Information Modeling of the Forestry Sustainable Development in Bulgaria

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Abstract: The paper discusses practical problems of a project devoted to modelling sustainable development management of the Bulgarian forests. The presented model is Web-based and uses the resources of Geographical Information Systems (GIS) for the creation of database of modelled forest plantation, simulation of normal and random events of plantation, statistical analysis of the results of plantation. The authors present comparative analysis of the ideal plantation and its visualization. The dynamic nature of the model allows its implementation in the strategic management of forestry. The project is expected to have significant contribution on improvement the quality of the forestry management by duly evaluation of possible effects of plantations and the conditions of their sustainable use. It is expected that a network of models would be created in future to account the growth indicators of the real plantation at given environmental conditions.

The informational modeling of the forestry development is stimulated by the economic significance of this sector as well as of the need to manage it in sustainable way. As a result we initiated Web-based study on modeling sustainable development management, which resulted in the model presented below.

1. Preconditions for creating the model.

Our starting point is the understanding that forestry has global significance for the future of our planet. About ¼ of it is covered with forests and the deforestation is defined as one of the main reasons for the global warming. In the United Nations Conference on Environment and Development (UNCED) 1992, the forest problems were among the most discussed between developing and developed countries. UNICED [6] developed "Forest principles", which explicitly defines the way the forestry is to be managed in the present conditions and tendencies, which according to the World Resources Institute (http://www.wri.org) after 1980 are:

- slight rise in industrialized countries;
- reduction by 10% in developing countries.
- deforestation in tropical zones – about 130 000 km^2 per year.

In preparing the model we also refer to the numerous certificates for the sustainable forest development, the more important of which are these produced by the Forest Stewardship Council (FSC) (http://www.fscus.org), and by ISO (ISO 14001 съвместно с ISO 14004).

All these documents and experiences allowed us to define sustainable development of the forests as such a development in which the forests are kept in a way so that the next generations could use them in the same way as the present generation. We did not exclude in some cases the partial application of the Hartwick rule [Perman (2003)] – the deterioration in some forests can be compensated by the improvement of other forests so that the total stock remains the same or increases. It however is applied mainly to the industrial forestry as forests are unique product and in most of the cases no compensation is possible.

The model also took into account the fact that the transition to sustainable forestry demands data and technologies. Our preliminary study indicated that the necessary knowledge and information were available, not their collection and systematization requires a lot to be done. No progress could be reached until this activity is not released as the information technologies, particularly GIS, play leading role in modeling of sustainable forestry. In our vision GIS was the basis to reach optimal solutions in forestry generating and production as well as in preparing long-run forecasts crucially needed for sustainable development management of this sector.

2. Survey of the GIS modeling of forestry. Basic computer models of forestry

As methodical start we faced different models, which explain the nature of the forest phenomena:

- Model of growth of forestry stock and forestry ecosystems.
- Model of forest disasters - calamities, forest fires, wind/snow storms, etc;
- Model of forest biodiversity;

- Economic model of forestry valuation.

They all are used in various degree for strategical planning of the forests. In the work on our model we concentrated mainly on the following models:

2.1. The Canadian model of sustainable forest.

This model [2] is used at local, national and international level since 1992. The basic opportunities which this model allows are:

- Developing instruments and methods for sustainable management of the forests - methods of alternating logging, video materials for the quality of water resources in the forests, set of indicators for sustainable growth of forests;
- Data base processing for the national model of forestry management;
- Improvement of current nets for collection and dissemination of data;
- Increasing involvement at local level in forestry management;
- Training of the forestry staff.

The model is based on Internet and intranet database.

Such programs exist in Russia, Mexico, USA.

2.2. NASA project

This project is interesting for us in modeling and monitoring the changes of the forest ecosystem as a result of natural and anthropogenic actions. The useful feature of the model is the fact that it is based on remote sensing of the ecosystem status. The project has web site, including information about the goals, model interface, interactive soil map, various presentations and publications, which makes it applicable in a broad spectrum of GIS modeling.

In our opinion this model could be used as a starting point for studying selected forest plantation with his parameters - climate, vegetation, soil, solar radiation, slope, landscape etc. This application generates a trend charts about the development of the main stand parameters - biomass, mean height, stand volume, species relationships etc.

2.3. The merits of the project "Flux model" of the Center for protection and monitoring at UNEP and the Edinburgh center for measuring of the carbon concentration can be seen from the ambition of the project [7] “to define the highest priority forests endangered by the climate change”. The project allowed preparing a reaction model reproducing the behavior of the forest ecosystems to the climate change. As a result database of reaction models was created as an open system with the possibility of further extension in future.

2.4. The project of Wageningen University [4] named Forest Models for Sustainable Forest Management, FORMOD) was the next studiy used by as a basic for our model. The Wageningen study is developed by Russian and EU specialists and his goal is to create a collection of instruments for forestry management in various conditions of environment, which is of special interest for our needs. Based on hierarchical structure of models following conditions influencing the growth of a given forest population it allowed us to formulate basic instruments for forestry management adjusted to the concrete conditions of Bulgarian economy and legislation. Due to various temporal and space parameters the models are interrelated into a network.

2.5. Bulgarian experience was of paramount importance in formulating of our model. The association of forest certification has developed national regulations for forests certification applicable to all kinds of Bulgarian forests and ownerships, which was necessary to outline properly the framework of the model.

As a whole in our starting activity we have a good methodological and methodical bases to create an informational model of sustainable forestry in Bulgaria. Moreover by now there are not other projects modeling sustainable development forest in Bulgaria.

3. Basic aspects of informational modeling of sustainable forestry in Bulgaria

In outlining the structure of the information modeling of sustainable Bulgarian forestry we propose to include:

- dataset determination of a model forest including natural parameters, managerial and random events;
- determination of parameters of ideal forest;
- project of the GIS database (geodatabase) of the ideal and the model forest;

- selecting and registration of map layers
- creating instruments (interface, file organization, referencing) of the modeling parameters of the real forest in the GIS database;
- selecting and using of GIS to create charts and estimate the real state of forestry plantation by means of various parameters;
- selecting and using statistical and geostatistical software packets for analyse and forecasting of model forest development;

An experimental functional structure of the informational modeling of forest development is shown on Figure1.

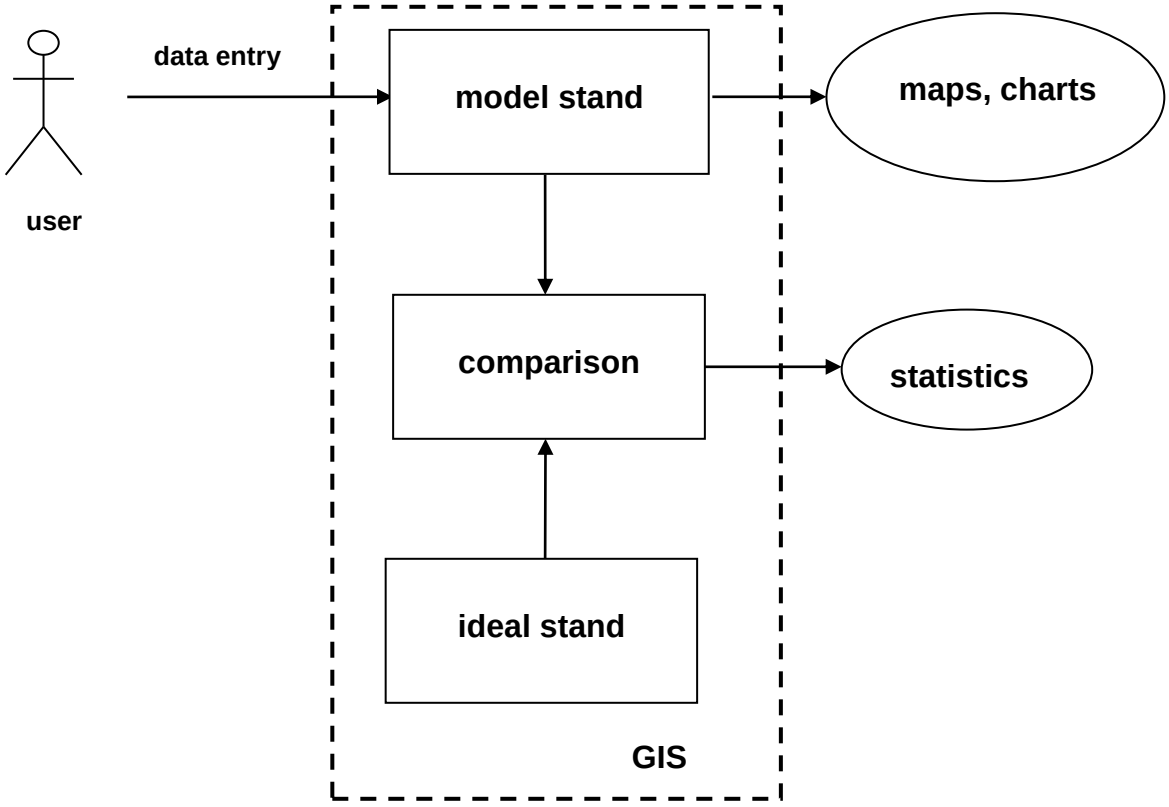

Figure 1. An experimental functional structure of the informational modeling of forest development.

Our proposal is to construct the model in the following way:

3.1. Project of interactive web site.

The project will be web based including the following base activities:

- data gathering for the Bulgarian forests – available for example by forest cadastre, satellite imagery, http://www.pinea.info etc;
- remote entry of model forest data (climate, soil, aspect, inclination etc) and additional parameters (cuttings, random fires, calamitets, frosts etc);
- remote entry of ideal forest model data;
- tracing of the tendence of stand growth of the model forest based on regression and dispersion analysis;
- output of map layers and diagrammatical trends of development of the model stand;
- feedback by discussion;

- finding and support of web links to other models.

3.2. Web site interface

The interface of the web site is planned to include: Administrative module, Comparison facility and Output facility (see Figure 2). Server-side database includes the tables "Model forest", "Ideal forest" and "Random Parameters". Additional nomenclature tables are included into the database too. The users can select an event, which is applied to the model forest and to study various options as every event has a set of selected parameters. It allows to test various options and to choose those which are socially and environmentally acceptable.

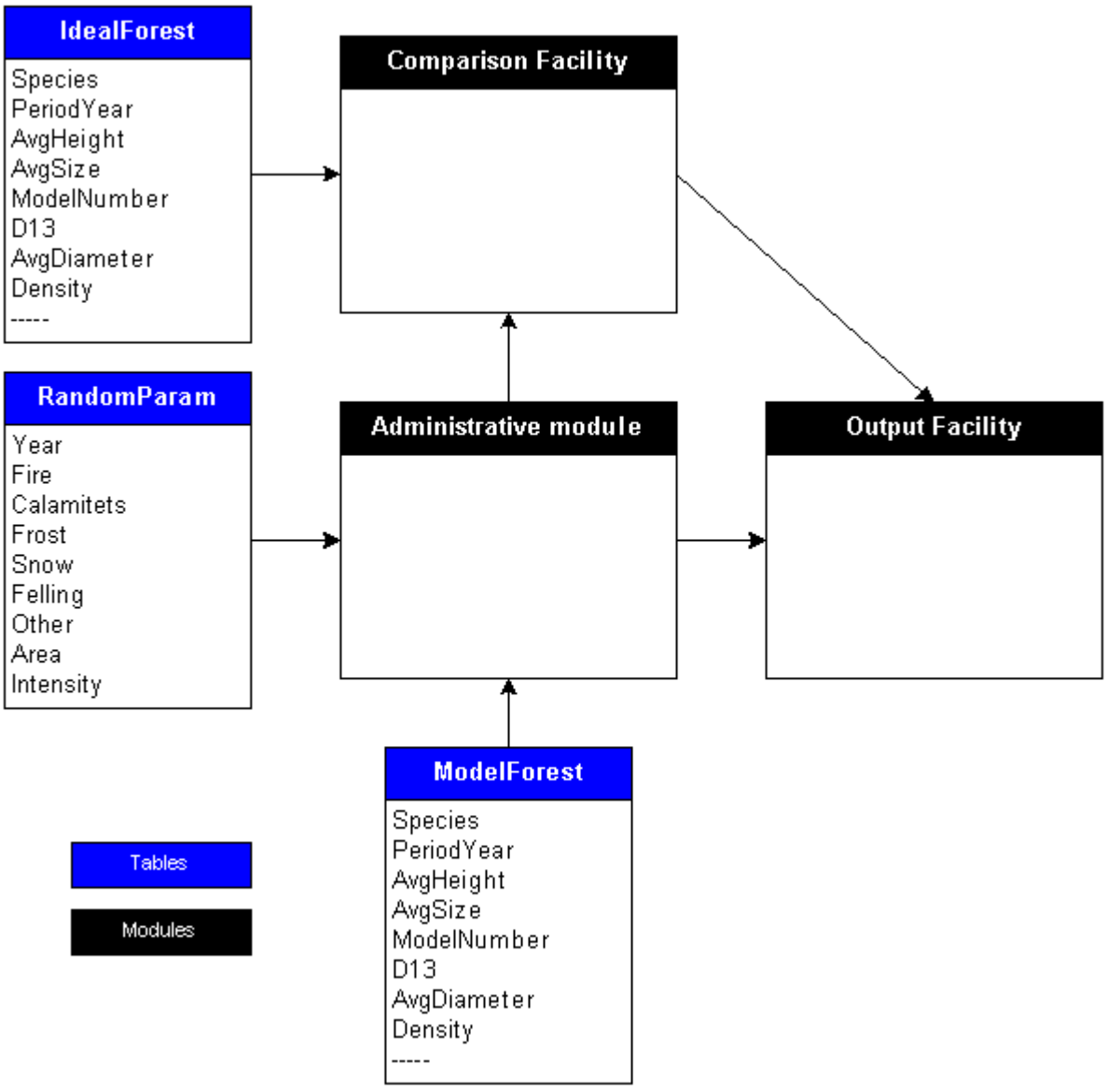

Figure 2. The Website interface of the model.

3.3. The software and hardware for the project includes:

- Personal computer with Internet connection;
- Database management system – MySQL;
- statistical packet (for example, StatGraph);

- GIS ArcView 8.3;
- Programming language PHP 4.0;
- Servers: MIS, Apache, GIS, FTP.

4. Application of the model.

As a result we initiated a dynamic model, oriented to be basic instrument in outlining the strategy for forestry management. The next stage envisages extension of the model to create network of models for real plantation growth accounting at a given environmental conditions. A network of models is foreseeing for the different types of environment. Our expectations are that this activity will stimulate the attempts for more efficient management on micro and macro levels and will contribute the sustainable use of forests.

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