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CREATING LAND ASSESSMENT DATABASE FOR VEGETABLE CROPS IN PERUSHTITZA VILLAGE, BULGARIA

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Abstract

Development of vegetable crops is an increased process in Bulgaria. The region of Perushtitza Village is a special area because of its tomatoes production. The main purpose of this report is to investigate and analyse some of the important factors for sustainable vegetable cultivation. The volume of data include information about biological requirements for cultivation, climate, irrigation, atmospheric conditions, elevating, meteorological geographical features, land cover and land use, soil, monitoring and agricultural facilities, socio-economic conditions like existing irrigation systems, road systems, mechanization, production transporting, etc. All the information is prepared for using GIS application by converting it into spatial database.

Key words*: vegetable crops, GIS, assessment, spatial database.*

INTRODUCTION

Agriculture is one of the world's most important branches, necessary for people livelyhood. Economy of Bulgaria country is predominantly based on agriculture and majority of population depends on agricultural occupation. Therefore, it requires to carry long term scientific land use planning and to implement for the balanced, multi-dimensional and sustainable development of the country on the basis of physical features, composition, quantity and capability of the land. Main vegetable cultures cultivated are tomatoes. The present study took place on the land of Perushtitza Village, Bulgaria. This region is known with its wine fields, but there are complex of very good physical land characteristics for growing of vegetable crops. In this region, land use refers to the major classification of the use of the different parcels of land in the holdings. All land operated by agricultural holdings are classified as either agricultural land or non-agricultural land. The total numbers of all agricultural holdings has been increasing during the last few years. The area used for output of vegetables, especially tomatoes, depends on their biological requirements and land characteristics. The factors for good quality productions are based on land, soil and climatic parameters. In addition, they are combined with some characteristics, which refer to the nearest roads systems and collecting centres. Attributes of the study area has marked effects on the tradition and culture and in turn to the cultivation practices (Baniya, 2008). All information is collected from different scientific, experimental and literary sources. This data is gathered, analysed and presented by thematic maps. For establishing sustainable vegetable cultivation all collected data is transformed into spatial data for using GIS application. The aim of this study is preparation of combined and varied database of profitable vegetable development for suitability land assessment by using GIS tools.

MATERIALS AND METHODS

Cultivation is the act of making use of environmental resources to get production for livelihood of mankind. Therefore, cultivation involves both characteristics including qualities and human activities. For profitable use of land and getting more quality yields of vegetable productions is important to know based factors about crops development. They are complex characteristics and depend on biologically requirement of vegetables.

– **Geographic information**

- Digital administrative maps of the region, municipality, digital cadastral maps and maps of reclaimed property in the studied area. The digital model formats are ZEM, CAD. Information source: the Geodesy, Cartography and Cadastre Agency.
- Digital soil map of the area in scale M 1:10000. Soil maps reflect in detail the boundaries between the separate soil types. Information source: The Soil Resources Agency and the Institute of Soil Science "Nikola Pushkarov".
- Topographic maps in scale M 1:25000 and digital elevation models

– **Attribute information**

- Air temperature in °C for period of 10 years (2004-2013), especially the months from April to October. This period is enough to establish dependence between variety of maximum, minimum and average temperatures.
- Summarized characteristics for tomatoes growing include complex of important factors, necessary for vegetable development. It combines information about temperature, soil texture, organic content, soil reaction, irrigation, soil depth, slope, access of road and access to collection center. The values are got from some established books and full papers (N. Panaiotov et.all, 2006; T. Murtazov et.all, 1987; Baniya, 2008). All necessary and vital information about tomatoes growing is presented on the next table.

Table 1. Diagnostic characteristics for suitability of tomato

Parameters	Potential Ratings		
	High	Moderate	Low
Temperature (° C)	18 -26	15 -18, 28 -35	< 15 & > 35
Soil texture	Loamy, sand	Sandy, loam	Clay, sand
Organic matter content (%)	> 2	1.5 - 2	< 1.5
Soil reaction (pH)	5.6 - 6.6	6.6 - 7.5	< 5.6 & > 7.5
Irrigation	Regular	Readily available	Rained
Soil depth	> 80 cm	50 - 80 cm	30 - 50 cm
Slope (degree)	Flat to 2	1 - 5	5 - 8
Access of Road (km)	near < 10	10	> 10
Access to collection centre (km)	near < 20	20	> 20

– **Assessment rate**

- In land suitability analysis, a map represents each evaluation criterion with alternatives (like S1, S2, S3) indicating the degree of suitability with respect to a criterion. These classes have to be rated, how important is the class S1 with respect to a particular criteria to contribute for the final goal (suitability). In this particular land suitability analysis the criteria are mainly related to climate factors, elevation structure, soil characteristics, infrastructure and environmental information. The next table explains suitability criterions.

Table 2. Suitability rate

Suitability classification	Explanation
igh suitable (S1)	Suitable capacity of locations is high and satisfies all criteria set up.
Medium suitable (S2)	Suitable capacity of locations is medium and satisfies most of the criteria set up, but some criteria are not satisfied.
Low suitable (S3)	Suitable capacity of locations is low and satisfies some of the criteria set up, but most of the criteria are not satisfied.

The methodology is based on matching soil/land characteristics against agronomic requirements of crop and then the suitability classification will be assessed. The physical land suitability evaluation used limiting factors method assigning the suitability classes, in which the lowest suitability class will limit for the rest of factor (Baniya, 2008).

All collected information is classified by suitability rate and prepared for using of GIS applications. Using suitability classification for land assessment, gathering data can be presented by thematic maps, using GIS tools.

RESULTS AND DISCUSSIONS

Attributes of the study area has marked effects on the tradition and culture and in turn to the cultivation practices. So the result of the data collection is influenced by characteristics of farmers, climate and topography research locations (Baniya, 2008). The information shows the basic facts, which have to be considered for the data analysis and interpretation of the results. Being one of the complex areas and variety topography, consideration of the study area information is of prime importance. This study includes information from the climate, meteorology, environmental characteristics and infrastructure of the Perushtitza Village, Bulgaria. This region covers 4871.6 ha, including 2298.9 ha land using area. Elevation changes from 150m to 800 m. The relief is various from plane to hilly. The urban part is situated on plane and agricultural land. There is concerned most of the useful area for vegetable growing. Most important biological requirements of tomatoes, gathered on Table 1 are presented by thematic maps, using GIS applications. All collected data is transformed and ready to use in GIS for assessment purpose.

Vegetables crop production is an integrate part of Bulgarian agriculture. Extensive experience and rich national traditions in growing vegetable crops determine Bulgaria as an established producer of vegetables. According to Toskov (2013) the proportion of fresh vegetables and potatoes in the gross production of agriculture sector is 10.2% and the gross production in crop production - about 20%. These facts determine the importance of vegetable growing.

The using of GIS database in vegetables crop production will help to increase the knowledge of the vegetable growers relating with the selection of areas, selection of suitable productions direction and varieties and applying of good agricultural practices for sustainable vegetable production sector. Several authors point the need for developing strategies for the production and realization of vegetable production (Stoeva, 2013; Christova et al, 2013; Toskov, 2013; Nikolova, 2013). According to them, the developed measures should be complex are reflected in a general system for effective management of vegetable farms. One of important aspects of these strategies is to support vegetable growers by creating a database which allows quick access to practical and applicable information. This could be achieved by using GIS information systems (Haytova et al, 2014).

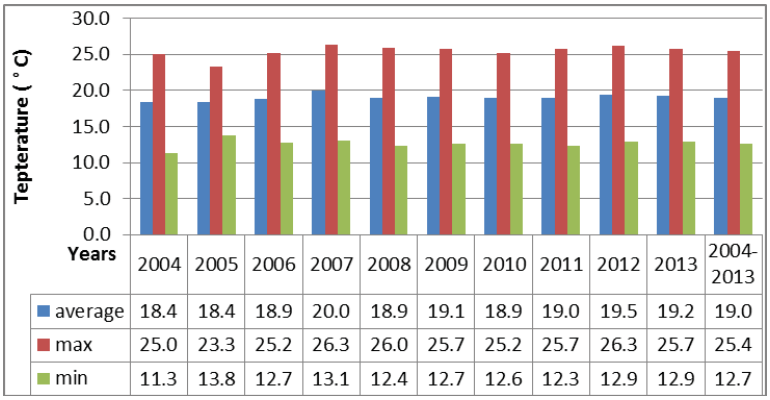
The Perushtitza Village belongs to the temperate continental climate zone. However, topographic setting causes to have great variation in climatic condition between the valley basin and the surrounding hilly area. The topography of different regions creates a complex mosaic of topoclimates. Temperature is one of the most important data for vegetables. Studied range of air temperature in °C is 10 years - from 2004 to 2013. The vital months for tomatoes growing are from April to October. This period is enough to establish dependence between variety of maximum, minimum and average temperatures. This state is followed by the next charge.

Elevation is the main influencing factor on temperature, together with geographical location and aspect. About 99% of the variation in temperature can be explained by elevation and geographical location, and 90% by elevation alone (Baniya, 2008). Average monthly minimum temperature at the study area ranges from 12.3°C to -13.8°C. Similarly, maximum temperature ranges from 25.0°C to 26°C. From analysed data on the Figure 1 can be made a conclusion that the temperature variety is between established frames, mentioned on Table 1. According to suitability classification, rate S1 is appropriate for this region.

According to the relief, the region is characterized of varied types of land forms. In the North part slope is 1-2 degree, but in the South part it slowly transformed to the hilly with degree up to 12. This part is taken by forest and rocks. In the next map this part is

coloured by no fill. Next thematic map (Figure 2) shows all slope distribution in Perushtitza region. From analysed data 63.4% (1423.4 ha) of the area is with slope 2°, 34.2% (768.0 ha) with slope to 5° and 2.3% (53.7 ha) with slope more of 5°. Compare to the biological elevation requirement, the slope is classified on rate S2, because of its variety relief.

The thematic map on Figure 3 presents soil types covered this region. Predominated are clay and rendzins types. Map depicted for the soil classification according to FAO system, show eight soil groups present within small area of the region, presented on Figure 3.



Years	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2004-2013
average	18.4	18.4	18.9	20.0	18.9	19.1	18.9	19.0	19.5	19.2	19.0
max	25.0	23.3	25.2	26.3	26.0	25.7	25.2	25.7	26.3	25.7	25.4
min	11.3	13.8	12.7	13.1	12.4	12.7	12.6	12.3	12.9	12.9	12.7

Figure 1. Distribution of air temperature for period of 10 years (2004-2013)

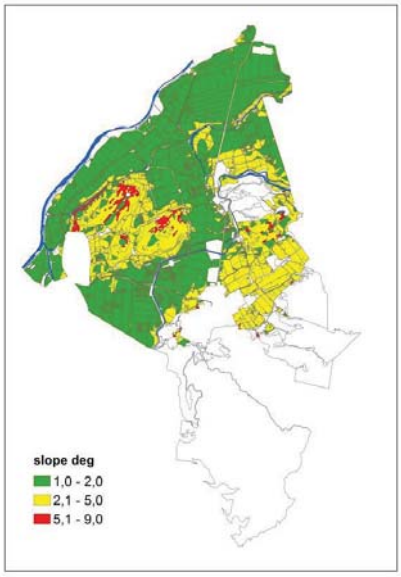


Figure 2. Slope Distribution

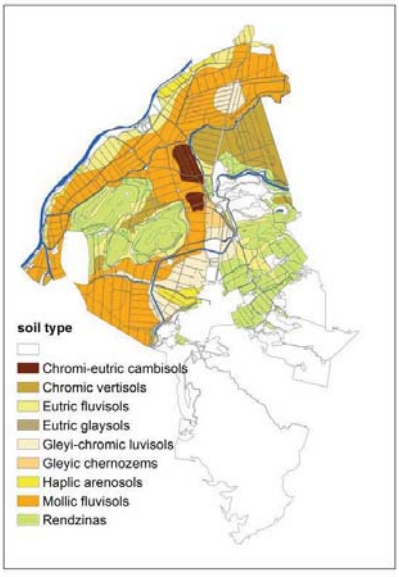


Figure 3. Soil type

On this basis it can be concluded that variations in the soil types can be related in the variation and orientation in the land form and cultivation practices. Pattern of land use and cultivation implies that soil appears to be exhausted in terms of nutrients. To bring back soil into good quality require to increase the organic matter contents, therefore need of constant application of organic manure seems necessary (Baniya, 2008). Most spread soil

types convert the region into suitable land for vegetable production.

Soil parameter to be studied has been categorised into physical characteristics and chemical characteristics. Soil texture means the relative proportion of the various size groups of individual soil particles. Texture provides important information regarding water holding capacity, permeability, irrigation requirement and erodibility. Growth and development of the plant primarily based on the soil texture. Root penetration, nutrition absorption through soil particles, water holding capacity, water infiltration and percolation are affected by texture type. There is a big vegetable diversity found in terms of soil texture in Perushtitza Village. It possesses Loamy, loamy skeletal and loamy bouldery type of broad texture class. Loam and sandy loam are much more preferred soil type for the vegetable farming community which is one of the most suitable categories and accounts for 61.3% of the total existing agricultural land area of the valley. About 1.6% i.e. 823.0 ha of agricultural land area have very rough texture and apparently not able to support any crop cultivation, this is categorized into unsuitable on the basis of texture parameter. This distribution is presented on Figure 4.

Soil reaction is the degree of acidity or alkalinity of the soil and pH is the negative logarithm of the H ion activity. This refers to the relative activity of the H ion in the soil solution. In present investigation pH value ranges from 5.6 to 7.5. pH of given soil presents an indication of the degree of availability of many soil nutrients and the favourability of soil condition to microbial activity which contributes to the fertility in turn. Thematic map (Figure 5) presents the area with the best content of pH in the soil - 80.1% of the area is with soil pH from 6.6 to 7.5. So the soil reaction is enough for vegetable development.

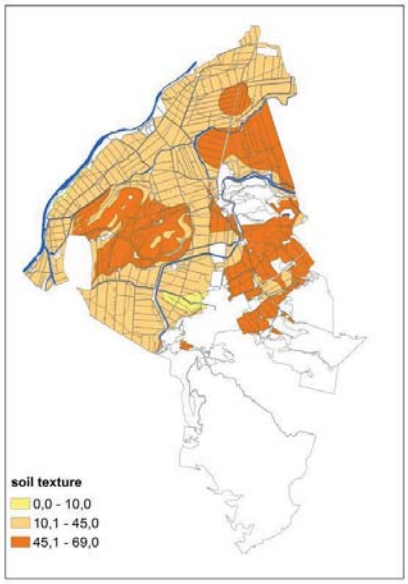


Figure 4. Soil texture

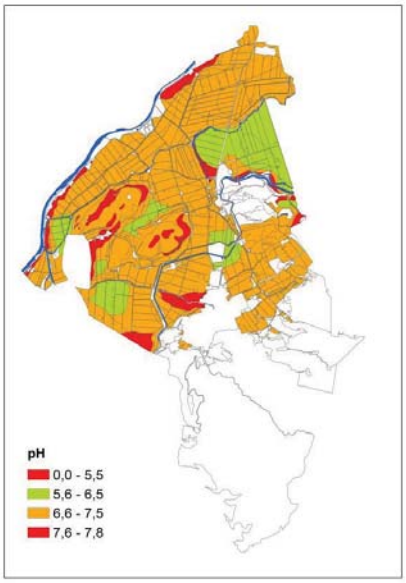


Figure 5. Soil pH

Organic matter content of the soil is an important parameter related to soil fertility. Further decomposition of organic matters by microbial activities yields humus. These are true nutrient to the plant available in soil. Good humus content in soil improves infiltration rate and water holding capacity. The most organic matter is ranging to 2%. It covers 53.3% of useful agricultural land (Figure 6). Irregular spread of humus

influence on variety of vegetable quality productions. Data analyze shows good diversity of humus in this region.

This region is situated between different kinds of road systems. There are one of the biggest important marketing roads and market-places for vegetable production. Nearby are collecting centres for vegetable production in Plovdiv city, Yoakum Gruevo, Parvenec and other manufacturing centres. Link between them is realized by good supported road systems. Irrigation is realized by built irrigation canals and good environmental conditions. There are located some of the rivers Vacha, Kriva, Qdenica, Stara, et.all. The terrain is with high-level water holding capacity. The map on Figure 7 presents roads distribution and irrigation canals in this region.

Christova and Ilieva (2013) recommended the development of the sector Vegetables crop production is used both economic and technological tools. On the one hand will increase the technology base, and the other will increase knowledge of vegetables growers. The creation of a GIS database has practical effect and allows producers to receive in accessible all relevant information for the specific parts of agriculture land. The use of GIS in vegetable could facilitate the planning, organization and production of vegetable production, in compliance with the requirements for quality. Assessment of land use is directly related to the determination of suitability for vegetables crop production and also the determination of the limiting factors for the cultivation of vegetable crops (Haytova et all, 2014). So, farmers will receive specific recommendations well-founded in research for growing vegetable species according to their biological requirements and potential. It obtained a classification of vegetable species under their suitability to a specific area, relevant with the interests of vegetables growers.

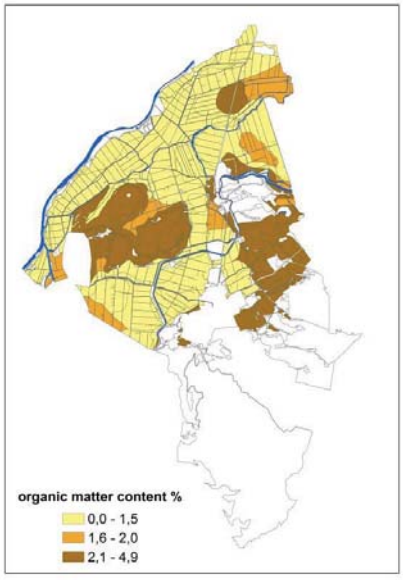


Figure 6. Organic matter content

Figure 7. Infrastructure-roads and irrigation canals

Refers to the climatic and infrastructure characteristics of studied area, the suitability rate can be defined to the S1- high suitability region for tomatoes growing. This assessment can be useful for more farmers and profitable for marketing centres.

All studied factors present important frame for good profit of tomatoes growing. Necessary characteristics are reduced to suitability classification. In this way all information can be presented mixed or separately. The item of doing it is called GIS.

By its large resources possibilities, commands and tools, this Geographical Information Systems has a power to action with huge amount of information. But for working with it, all collected and necessary information has to be transformed into spatial data. The process of converting non-spatial information into spatial database is firstly and the most important step of analysing. Using suitability rate the spatial data can be assessed and the result can be presented by thematic maps. The using of GIS database in vegetables crop production will help to increase the knowledge of the vegetable growers relating with the selection of areas, selection of suitable productions direction and varieties and applying of good agricultural practices for sustainable vegetable production sector.

CONCLUSIONS

Geographical Information Systems (GIS) consists of various components, starting with the incorporation of geographical data from remote sensing sources or maps and is then converted into a computer-readable form (Baniya, 2008). Useful suitability assessment is based on biophysical and infrastructure resource information. The spatial data can be manipulated and overlaid for analytical operations. This functionality required to work with different data structures. Crop analyse includes soil/water requirement, geostatistic analysis, land use are used to identify and make sense of complicated spatial relationships and, ultimately, substantiate trends and theories. It helps to solving spatial problems depend on climate, soil, elevation, area structure and socio-economic conditions, visible appeared on the thematic map.

Vegetable cultivation is one of the most important parts of agriculture development. All comprehensive conditions and factors, which influenced on plan production, are presented by thematic maps. Agriculture database activities as collecting, organizing, transforming, analyzing and presenting the land using of the studied area, are realized by GIS modeling. Establishing appropriate suitability factors is the construction of suitability analysis (Stefanova et.all, 2014).

It is very essential to understand environmental capacity to support appropriate vegetable cultivation. GIS analyzing gives us overview of all necessary factors and parameters for sustainable and profitable vegetable development. Using assessment maps agricultural activities can be planned for further improved activities and aimed minimizing yield losses. It is essential to can make forecast of vegetable benefits and to achieve complex management for improving environmental conditions.

ACKNOWLEDGEMENTS

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