

POSSIBILITY OF PREPARING THEMATIC MAPS THROUGH DEVELOPING OF THE GEOGRAPHIC INFORMATION SYSTEM (GIS)

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Abstract

It is a well known fact that nowadays planning of sustainable development and land use requires a lot of reliable and good quality information, which serves as the basis for timely and adequate decision-making. One of the most important forms of information are various maps. Until recently, preparing of such data was, no doubt, a rather complex and time consuming task. However, at present, thanks to, first of all, the GIS technology it is possible to develop corresponding geographic information systems with databases which then allow comparatively simple and quick preparing of necessary thematic maps. The paper first presents the method of developing the Geographic and Land Information System (GLIS) of the Karlovačka County which, although developed for the purpose of agricultural development, may also be used in development of forestry, environment protection, physical planning, water management and for soil conservation and regulation. Several examples illustrate the possibilities of preparing of specialized maps based on this GLIS. The basic data for developing of the geographic and land information system were the data of the Basic Soil Maps and topographic maps of the Republic of Croatia at the scale of 1:50 000 or 1:25 000, and the data from other studies made for the purpose of agricultural development in the area. These data, together with the results of processing and analysis this data, by digitalization, generalization and interpolation, were incorporated into an integrated database of the geographic and land information system by using Microstation, AutoCad, ArcInfo, ArcView and Access software and the corresponding hardware. GLIS database consists of two parts. The first part includes the data referring to polygons - pedological contours, and the other part the data on pedological profiles. The base is organized in a way that enable prepare different thematic maps, but it can be also used in digital form allowing simple and easy access by the ArcView program package to all information, either by the base search or by putting questions. The data included in the database are the basis for preparation of numerous specialized thematic maps at various scales. As an example of the use of GLIS for agricultural development, a thematic map showing soil suitability for vegetable production was made, which, by area inventory shows that in the County there are 15 197.6 ha of soils suitable for vegetable production, which is only 4.56 percent of the total area of soil. The second example of the use of GLIS is in physical planning, where the land classification map was made, defining soils of classes 1 through 5, which are protected by the law (N.N. 54/1994) from being used for non-agricultural purposes. Such soils comprise the area of 189 057.0 ha, which is 56.79 percent of the total area. Thus, these soils must be paid proper attention and protected from uncontrolled and unjustified use for purposes other than agriculture. Other examples of the use of GLIS is in land conservation and development. The specialized map was made showing the requirements for liming, which allows determining the distribution and areas of soils that require this agrotechnical measure.

Key words: *Thematic maps, database, GIS Technology, land*

1. INTRODUCTION

Planning of sustainable development and rational land use requires a large amount of reliable and good quality information to serve as the basis for timely and adequate decision making. Different maps are one of the major sources of such information. Until recently, procurement of cartographic information was very complex and time-consuming. Today, however, primarily owing to the GIS-technology, it is possible to create appropriate Geographic

Information Systems (GIS) with databases enabling a relatively simple and quick preparation of numerous thematic maps and thus provide land information required for making correct decisions in planning land use and land management.

A comprehensive Geographic and Land Information System (GLIS) has been designed for the needs of agricultural development and regional planning in the territory of Karlovac County. GLIS is an example of the present-day application of GIS for land use purposes in Croatia. Karlovac County is part of the central Croatian macroregion and covers an area of 3,329 km², or 5.9% of the total area of Croatia, Fig. 1.



Figure 1: Situation of Karlovačka county in the Republic of Croatia

Agricultural areas of this region constitute a natural resource of strategic importance for further economic development of this County. They should be, therefore, allocated for an optimal use in terms of intensive utilization, as well as protected from uncontrolled reallocation for non-agricultural purposes. Making use of the new potentials of the GIS technology in pedocartographic investigations, a comprehensive Geographic and Land Information System has been designed for Karlovac County. This method of research as well as data and research results organization has a number of advantages over previous traditional investigations. Among other things, it provides GLIS users with a relatively simple and quick way (using the ArcView program package) of obtaining the required maps, and thereby also information indispensable for correct decision making in land use planning.

There are numerous examples of GIS-based thematic maps of Karlovac County. This paper presents only a small part of thematic maps (layers) from the County's GLIS for the needs of agricultural development, regional planning and soil conservation and improvement.

2. INVESTIGATION OBJECTIVES AND TASKS

The principal investigation objective was to produce a comprehensive Geographic and Land Information System (GLIS) of Karlovac County for the purpose of intensive agricultural development, regional planning, soil conservation and improvement. With respect to this objective, the following tasks were formulated:

Compile a basic soil map according to the standards set for semi-detailed map preparation (1:50,000); Classify the area according to the utilization type; Determine the main properties of soil mapping units (parent material, slope angle, drainage, way of wetting, land use, vegetational cover, ecological depth, stoniness, rockiness) as well as the main chemical properties of the surface horizon (content of phosphorus, potassium, humus, carbonates, available lime), organize them in the database form and refer them to the relevant land area; Demonstrate the spread of soil profiles, and put together the results of field and laboratory analyses (physical and chemical properties) in a supplementary database, and refer them to the basic soil map; Define the measures required for further soil improvement aimed at intensive agricultural development (liming, erosion and torrent protection, supplementary agrotechnical practices, fertilization types, drainage and supplementary irrigation), integrate them in a database, and refer them to the basic mapping data; Perform land suitability

evaluation for multiple utilization in agriculture, as well as land capability evaluation for regional planning, and recommend the optimal agricultural management programs for particular mapping units. Organize the results in the database form, and refer them to the relevant area; Integrate all input data, as well as investigation results, and form GLIS in such a way as to enable its use with the ArcView program.

3. MATERIALS AND METHODS

The main source of pedological data for the Geographic and Land Information System of Karlovac County was the Basic Soil Map of the Republic of Croatia, scale 1:50,000, in printed and handwritten form with the appertaining legends (xxx Project Council for the Soil Map of the Republic of Croatia), the regional monograph Soils of the Upper Sava Valley (Kovačević et al., 1972), as well as a number of studies prepared for the needs of agricultural development and land improvement in this area. Based on the topographic map, scale 1:50,000, water areas (rivers, lakes, fish-ponds), settlements, and forest areas were separated. Digital data on the boundaries of the County, communities and settlements were obtained from the regional land survey service.

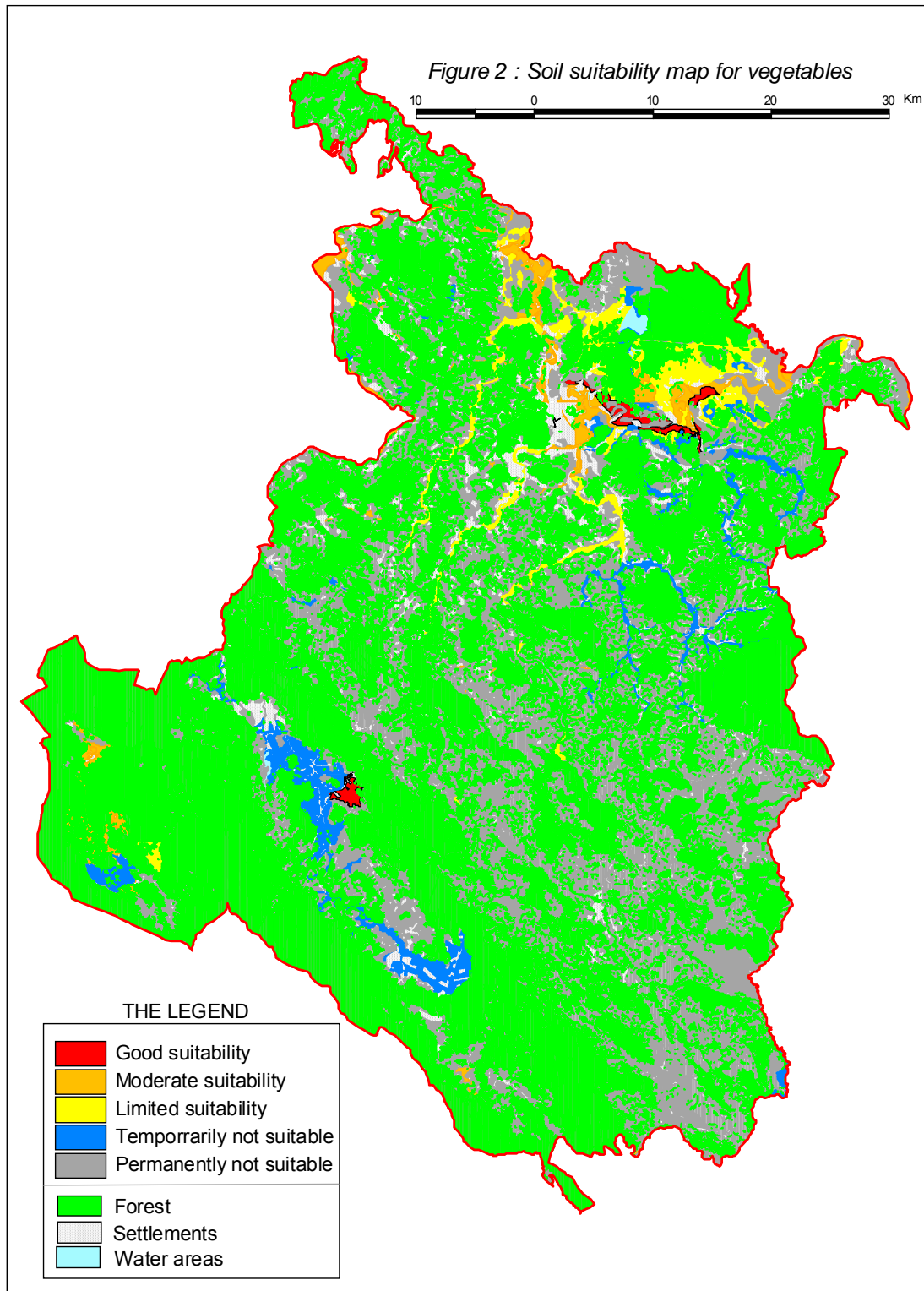
Methods of work are based on the Info technology, and comply with the methodology of GLIS construction, that is, with the criteria and standards of producing maps in the scale of 1:50,000. Digitalization of all contours was made using the AutoCad program, while the ArcInfo program was applied for the polygonal structure. Databases were compiled by means of Access. All input data, investigation results and GLIS formation were ultimately interconnected by means of ArcInfo and ArcView programs.

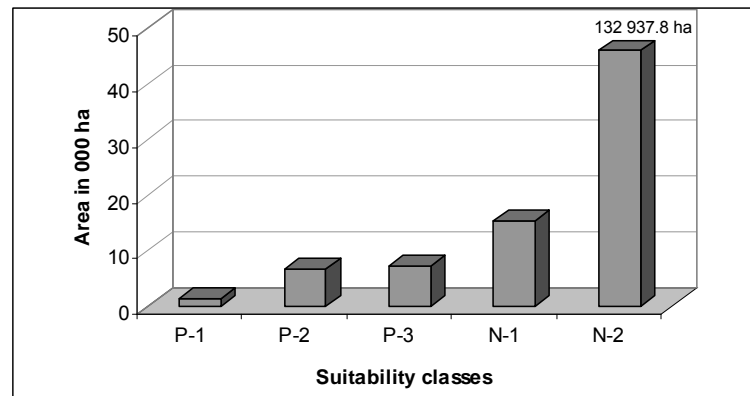
Evaluation of land suitability for multiple agricultural utilization was done pursuant to the FAO land evaluation criteria (FAO, 1976; Brinkman and Smyth, 1972, Vidaček, 1979), and the land capability evaluation according to the Rulebook on Land Capability Evaluation (xxx NN 47/82, Kovačević, 1983).

4. INVESTIGATION RESULTS

Input data and investigation results constitute the basis for designing a number of thematic maps. Forty-six thematic layers (maps) were designed digitally for different purposes in Karlovac County, which, including forests, is twice the number of GIS layers. As part of evaluation of area attributes, certain physiographic properties of the terrain as well as physiographic properties of soil were digitally worked out. They served for evaluation of multiple land utilization for particular branches of agriculture (vegetable production, viticulture, fruit growing, cropping, grassland farming, fisheries, etc.). As an example of applying GLIS for this purpose, a map of agricultural land suitability for vegetable production is presented in Fig. 2. Based on the results of evaluation of the suitability of mapping units for vegetable production, incorporated in the comprehensive Karlovac County GLIS and processed with the ArcView program (software), and by selecting appropriate commands, it was possible to make a map displaying the space distribution of particular suitability classes and subclasses. It was also possible to take an inventory of areas so as to identify the soil resources for vegetable production available in Karlovac County. It was found that the County has only 15,198 ha or 9.3% of soils suitable for vegetable production with respect to the total agricultural areas. In this, only 0.8% belong to the class of highly suitable soils (P-1), 4.1% to the class of moderately suitable soils (P-2), and 4.4% to the class of marginally suitable soils (P-3). The presence of soils currently not suitable for vegetable production (class N-1) was also recorded, that is, soils with some limitations that may be surmountable, turning the soils into suitable. There are 15,420 ha or 9.4% of such soils, which points to considerable soil reserves for the future development of this branch of agriculture. There are as many as 132,938 ha of permanently not suitable soils (N-2) for vegetable production, which amounts to 81% of the total agricultural land, Graph 1.

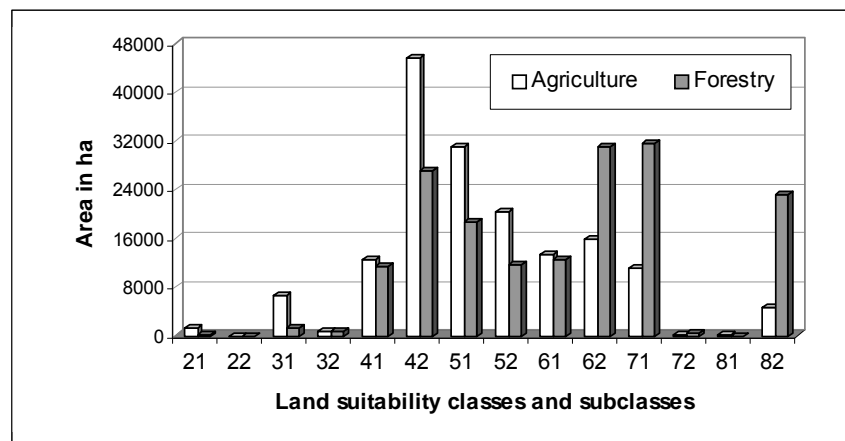
Figure 2.





Graph 1: The area of suitability classes for vegetables

For the needs of regional planning and designing regional plans, we also present a land capability map as the basis for soil protection from its uncontrolled and unjustified reallocation for other, non-agricultural purposes, Fig. 3. This land capability map provides the regional plan designers with the information necessary for allocation of the optimal use to each particular area in regional planning and land utilization planning, and to protect the best quality soils. Namely, Croatian law (NN 54/1994) stipulates protection of land of capability class I-V. Data processing was done using the ArcView program, giving the space and quality distribution per land capability classes and subclasses. Inventory of areas belonging to particular land capability classes and subclasses revealed a high participation of soils of capability class I-V, which are protected by law and must be provided with adequate protection. There are 189,057 ha or 56.8% of such soils in the County. Most of them (118,254 ha) are on agricultural areas while 70,803 ha are under forests, Graph 2.



Graph 2: The area of land capability classes and subclasses

Soil data were separately elaborated digitally as part of soil improvement for the needs of intensive plant production. Several thematic layers were separated (amelioration, subsoiling, mole drainage, ameliorative fertilizing, irrigation, liming and similar requirements). An example of liming requirement is given in Fig. 4. For this purpose, relevant data were entered into the GLIS database, which made it possible to make the appropriate map (layer). Analysis of this map enables definition of the space distribution of those soils which require the measure of liming. Detailed elaboration of this map demonstrated the space distribution of particular classes of liming requirements, which showed that Karlovac County has 92,084 ha of agricultural soils (or 56% of the total agricultural land) that require liming of various intensity, Graph 3.

Figure 3.

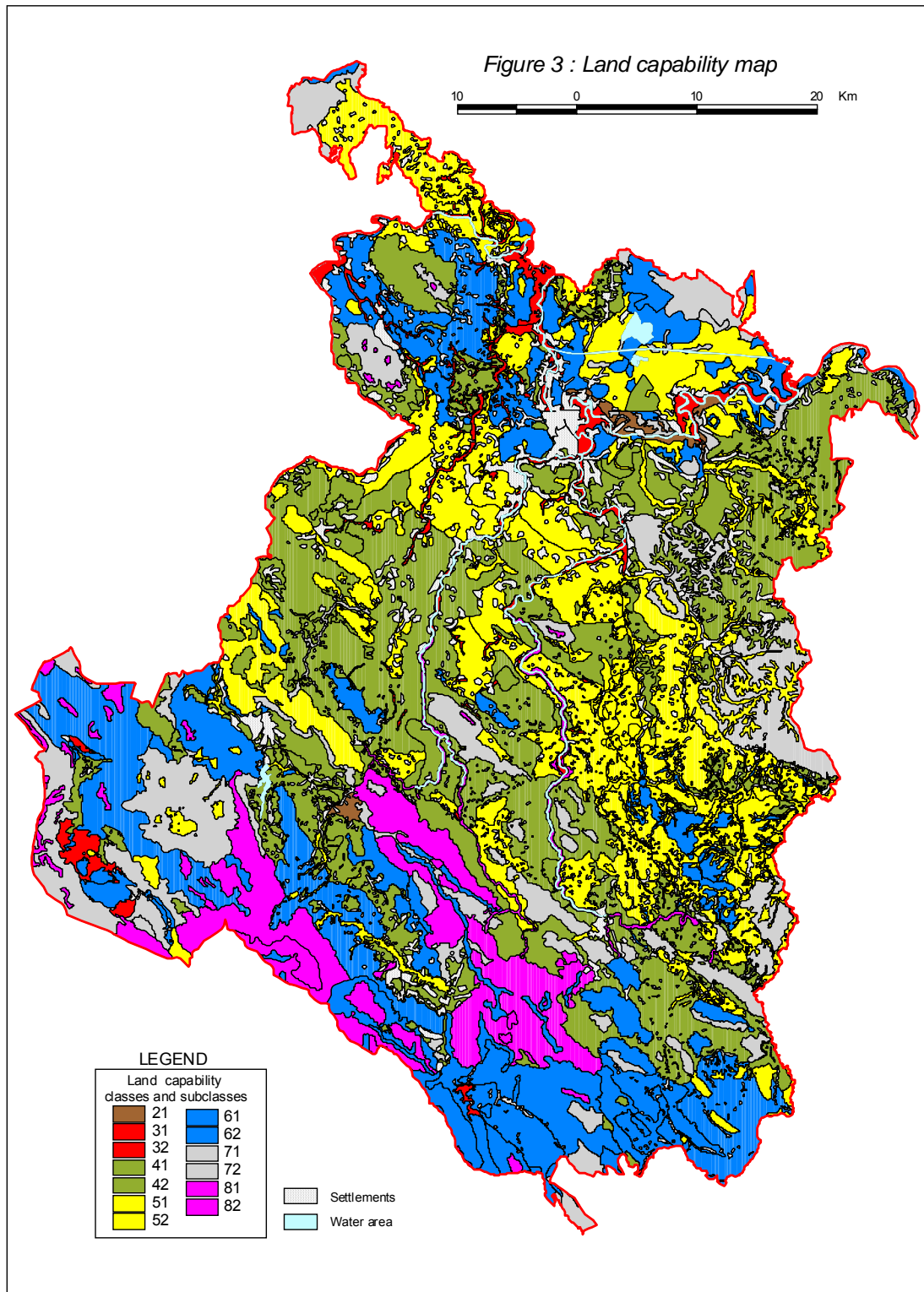
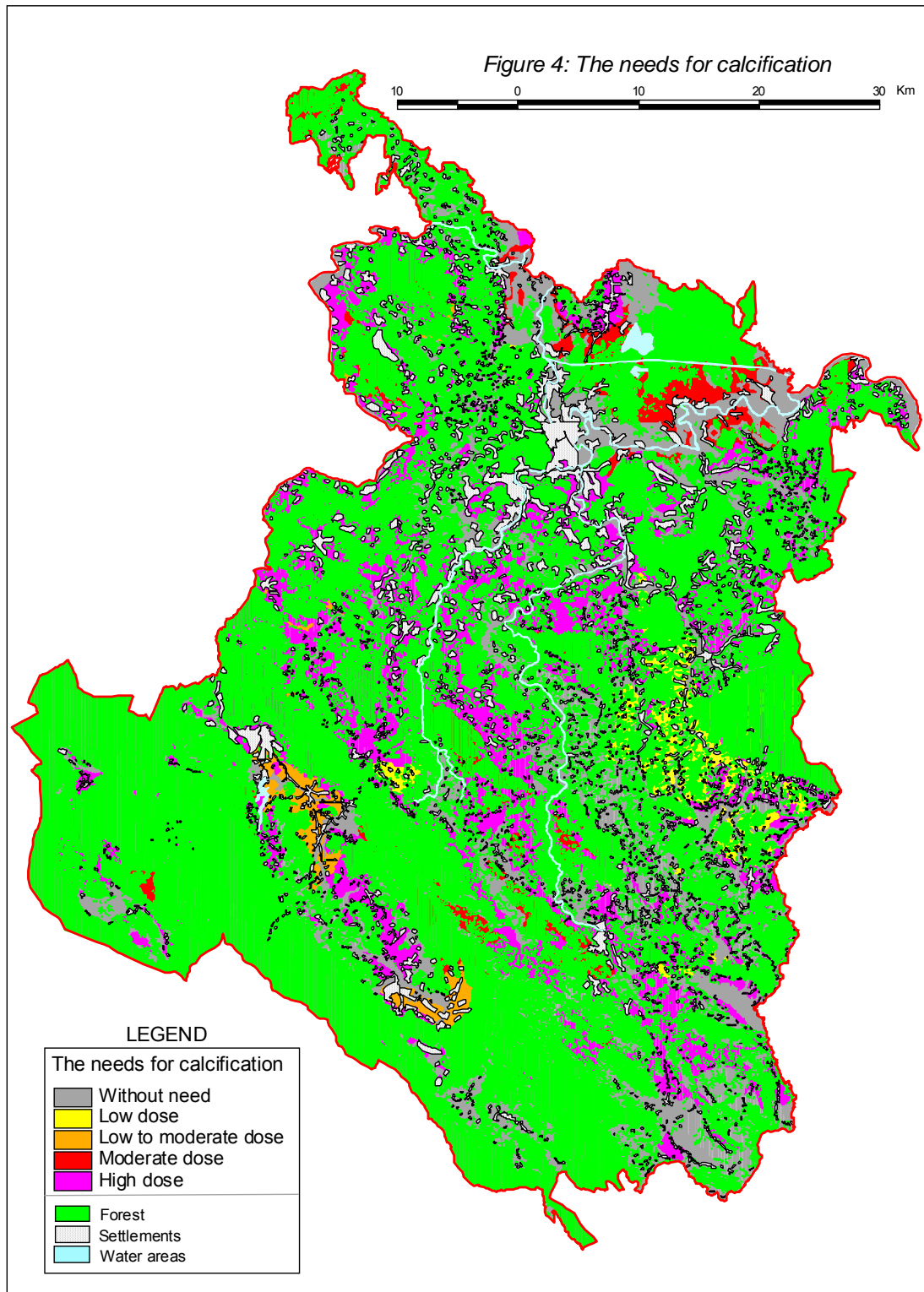
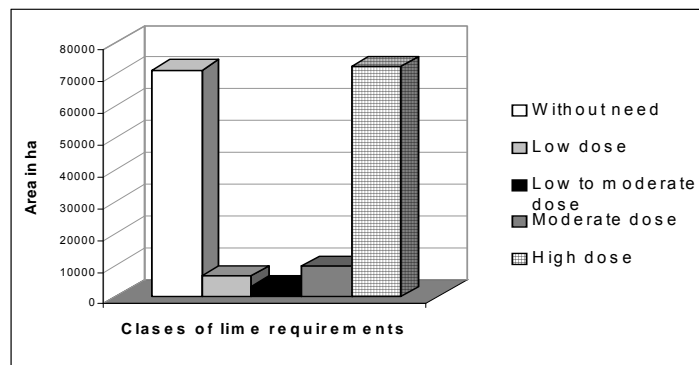


Figure 4.





Graf 3: Liming requirements of agricultural land

Soils that do not require liming involve only agricultural land of river valleys, made up of recent alluvial deposits, which are mostly flood protected.

5. CONCLUSION

A complex Geographic and Land Information System (GLIS) was designed for the needs of agricultural development and regional planning of Karlovac County. This method of investigation and project designing has a number of advantages over the methods applied to date. These advantages refer to the great potentials of digital interpretation of data and investigation results, enabling users to get reliable, among others also cartographic, information in a relatively simple and quick way. The paper gives examples of possible creation of thematic maps based on GLIS, which are indispensable for planning further development of agricultural production and regional planning, as well as examples of taking land inventories, whereby concrete data on land resources can be readily obtained. Without GLIS, procurement of such information would certainly be much more complicated and time-consuming.

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