronic space-oriented images (plans, maps, schemes as well) and data bases in one informational environment. Such integration improves efficiency of their analysis and processing, and reflection of these data in usual look for common people understanding and seriously simplifies and improves mechanism of managerial decision making.

GIS contain cartographic information about location and borders of every separate hunting land, its name, legal address and contact information of households. That is why any hunter would be able to orientate himself through internet on his computer or mobile device, would find hunting place and would be able to find out whom to contact for permissions.

Further on one can connect GIS to electronic service of receipt of applications for hunting permissions. GIS availability will seriously simplify procedure of choice of hunting locations and getting corresponding permissions by hunters.

GIS creation assumes connection of space images of Chernihiv oblast territory to system of coordinates WGS 84, adjustment of topographic base connection to system of coordinates, tracing of hunting lands borders with their description and cartographic materials, and also connection of the net of rides, forests structure on the territory of certain region to WGS 84 system of coordinates. Besides, within the framework of GIS preparation it is necessary to perform decoding of space photos for the whole territory of Chernihivska oblast under categories “forest”, “field”, “bog”, “populated locality”, “waters”, “others”; also it is necessary to

conduct tables correction for binding materials of measuring tasks (winter route measuring, measuring of chickens, water fowls, dippers, semi-aquatic mammals, hoofed animals as well).

For possible use of GIS in management of hunting sector first of all it is necessary to work out the structure of cartographic data base on hunting territories of the region (fig. 1), by ensuring further use of this information for operative sphere management.

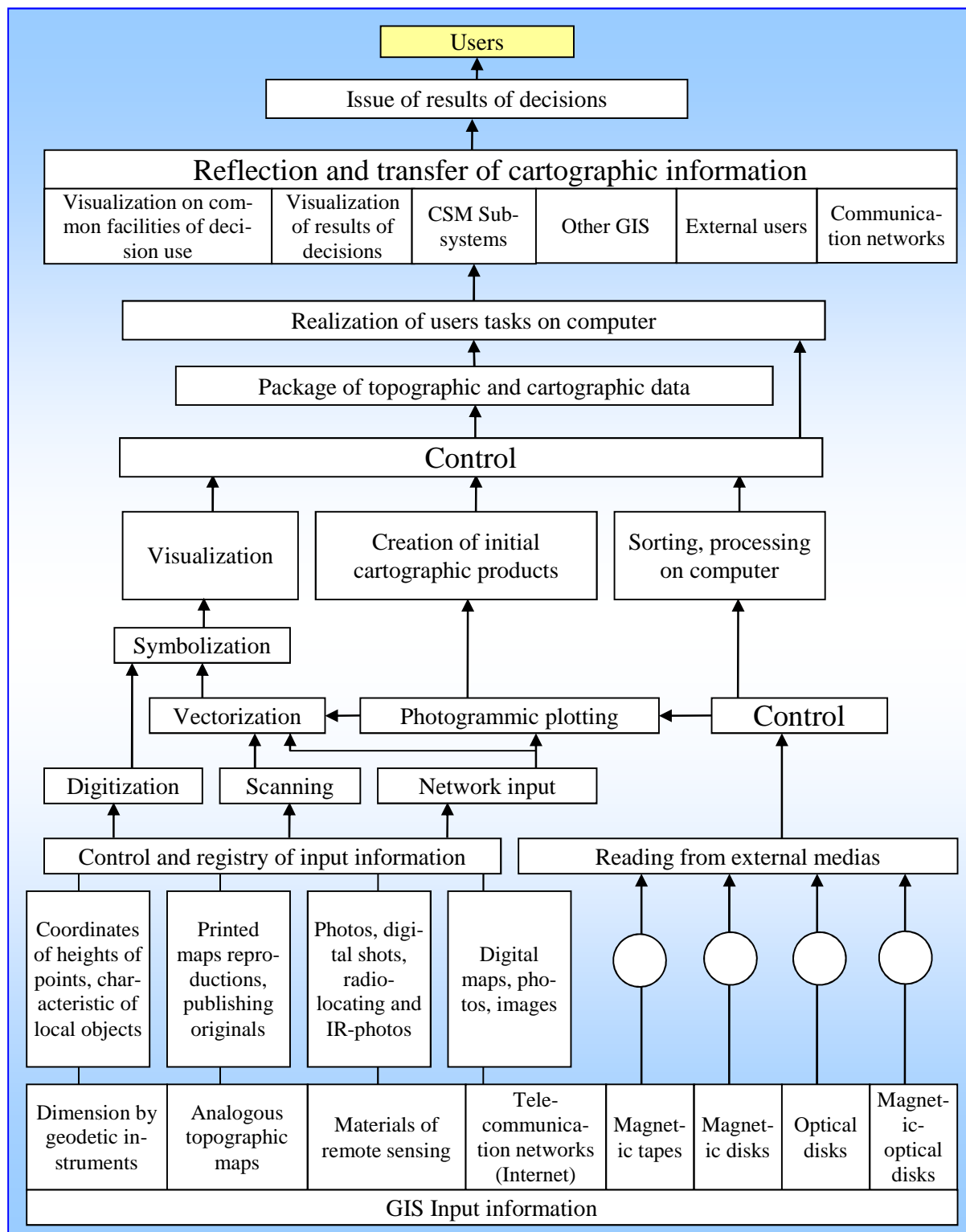


Fig. 1. Functional scheme of cartographic data base creation

GIS structure work-out presupposes use of abstract theorems and methods: system theory and systematic analysis; fundamental principles of informatics, geoinformatics; geodesic and aerophotogrammetric methods of topographic maps creation; modern methods of collection of geodesic information on the basis of GPS-technologies; methods of cartographic modelling; methods of cadastral territory sensing; methods of territory monitoring with use of ERS (Earth remote sensing).

While creating digital model of investigated territory it is necessary to take into consideration its multi-function purpose and possibility of use for solving wide range of territory management tasks.

Taking into account world tendencies that formed in investigated field it is proposed to found on such modern informational technologies: basic Internet technologies; ideology of informational archives and architecture "client-server"; SQL-oriented instrumental systems (DBMS, ORACLE, INFORMIX as well); CASE-technologies of projecting of information systems and data bases; GIT; technologies of creation and information distribution on modern media bearers; development of graphic and text editors systems; multi-media technologies and technologies of virtual reality creation.

Technical scheme of creation of data bank of diverse information for GIS in territory management is presented below on fig. 2.

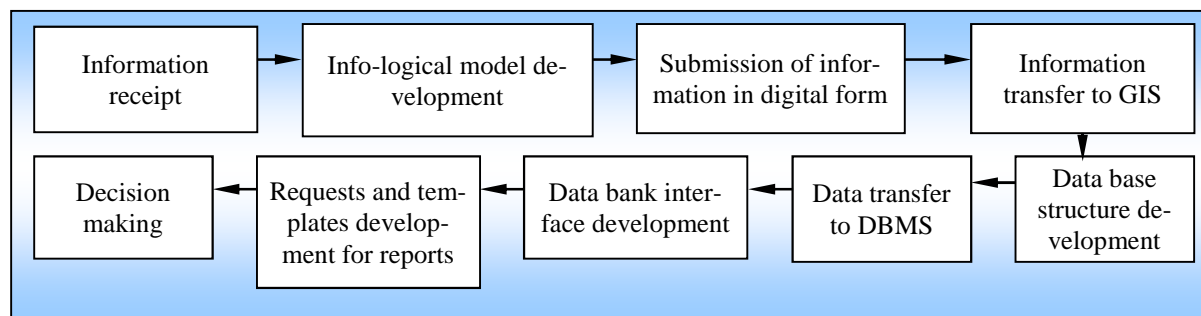


Fig. 2. Technological scheme of creation of data bank of diverse information for GIS monitoring of hunting sector

As initial cartographic material it is proposed to use: review-topographic maps with scale 1:1000000 for the region territory and neighboring territories; topographic maps with scale 1:200 000 for the region territory; geological maps with scale 1:200000; topographic maps for agricultural and forests lands, vessels rivers with the scale 1:100000, 1:50000, 1:25000, 1:10000; for solving different tasks including monitoring tasks one should use maps with the scale 1:5 000, 1:2 000, 1:500.

With system approach the process of GIS development is interpreted as search of optimal system structure by dividing it into sub-systems. In such a way the development concept "from up to down" is realized.

Structure of generalized GIS scheme is possible to implement on the basis of analysis of input/output informational flows that are functioning in computerized system.

General scheme of technological processes of cartographic information processing in GIS is presented on fig. 3.

Aggregation of input and output GIS data might be presented in form of independent technological collections of three groups: modelling and preservation, submission. It is true; information collection is performed independently from data conservation. Data is maintained independently from information collection and submission procedures. For submission (hand-out) of information in this or that form is provided independently from modelling types.

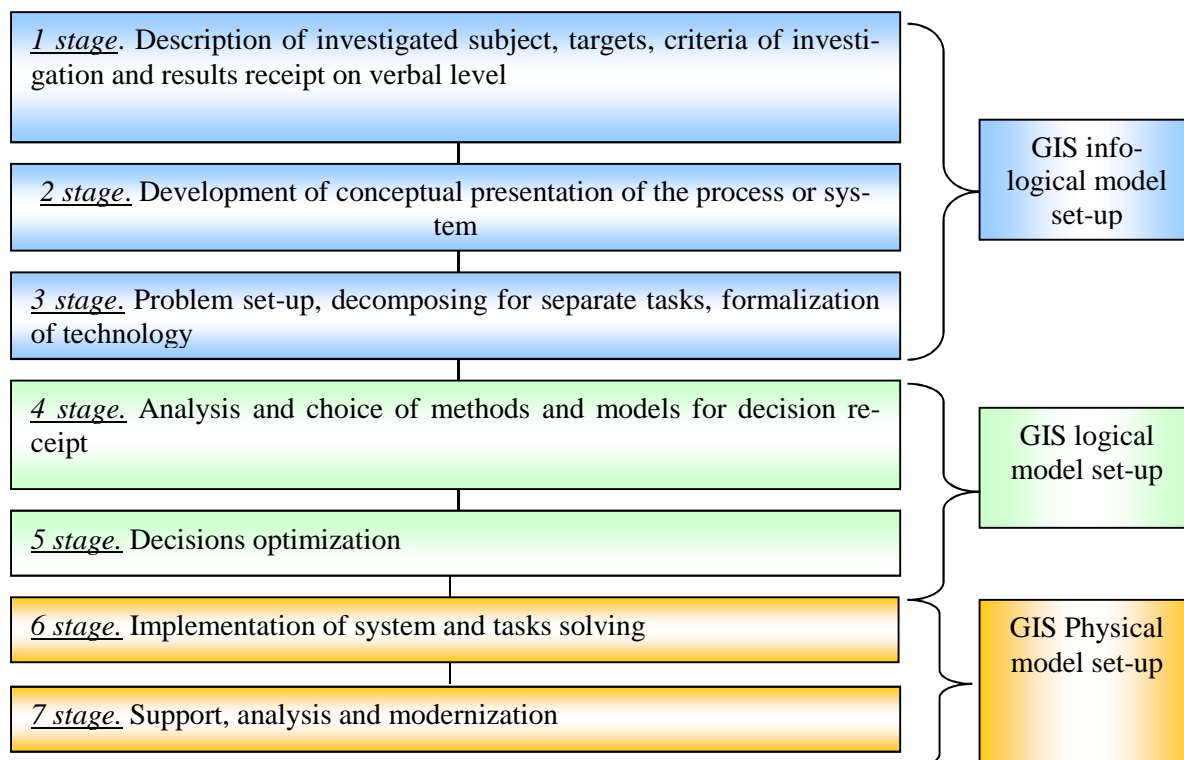


Fig. 3. Scheme of computerized system set-up

Such conditions are enough to present input X and output Y flows of generalized GIS in form of independent collections (in form of Cartesian multiplication [4]:

$$\begin{aligned}
 X &= (X_1 \otimes TT_c \otimes TT_m \otimes TT_s); \\
 Y &= (X_y \otimes DML \otimes DMM),
 \end{aligned}
 \tag{1}$$

where  $TT_c$  – technical task for information collection;

$TT_m$  – technical task for conservation, update and modelling;

$TT_s$  – technical task for data submission after final processing;

$X_1$  – range of initial data that are measured or collected with the help of different technologies;

$X_y$  – range of unitized data that are received after collection and initial processing;

DML – Digital model of location that is maintained in GIS data base;

DMM – Digital map model that is generated for visual submission on display or for printing.

Within framework of this theory DMM is actually a reflection of digital model of location with the help of means of computerized visualization. Use of DML and DMM is vividly traced in technology of MGE module system work (Modular GIS Environment) and a range of other GIS packages.

Range X is a complicated data collection received with the help of different technologies: from photos, geodesic methods on location, from maps, with the help of GPS systems (Global Position System), from archive table data as well.

On the basis of these conditions of general system theory lets present generalized GIS in form of stratified three-level structure (fig. 4):

For conceptual building of GIS according to (2) it is necessary to determine NRM, NRS, that is informational basis.

Thus, using system approach it is possible to build structural scheme of generalized GIS in form of three-level system (fig. 4) and to conduct comparison of different GIS between themselves on these levels; and also comparison of GIS to other computerized systems.

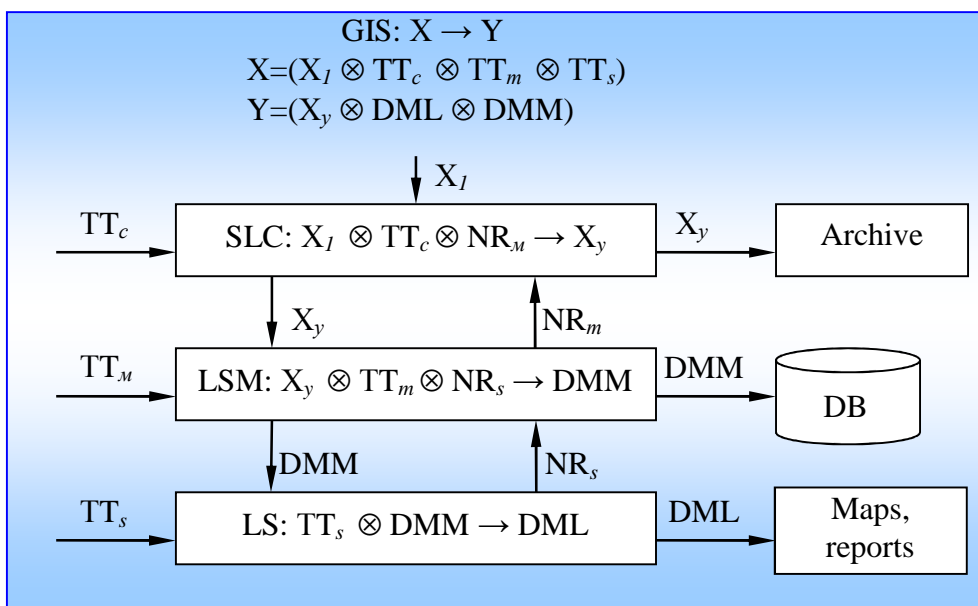


Fig. 4. Structure of generalized GIS

Normative requirements in (2) are determined with further analysis that is with the transfer to next stages of composition.

Term generalized GIS means that while one considers GIS he should disregard its specific use.

$$LSP: X_I \otimes TT_c \otimes NR_m \otimes X_y;$$

$$YMX: X_y \otimes TT_c \otimes NRS \otimes DMM; \tag{2}$$

$$PL: TT_s \otimes DMM \otimes DML,$$

where SLC – system level of collection and initial processing of information;

PMX – system level of modelling, conservation and update;

LS – system level of data submission;

NRM, NRS – normative requirements to data while modelling and submitting of information correspondingly; they are analogues of intermediate out-put informational flows.

Functioning of generalized GIS according to its formalized description (7.3) and scheme (fig. 4) is conducted in the following way [4].

On the first system level (LCP) there is a collection of initial data  $X_I$ , which are received with the help of different methods and technologies and that is why they have different structure, format and presentation. During initial processing these diverse data are corrected and unified. As a result certain unified sub-range of data  $X_y$  is formed and its partially maintained in form of archives and is fully transferred on the level of modelling and conservation.

On second system level (LMC) the following is performed: analysis of unified information  $X_y$ , set-up of connections between model parts; removal of redundancy if any; check on integrity and consistency of data; determination initial and external keys; formation of metadata as well. Sub-range  $X_y$  contains necessary data for constructing digital model of location which is maintained in data base in form of range of graphic and symbolic information. DMM serves as basis for solving application tasks on the basis of different modelling methods. These processes also take place on the level PMX. In the result of processing, the digital model that was formed or result of its use are being prepared for visual presentation. For this it is transferred on third system level.

On third system level (LP) of DMM is transformed into digital model of map which actually serves as basis for information presentation.

By analyzing groups of tasks of data processing on three system levels it is possible to mark the following.

On the first level the tasks of initial information processing are most widely presented: detection, structuring, decomposition, composition, measuring, compaction, control, unification.

For the second level the most important are tasks of typification, geometric transformation, expert type, build-up of digital models, synthesis as well.

On the third level the most significant are tasks of optimization, composition, synthesis as well.

It is natural that tasks and methods of modelling might be present on every level to a different extent but the type of level determines their importance and meaning.

In general aspect GIS might include such sub-systems:

- semantic modelling (coding) of information that is collected (1<sup>st</sup> level);
- imitation modelling for control over input information (1<sup>st</sup> level);
- geometric modelling (1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> level);
- imitation modelling for control over model solutions (2<sup>nd</sup> level);
- correcting of information on the basis of vector or scalar criteria (1<sup>st</sup> and 2<sup>nd</sup> level);
- interactive (intellectual) modelling (2<sup>nd</sup> level);
- semantic modelling (coding) of information that is maintained in DB (2<sup>nd</sup> level),
- documentary supporting (3<sup>rd</sup> level).

During initial information collection the major is semantic modelling. Invariant modelling has a priority on the second level. Intellectual modelling occupies the essential place during interactive processing and in processes of control and correction. Finally informational modelling is major in subsystems of documentary supply.

Thus, independently from type of instrumental system that is the basis for certain GIS, any GIS must have general attributes and characteristics of generalized GIS.

Let's take GIS as complete (informational) system if it contains all three system levels determined above. If not, we will talk about incomplete GIS.

Given method is possible to use not only for GIS but for any computerized system. Thus any information system, management system with similar given conditions (7.2) it is possible to present in form of three-level system. This affinity of system structures that differ by tasks and targets as well as the unity of information transformation gives a reason to talk about unity of concepts and methods of data processing in these systems. Thus on the level of systematic GIS structure and other computerized systems there is a generality of principles of data processing for application tasks including management, production arrangement, projecting, maintenance and update of data. This generality is a result of integration.

System approach allows to build GIS scheme in form of main levels of information processing and to conduct comparison analysis not only with other computerized systems but also with GIS assigned for different tasks solving.

On the basis of above-presented thoughts the pilot project of hunting households in Chernihivska oblast was created (fig. 5).

**Conclusions and propositions.** The development of GIS monitoring of hunting lands will allow: ensure citizens' rights for public information, announced by Constitution of Ukraine; increase efficiency of managerial decisions by methods and tools which use digital maps and digital models of locations; integrate informational resources of field into unified regional informational space.

Within framework of created geoinformational project it is possible to trace nature and economic conditions of hunting households in the region, to perform inventory and site class determination of hunting lands, to conduct analysis of hunting business activity both for the latest and for any previous revision period, to plan activities to protect animal world as well as



biotechnical and exploitation activities, to determine actual quantity of animal types which are objects of hunting and optimal density of existence of hunting animal types on one square unit, to determine pass-through capacity of hunting lands, to find out the most efficient approaches of activity of hunting household, to give recommendations on increase of hunting lands value.

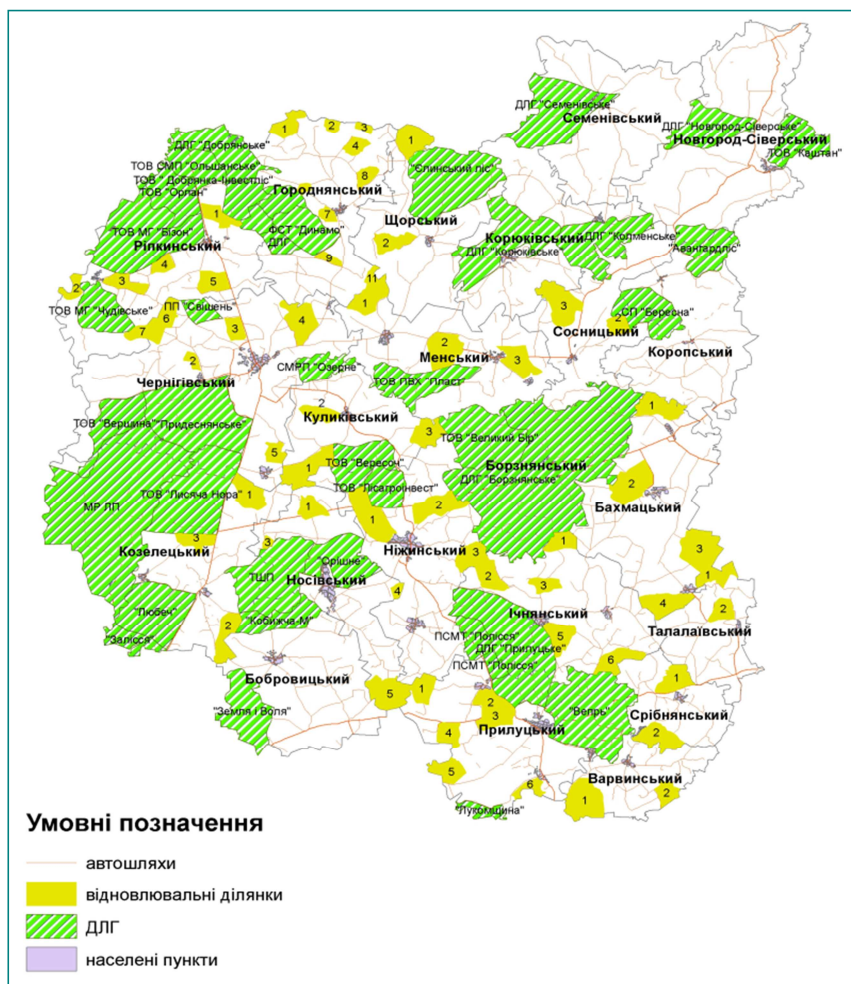


Fig. 5. Map of hunting lands of Chernihivshchyna (adapted from Y.S. Simakina)

GIS development will allow optimizing management of hunting sector in Chernihivska oblast, receiving true-to-fact information on territories of hunting lands, increasing accuracy of accounting reports.

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