APPLIED GEOGRAPHY - APPLICATION OF GEOGRAPHIC INFORMATION SYSTEMS (GIS) AND ANALYTIC HIERARCHY PROCESS (AHP) IN AGRICULTURE THROUGH THE EXAMPLE OF WINEMAKING, VITICULTURE AND WINE TOURISM IN SERBIA

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- One of the areas of studying geography is agrarian (agricultural) geography.

- In viticulture, this is described as: space (territory, vineyard, viticultural region, viticultural area) and production of grapes and wine (agricultural activity).

- What does a geographer do? The geographer is interested in the spatial distribution of viticulture: location, grape varieties, nature and geographical environment, cultural characteristics of the local population, economic, social and political structure of the area. For the factors of viticulture development: climate, terrain topography (slope, exposure, altitude), soil fertility and composition, human influence on the development of viticulture, market opportunities (sales, placement of goods on the market) and demand (buyers' interest in wine), use modern techniques and technologies in viticulture

The tradition of viticulture in Serbia

- The earliest cultivation of vines began 7000 years ago between the Caspian Lake and the Black Sea.

- On the Balkan Peninsula, the development of viticulture began before Christ. Later, the Greeks and Romans (III and IV centuries) played a major role.

- Slavic tribes also continued the tradition of growing vines during the 5th and 6th centuries.

- During the rule of the Turks, viticulture on the territory of Serbia stagnated.

- During the Austro-Hungarian rule, organized wine production began in Serbia (various, joint factory associations, joint plantations were formed). In this period, the export of wine from Serbia to the world market (France, Germany, Russia, Romania, etc.) begins.

- During World War I and II, economic conditions were bad and stagnation arose due to war events. After World War II, a period of socialism followed in Serbia.
- Viticulture was neglected in relation to other agricultural branches such as animal husbandry and arable farming
- The most represented varieties of white wines are international: Italian Riesling, Rhine Riesling, Chardonnay, Sauvignon Blanc. On a smaller scale, regional, domestic varieties are represented: Smederevka, Župljanka and others. Among the colored wines, the international varieties Cabernet Sauvignon, Prokupac, Merlot, Burgundac black and others dominate. The most common table varieties are Muscat Hamburg and Kardinal

GEOGRAPHICAL ELEMENTS IMPORTANT FOR WINEMAKING AND WINE-GROWING

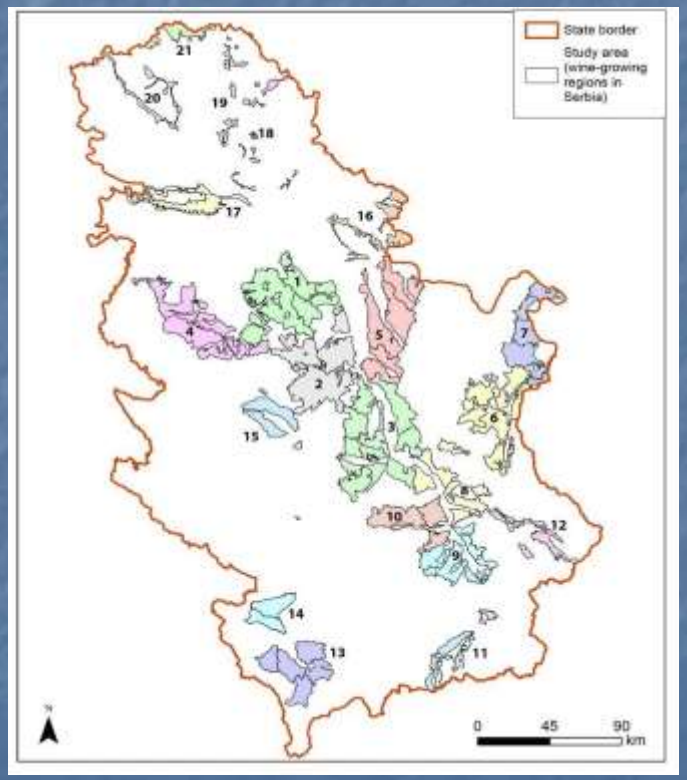
•light, heat and humidity, and they depend on the **mathematical-geographical position.**

•In the northern hemisphere, the vine is spread between 35° and 45° north latitude, and in the southern hemisphere between 30° and 45° south latitude. Serbia is located in the southern part of the temperate climate zone, between 41°50' and 46°10' north latitude.

The vineyard area of Serbia covers a total area of 23,675 km², of which 99.86% is up to 800 m above sea level, as well as rezoned areas above the 800 m mark with 31.42 km² (0.13%). There are 22 wine-growing regions and 77 vineyards in Serbia.

Wine-growing regions:

1	Belgrade	12	Nišava
2	Šumadija	13	South Metohija
3	Three Morava	14	North Metohija
4	Pocerina-Valjevo	15	Čačak-Kraljevo
5	Mlava	16	South Banat
6	Knjaževac	17	Srem
7	Negotin	18	Potisje
8	Niš	19	Banat
9	Leskovac	20	Teleč
10	Toplica	21	Subotica
11	Vranje		



Elaborated by Radmila Jovanović

About AHP Methodology

AHP method (Analytical-hierarchical process). The analytical hierarchy process was introduced by Thomas Saaty (1980) as a useful tool for complex decision making

Each evaluated criterion has a certain weight. The higher the weight value, the more important the corresponding criterion is.

Elevation. In more northern and colder wine-growing areas, vines are grown at lower altitudes compared to southern and warmer areas. With an increase in altitude, the temperature decreases (for every 100 m of altitude, the average annual air temperature decreases by 0.55ºS), solar radiation increases by 18%, so that in hilly and mountainous terrains there is a greater warming of the soil and plants.

Relief energy - height difference in meters between the lowest and highest elevation per km2 (m/km2). Even more remarkable is the height breakdown of the relief. This is how we distinguish: plains (0-5 m/km2), poorly divided plains (6-30 m/km2), poorly divided relief (31-100 m/km2), moderately divided relief (101-300 m/km2) and distinctly broken relief (more than 300m/km2).

Slope and exposition. The slope and exposition of the terrain affect the intensity of light, heat and humidity of the air and soil. With a moderate-continental climate, the brightest and warmest are the southern, southwestern and southeastern sides. Favorable expositions are east and west. Northern exposures are colder and less well-lit, so the yields on these sides are irregular and the quality of the grapes is poorer.

Climatic conditions are also influenced by the territorial distribution of the intensity of solar radiation (insolation), the movement of air masses, the configuration of the terrain, the penetration of cold air masses...

When applying gooseberry in agriculture, it is first necessary to identify the characteristic types of climate of the analyzed area. In Serbia, from the north to the south of Serbia, 3 climatic areas are distinguished:

1. continental - characteristic: warm summers, cold and harsh winters
2. moderately continental - characteristic: moderately warm summers and winters, while spring is cooler compared to autumn
3. modified Mediterranean climate - characteristics: short and mild winters, long and hot summers. Autumn is warmer than spring.

Precipitation - The distribution of precipitation should be regular during the growing season. The main form of precipitation in wine-growing Serbia is rain. The root of the vine develops most at a soil depth between 30 and 70 cm, so light rains (below 5 mm) are not of great importance. It must be 10 mm in 24 hours. In wine-growing Serbia, the amount and distribution of precipitation in the growing season are not the most favorable. The amount of precipitation ranges from 350 to 600 mm, and the distribution of precipitation is uneven.

Of the other forms of precipitation in the growing season, **precipitation in the form of dew, fog, and hail occasionally occurs,** which are unfavorable forms of precipitation for grapevines. Hail has a very unfavorable effect on the vine, causing great damage. Dew and fog create minimal damage compared to hail.

Snow contributes to the creation of moisture in the soil and serves as protection against severe winter frosts. On the other hand, a large amount of snow and sudden melting can cause damage and negative consequences to the vineyard in the form of soil erosion and the occurrence of floods or in the form of large ice deposits

Insolation One of the most important abiotic factors for photosynthesis is the influence of light. The productivity and quality of the vine depends on insolation. This means that higher light intensity means better productivity. The lighting conditions in the vineyards are influenced by the exposure and slope of the terrain, the length of the light and dark part of the day, latitude, and altitude. In the Northern Hemisphere, the southern sides are best lit during the summer period.

Cloudiness - The duration of solar radiation in Serbia increases from January to July, and then gradually decreases until December when it reaches its minimum. Spring is cloudier than autumn, and July and August are the clearest. Cloudiness decreases from mountain to valley.

Air humidity is an important factor for the development of vines. Certain varieties and types of vines have acquired the power of adaptation in areas with different humidity. They can thrive in dry conditions, but do best in areas with moderate humidity. The most favorable relative humidity for vine growth is between 60 and 80%. Air humidity varies during the day and night. It decreases after sunrise, reaches its lowest value around noon and increases in the evening and during the night. Covering a multi-year period, the amplitude of relative humidity is 10.7%, with a minimum value in Belgrade of 68.6%.

Air currents in wine-growing Serbia

Air flow can have a positive or negative effect on the vine. Wind indirectly affects soil and air humidity. A positive effect is the drying out of too wet soils. Due to the exposure to the winds, negative processes occur in the vineyards. Soil moisture is lost below the normal level. This phenomenon is soil and air drought, and it has a bad effect on plant growth. Stormy winds from the north and northeast have a negative impact. The occurrence of strong hot and cold winds is negative, because they worsen the microclimate. In areas that are exposed to strong and frequent winds, growing vines is not profitable.

Water surfaces moderate temperature extremes, increase air humidity and light intensity. The vineyards are spread along the Mediterranean, Adriatic, Ionian, Aegean, Black Sea, Caspian Sea, near the Atlantic and Pacific Oceans. The vineyards are located next to Lake Leman and Lake Balaton, as well as next to the rivers: Danube, Main, Rhine, Loire, Moselle, Don, etc.

Water surfaces warm up more slowly than land surfaces during spring. During the summer and autumn, the accumulated heat is spent on the evaporation of water, which affects the cooling of the air. During winter, bodies of water gradually cool and release heat that warms the air. This affects minor differences between day and night values of air humidity and temperature. Spaces next to water surfaces also receive diffused light that reflects off the water and has a positive effect on photosynthesis. Moderate air flow and vine growth are influenced by water currents. There are 365 permanent and occasional rivers in the territory of wine-growing Serbia.

Land in wine-growing Serbia

Various pedogenetic factors, in combination with climatic, geomorphological and geological conditions, influenced the heterogeneity of the pedological cover in wine-growing Serbia. In the relief of wine-growing Serbia, several units stand out. These are: the Pannonian plain with loess plains and river valleys, abrasion terraces and surfaces and the mountain mass of the Dinaric and Carpathian-Balkan systems.

The ability to adapt to soils with different physical, chemical and biological properties affects the growth, yield and quality of wine.

1.soil structure - depends on the mechanical composition, size and stability. The best soils have a granular structure, crumbly and pea-sized, measuring 0.5-5 mm.

2.hardness - important for normal root growth. With higher hardness, root growth slows down

3. soil moisture - depends on the distribution of precipitation and its amount, hydrographic characteristics of the terrain, condensation of water vapor.

4.soil temperature - effects of radiation, mineral and organic composition. The optimum temperature for grapevine development is around 25°S. Low temperatures, as well as temperatures above 30°C, negatively affect the growth and development of grapes. Soil temperature has a positive effect on yield and sugar content in grapes.

5.chemical composition - The chemical composition of the soil is an important component of the vineyard area. Based on the pH of the nKCl solution, soils can be:

– very (highly) acidic pH < 4.5
acidic pH 4.51 - 5.50
- slightly acidic pH 5.51 - 6.50
- neutral pH 6.51 - 7.20
- slightly alkaline pH 7.21 - 8.00
- alkaline pH >8.0.

For the development and growth of the vine, acidity is the most important, especially weakly acidic, neutral and weakly basic reactions. The pH value varies between 6 and 7.5.

Accessibility - The development of the transport system has a multiple role in the development of a country, and thus a greater economic contribution. Improving the traffic network increases the attractiveness of tourist destinations, the mobility of the population and tourists, and provides a better quality of services. On the other hand, an insufficiently developed transport network can adversely affect the tourist destination and tourist traffic.

Good traffic connections allow better accessibility for tourists in areas with tourist attractions. However, if the tourist attractions are located along and in the immediate vicinity of the tourist destination, if the objects and localities are well connected by traffic, the destinations can increase their value. Transport is one of the basic prerequisites for the development of tourism and a key element that connects tourists and destinations that are accessed

Attractiveness - Tourist attractions are defined as elements of the natural and social environment that attract and motivate tourists to visit certain tourist destinations. Tourist attractions play an important role in forming the offer of tourist destinations, making the key motivation for visitors

Conclusion

In the wine-growing areas of Serbia, there are vineyards with significant wine production, especially those with a long tradition, which are the most sought after on the market. However, a complicating factor for building a tourist product of wine tourism is a small number of wineries and wines with protected geographical origin, non-operative working hours, a small number of wineries that offer additional services in addition to tasting and selling wine, an unclear or non-existent concept of interpretation of the area where wine is produced . For those wineries that exist and are part of a tourist offer, the problem is that they do not manage to attract a sufficient number of visitors, and the share of income related to tourism in relation to the total income is small. There are few studies on the motives for participating in wine tourism.

Thank

you

for

your

attention!!!

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