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## **ELECTRONIC ECOLOGICAL LIBRARY: NEW APPROACHES, TECHNOLOGIES AND POSSIBILITIES**

*There had been suggested new approaches, models of data and technologies for processing, systematization and indexation of ecological information as well as ensuring possibilities for search for maximum relevant information within the minimum time, using in particular, spatial – oriented technology for presentation of ecological information. Attention had paid to filling in the library with information and new directions of using information in the library which become available in case of using the suggested approaches, models and technologies. There had been emphasized issues of copyright and rights for intellectual property for sources of ecological information, ensuring different levels of access, granted by the owners of information.*

**Key words:** *electronic ecological library, ecologic information, geoinformation systems, web- interface of the library, methods for automation of search – information devices*

### **1. Initial conditions and tasks setting**

Much attention, recently paid to ecological issues, consideration of ecological aspects practically in any sphere, caused the appearance of great amount of sources of ecological information. This, in turn, put forward the new tasks of its systematization, arrangement, ensuring possibility to search for maximum relevant information within the minimum time (relevant – measure of correspondence of the obtained results to the enquiry [1, 2]), Using traditional approaches and technologies for creation and registering electronic libraries is not that efficient.

Search for ecological information is restricted by possibilities to search for the information sources by the name, author, key words, text in the abstract and other parameters, which are usually given in typical librarian cards. For example, it is necessary to get acquainted with the research results of ecological character in the basin of the river Southern Boog. Using traditional searching approaches makes it sufficient to search for sources, which name or abstract contains words “Southern Boog” in different grammatical cases. But this is a false approach, since its results will not contain sources dedicated to researches of Podillya region, forest and steppe regions of Ukraine, right waterside part and south of the country, Khmelnytsky, Vinnytsia, Kirovograd, Cherkassy, Odessa oblasts and other regions, parts of which belong to the basin of Southern Boog and thus have to be among the enquiry results of the basin of the Southern Boog river. This requires the georeferencing to the region, but not the way it is accepted in library catalogues – following key words, location of printing house, authors or customer.

There is also the problem of reprinting information from one source to the other. It is possible to find 100 books with the same information. This initiates the necessity in formation of the unique bank of data of ecological knowledge allowing hoarding knowledge (models, algorithms, reference information) which is an original and basic for understanding ecological processes and dynamic of their development. Correspondingly, it requires searching technologies as for the content (assignment, connection) of information, but not only as for its representation as text enquiry.

Determining ecological information, it is not possible to operate with sources like electronic versions of the books, papers, reports on scientific and research works, PhD thesis etc. Ecological

information – this is data basis, specialized information systems, different types of maps etc. This requires technologies for simultaneous information search in text files, data basis, on electronic maps [3].

Thus, there is a task of development of new approaches, models, processing technologies, systematization and indexation of information of ecological character and ensuring possibility of search for maximum relevant information within the minimum time.

## **2. New approaches and technology for systematization, classifying and search for ecological information**

Let us first determine the notion of “ecological information” following the definition of Aarhus Convention [4]: “Ecological information means any information in written, audiovisual, electronic or other material form”:

- a) on state of components of environment, such as air, atmosphere, water, soil, earth, landscape and natural objects, biological varieties and its components, including genetically changed organisms and interaction between these components;
- b) on factors, such as substances, energy, noise and radiation as well as activity or measures, including administrative actions, agreements in the sphere of environment, policy, legislation, plans and programs which influence or may exert influence on environmental components, mentioned above in a), and analysis of expenses and results, as well as other economic analysis and assumptions, used in decision making on issues, relating to the environment;
- c) on health state and safety of people, living conditions, state of objects of culture and buildings to the extend, the state of environment components influences or may exert influence upon them either through these components, factors, activity, or through measures indicated above in b)”.

Much attention had already been paid to creation of libraries. Some aspects of these issues and ways for their solution are described in works [1-3, 5-7]. The site of NAS of Ukraine (<http://www.publications.nas.gov.ua/news/Pages/050308.aspx>) presents shorthand record of the seminar “Outlooks of creation of electronic libraries”, which took place on 5 March, 2008 with the participation of the representatives of National Academy of Science of Ukraine, Ministry of Education and Science of Ukraine, State Fund of Fundamental Researches of Ukraine. For creation of electronic ecological library (or, what is more concrete, electronic library of ecological information) along with traditional technologies it is suggested to use the new ones, which take into account the nature of the ecological information itself, in particular, its geographic referencing to the real ecological objects. It is suggested to use spatial-oriented technology of systematization and presentation of information in the catalogue of library resources. This needs the creation of geoinformation system with maps of different geographical zoning of the territory of Earth in general and of Ukraine in particular as for the different criteria: administrative division, natural zones, basins of rivers etc. It is also necessary to stipulate for possibility of additional furnishing the system with other maps, develop an algorithm for strict georeferencing of different types of works

to these regions. If it turns impossible to strictly refer the work to the specific region, as, for instance, the monograph “Environment Protection”, it should then be referred to the bank of generalized information, that is, theoretically, it may refer to any region.

It is necessary to create comfortable interface, which could allow choosing the stratum (kind of zoning) which form one map together. Enquiry for search for sources shall be used only for those sources, which relate to regions, presently reflected on the map – those regions (stratum) which are switched off and are not presently displayed, shall not be processed. By default all the stratum are switched to.

The following stratum of zoning of Ukrainian territory may be considered as referencing:

- administrative division: oblasts, Autonomous Republic of Crimea, cities of Kyiv and Sevastopol, regions of the oblasts (fig. 1);
- basin devising: basins of the big rivers (Dnieper, Dniester, Danube, Western Boog, Southern Boog, Siversky Donets, Tysza and others), middle rivers of Ukraine and other water regions (Prychornomor'ya, Pryasov'ya) (see fig.1);
- seas (Sea of Azov and Black Sea);
- geographic division of oblasts (Central, South, North, East, West );
- nature zones: mixed forests, forest – steppe, steppe;
- other kinds of zoning: Podillya, Galychchyna, Zakarpattya, Prykarpattya, Crimea, Donbass, Chernobyl zone etc.



Fig. 1. Combined map of two stratum “Administrative division” and “Basin division” of Ukraine (marked basin of the river Southern Boog) [8]

Layers of zoning of Ukrainian territory should provide for different levels of generalization of objects during their reflection on the PC screen in the search system. For instance, the stratum “Administrative division” at first reflects only boundaries of oblast. Increasing scale up to the level of one or two oblasts allows to view the boundaries of administrative regions of these oblasts. Analogically, in the stratum “Basins of the country” we view at first the basins of big rivers and

then, increasing scale, we see basins of middle rivers. Further scale increase allows to view basins of small rivers.

Search should be executed following the algorithm:

- select point on the map or set coordinates of the point, using mouse;
- select stratum of zoning types of the territory to be analyzed;
- set requisites, for instance “water monitoring” and references, issued after the year of 2000;
- view search results.
- Analogically it is expedient to systematize and classify the ecological information for the whole world and the Universe on the corresponding maps.

The results of such search should automatically determine the spatial relevancy which is suggested to consider to what extend the region under search is covered by the found source of information. Calculation of spatial relevancy  $R_p$  is suggested to find according to the formula:

$$R_p = \frac{S_o}{S_z}, \quad (1)$$

where  $S_o$  – square of the found object which belongs to the set region ;  $S_z$  – square of the set region.

Square of the found object which belongs to the set region is calculated by means of geoinformation technologies in a way of doing “intersection” over these regions. For example, there is a task to find the results of all the researches, done in the basin of the river “Southern Boog” (see fig. 1) for which  $S_z = 63700 \text{ km}^2$ . We assume that in the result of the search there had been found the report of scientific and research work on the system of the State monitoring of surface waters in Vinnytsia region. Analysis of objects’ intersection “Basin of the Southern Boog river” and “Vinnytsia Region” shows that the square  $S_o = 15900 \text{ km}^2$  belongs to the basin of the river Southern Boog that is approximately 60 % of the territory of Vinnitsia region. So, from formula:

$$R_p = \frac{S_o}{S_z} = \frac{15900}{63700} = 0,25.$$

It is expedient to ensure the georeferencing of these maps to the known banks of geographical and mathematical maps Google Map (Google Earth) and those similar to them which have free access in Internet.

Technology of search for ecological data as for the content is based on formation of bank of notions (ontology) which may be found in different cases in documents which are being processed. But the main difference between such technology and typical technologies of indexing key words in documents lies in the determination and saving different connections between these notions [2,3]. This substantially increases the relevancy of the search results.

### 3. Filling the library with information and its systematization

Work of the library first of all needs the solution of the problem of its furnishing with basic information and its further updating. It is possible to define the main information resources of ecological information and results of scientific researches of ecological character, which are of importance for Ukraine:

1. Scientific literature – monographs, papers, conference proceeding, abstracts of thesis, reports of scientific and research works etc, which contain ecological information or dedicated to issues of its generation and processing.
  - National Library of Ukraine named after V. I. Vernadsky (http://nbuv.gov.ua/);
  - Ukrainian Center for Scientific, Technical and Economic Information (UkrCSTEI) (http://test.uinte.kiev.ua/rus/databases/);
  - foreign sources, including OUN, EC (www.unep.org/, www.eea.europa.eu/, http://ec.europa.eu/environment/index\_en.htm, http://water.europa.eu/en/welcome and others; more detailed list is presented on the site of Ministry of Environment: http://menr.gov.ua/documents/sylky.doc);
  - other electronic and usual libraries of Ukraine and in the world which are for instance, in the registry of sources with free access: (http://roar.eprints.org/).
2. Ecological legislation – search on the site of Verkhovna Rada of Ukraine for documents of ecological character and formation of thematic catalogue of their references, Orders of Ministry of Environment and of other subjects of State system of ecological monitoring of Ukraine, methods for measuring the state of the environment and technological environmental impact upon it, other information of normative and methodic character (partially – in the kind of references to sources of the site of Ministry of Environment):
  - Site of the Verchovna Rada of Ukraine (http://zakon.rada.gov.ua/);
  - Ecological Legislation on the site of Ministry of Environment (http://www.menr.gov.ua/cgi-bin/go?node=Zakonodavstvo).
3. Electronic mass media (EMM) – electronic ecological newspapers, papers of the famous EMM dedicated to ecological issues: diary “Dzerkalo Tyzhnya” (http://www.zn.ua/), «Ecolife» (http://www.ecolife.org.ua/) and others.
4. Ecological institutions and organizations – the register, information in brief, web – sites of the institutions of world significance and institutions of Ukraine: scientific institutions of ecological character, institutions for higher education which train ecologists, enterprises of ecological profile (designing, manufacturing, educational and other), non – state public organizations with interest in ecology, central and territorial state bodies of ecological ministries and departments (subjects of the State system of ecological monitoring). Register must be created on the basis of thematic lists of corresponding departments including institutions of not only of ecological profile:
  - scientific institutions of NAS of Ukraine and MES of Ukraine – on the site of NASU http://www.rsc.nas.gov.ua/Pages/default.aspx;
  - list of institutions for higher education licensed by the Ministry of Education and Science of Ukraine, are presented on the site of MESU: http://www.mon.gov.ua/main.php?query=nz;
  - structural and territorial subdivisions of Ministry of Environment: http://menr.gov.ua/cgi-bin/go?page=142&type=left.
5. Ecological data, maps and analytical reports – all national reports on the state of environment in Ukraine, different analytical reports of Ministry of Environment, issued in different times,

generalized data of ecological monitoring, brief data of water fund, brief data of natural and reserved funds objects, cartographic information with free access, references to Internet GIS etc:

- operative data of hydro meteorological monitoring on the site of Ukrainian hydro meteorological center: <http://meteo.com.ua/>;
- information on main emergency situations of technogenic, natural and other character on the territory of Ukraine at a definite time on the site of the Ministry of Emergency Situations of Ukraine, for example as of 19.08.09 at 7 am:  
<http://mns.gov.ua/daily/showdailyarchive.php?day=19&month=8&year=2009> ;
- national reports on the state of environment in Ukraine, analytical surveys and thematic maps on the site of Ministry of Environment: <http://www.menr.gov.ua/cgi-bin/go?node=Dop%20p%20NPS>;
- sites (web - portals) of the monitoring systems of regional institutions: State Administration of Environment Protection of Vinnytsia oblast (<http://edem.vstu.vinnica.ua/monitoring/>) and in Lviv oblast (<http://194.44.208.29/ekomap/index.php>), Basin administration of water resources of the Western Boog river (<http://zbbuvr.lutsk.ua/Monitoring/Results.html>) and others.;
- catalogue of the sites of GIS organizations and institutions of Ukraine on the site of GIS associations of Ukraine (<http://www.gisa.org.ua/links.htm>);
- catalogue of cartographical resources of Internet on the site of Russian company “Data+” (official dealer of ESRI (USA) in RF): <http://dataplus.ru/Support/Catalog/index.aspx>;
- other thematic and regional sources.

The above lists present only the main sources of information with random examples in Internet. The issue of viewing and quality analysis of these resources is the subjects of separate papers. The list of the most visited web – sites of Ukrainian libraries is on the site of National Library of Ukraine named after V. I. Vernadsky : <http://www.nbuv.gov.ua/portal/librating.html>.

At the same time it is necessary to adjust the process of systematization and indexing of the resources already generated in other libraries, using the suggested technologies, together with entering new information – digitalizing resources which are kept in hard copies, search for new materials.

Final objective of processing of ecological information is singling out, systematization, classifying and building models of knowledge (original expression of mathematical models, algorithms in the kind of block diagrams, data basis and other), which allow to form the unique bank of ecological data and knowledge which are verified and are not repeated in other sources.

#### **4. Copyright and rights for intellectual property on sources of ecological information in electronic ecological library**

During the creation and use of electronic ecological library it is necessary to pay attention to the significant aspect of copyright and rights for intellectual property for sources of ecological information. The library should ensure access only to information which is considered as for free distribution by its owner. So, the information, upon consent with the owner of the resources, has to be submitted by one of the three methods:

- full access without restrictions – viewing, copying;

- access for registered users only;
- access upon the official enquiry in a written form – the organization sends the enquiry of the approved form (file pattern shall be placed on the site of the library) on the official form of the organization, signed by the manager. The password for access to information will be then sent on the e – mail address; copying of information is allowed.

It is also suggested to stipulate for such levels of information furnishing to the users:

- full – all the data upon the coordination with the owner of the resource are copied and placed in the library with full access for users (viewing, copying);
- full, but with references – the owner of the resource requires references to his site in which he himself allows viewing and copying of information – this may appear actual if the owner of the resources often updates information and methods for presentation, allocation of new and elimination of old data, deletion of hypothesis which turned to be false;
- declarative, but with the example – there shall be placed the news that definite information is available in some organization; there shall be stated the conditions of getting access to it, and an example of information for some objects determined by the owner of the resources;
- declarative – the same as “declarative but with the example”, but without the example of information.

For example, data of the state Hydrometservice of Ukraine, which characterize the availability of data (factors, years) on the observation posts with indication of contact information of service units, where it is possible to solve problems relating to their ordering and purchasing, may be placed declaratively.

### **5. Direction of using information of ecological library**

Much attention has to be paid to reflecting the results of the information search in the library resources. Traditional approach – is a list of found sources with the indication of their requisites and singling out those which were noted down in the enquiry. In view of the widening types of information sources in ecological electronic library, along with the traditional approaches, it is suggested to use the following means for reflection of search results:

1. List of ecological data which relate to object of the search, providing the examples of these data; when they are not available, it is necessary to note where and under what conditions these data may be obtained and ordered.
2. Maps of the region on the known cartographical servers: “Planet Earth”(Google Earth - <http://earth.google.com/>), “Ukrainian cartographical net” (<http://uamap.net>) and other.
3. Knowledge (models, algorithms) which relate to the object of the enquiry, in the kind of special appropriate designs, in which they are traditionally furnished (formulas, block – diagrams, UML – models etc.).

It is expedient to stipulate for iteration search [3], when elements of results of information search are used for detailing new enquiry, and this shall be done automatically – the system itself suggests a few variants. Detailing may be done thematically, following the georeferencing to the region, or as for the base of ontological notions, date of search etc. Principle of detailing means that the

system is “aware” which resources are available in the library and “suggests” what namely might be found. Thus, the non – perspective directions of search for information, which is currently absent in the library, is ignored. Thus, the catalogue of electronic ecological library created according to the suggested approach and technologies will allow to apply the following types of search:

- quick search for maximum relevant information according to typical requisites (authors, name, key words, printing house, year of issue, customer of work etc);
- search for information of the set type and themes for the set region;
- search for region, for which the researches of the set type and themes for the set period are not available, which is of importance during planning new scientific reaches, including those for PhD thesis;
- search for documents of ecological legislation on the set objects;
- combined search, when the enquiry of one type is formed on the basis of searching results upon the enquiry of the other type;
- iteration search, characterized above.

Systematization of sources and results of PhD researches as for themes and regional spreading, together with ecological problems which are determined in other documents (see national reports on state of environment of Ukraine and other), will enable to determine the regions in which actual researches of the set direction had not been yet conducted, and what ecological problems are not given adequate attention. This, in turn, will allow to determine and recommend priority directions and themes for PhD and Doctor Degree thesis in the appropriate directions and specialities. The necessity in such compiling and systematization of information had been emphasized in the report of the Head of HAC of Ukraine, made by V. F. Machulin [9].

## 6. Conclusions

There had been suggested the new approaches, models of data and technologies for processing, systematization and indexation of ecological information as well as ensuring possibilities for search for maximum relevant information within the minimum time necessary, in particular, with the use of spatially oriented technology for presentation of ecological information. Attention is paid to issues related to furnishing the library with information as well as to new directions of using information in the library, which will open in case of using the suggested approaches, models and technologies. Attention had been paid to the questions of copyright and rights for intellectual property for sources of ecological information and different levels of ensuring access for users to this information, allowed by information owners.

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