SUSTAINABLE DEVELOPMENT & COMPETITIVENESS OF REGIONS

Collective monograph Volume 5

CLIMATE CHANGE AND ITS IMPACTS ON SUSTAINABLE REGIONAL DEVELOPMENT

Academic publishing house "Talent"

University of agribusiness and rural development

Plovdiv, 2022

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КОЛЕКТИВНА МОНОГРАФИЯ

УСТОЙЧИВО РАЗВИТИЕ И КОНКУРЕНТОСПОСОБНОСТ НА РЕГИОНИТЕ

Том 5

ПРОМЕНИТЕ В КЛИМАТА И ТЯХНОТО ВЛИЯНИЕ ВЪРХУ УСТОЙЧИВОТО РЕГИОНАЛНО РАЗВИТИЕ

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COMPETITIVENESS AND SUSTAINABLE DEVELOPMENT OF AGRI-FOOD SECTOR

КОНКУРЕНТОСПОСОБНОСТ И УСТОЙЧИВО РАЗВИТИЕ НА АГРОХРАНИТЕЛНИЯ СЕКТОР

THE EFFECT OF CLIMATE CHANGE ON AGRICULTURAL PRODUCTION IN BULGARIA

Natalia Stoyanova

University of agribusiness and rural development, Bulgaria

Abstract: Plant organisms are phenological indicators of weather and climate and are often used as a non-instrumental tool for its analysis. The reactions of crops, their growth and development are a direct result of environmental conditions. Solar radiation, air temperature and precipitation are the main factors that determine their productivity. In search of the environment-plant connection, the science of agricultural meteorology emerged. This publication systematizes some of the main challenges facing agriculture and the main measures for adapting the sector to modern climatic conditions. Climate change and fluctuations lead to changes in the conditions of growth and development of agricultural crops. This has a direct bearing on the way the world produces, distributes and consumes food. Climate is directly related to the way and prospects for global production needed to sustain the human population. The number of people in the world is expected to grow to 10 billion by 2050. This poses a huge challenge to the global community on how to feed an additional 2.3 billion people through environmentally friendly methods and climate change.

Keywords: climate change, agricultural production, Bulgaria.

Introduction

At the beginning of the 21st century (as of 2017) in Bulgaria, scientists from the National Institute of Meteorology and Hydrology (NIMH) report an increase in average air temperature by 0.8°C compared to the period 1961-1990, as well as a change in precipitation distribution (Marinova et.al, 2017). Unlike the end of the last century, when the upward trend was well expressed in Northeastern Bulgaria (Koleva & Alexandrov, 2008), research now shows rising temperatures in southern and southeastern Bulgaria, defined as an area of frequent droughts in which cultivation of spring crops is risky in terms of humidification conditions in general. There has been an increase in the number of hot days (t max. <32 ºC) in recent decades. In most stations there was a statistically significant trend of increasing the number of hot days by an average of 3 (4) full days per decade. On icy days, which are related to the nature of winter, there is a statistically significant decrease of 2 to 3 full days (Gospodinov, I. ed. (2020)). because precise, local studies related to the conditions of the individual regions are needed here. In this direction the researches in the field of agrometeorology and agroclimatology are also oriented. This leads to a change in the length of the potential growing season, faster accumulation of the required temperature sums and shortening of the interphase periods, which affects the yield of agricultural crops. irrigation, selection of appropriate types and varieties of crops.

The agricultural sector is focusing on environmentalists (Sarov, 2019) as food production is one of the main causes of global environmental change: agriculture accounts for 40% of world land production and food is responsible for 21% of global greenhouse gas emissions. and 70% of freshwater use. In the context of several key drivers of change (demographic and economic growth, changing consumption patterns, technological progress, integration of global trade or climate change), all of which will affect the agricultural value chain, the agri-food sector will have to adapts to this growing demand for food, while tackling the challenges of sustainability and health.

Climate change in Bulgaria and their connection with the agricultural sector

Some climate models simulate an increase in air temperature for Bulgaria in the 21st century by between 2ºC and 5ºC when doubling the amount of carbon dioxide in the atmosphere. The projections are for more precipitation during the cold half of the year, in the period of moisture accumulation, when the plants do not have vegetation. During the warm half of the year the precipitation will maintain its levels or will decrease, which will increase the intensity and frequency of droughts and torrential rains. Modern climate forecasts are indicative and provide guidelines for the development of sectors.

The agri-food industry is a key pillar of the Bulgarian economy. It accounts for approximately 20% of total industrial production.71 It has a strong impact on both domestic and foreign trade, affecting Bulgaria's export earnings, domestic consumption and the overall living standard of the population. The value of the sector's final production was EUR 5.4 billion in 2018 (Table 1), which marks a 38% increase since 2010.

Table 1. Annual production value of food and beverage manufacturing in Bulgaria

	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Production value (EUR million)	3 945	4 222	4 380	4 511	4 476	4 690	5 025	5 321	5 456

Source: Eurostat, 2019

The accession of Bulgaria to the EU in 2007 has significantly affected the Bulgarian agri-food sector. Enterprises in the sector, which were already subject to privatisation, buy-outs and foreign direct investments, needed to comply with much stricter food safety regulations and to adapt to higher levels of competition from the common market. Like the agriculture sector, this has resulted in restructuring and consolidation. Increased investments into technologies, know-how and marketing have been necessary for the continued competitiveness of Bulgarian agri-food enterprises.

On-farm processing is the most popular in the fruit and vegetable, dairy and meat sub- sectors. These farmers sell directly to consumers (e.g. in dairy it is now common to have vendor machines with fresh milk to be placed in villages and daily re-charged from the dairy farm). As a next step, their marketing strategies cover contracting with local (in villages or small town) small-sized supermarkets and the careful expansion of sales, first, regionally, and then in more regions or nation-wide. The setting up of farm direct sales markets (where also processed food could be sold) is rather difficult at the moment, with the Wednesday market at the Ministry of Agriculture, Food and Forestry in Sofia being the most prominent and successful example. The RDP is yet to open the relevant measure, which can be a turning point for many small-scale farm processors and also farmers.

The agri-food sector exports to 160 markets worldwide. In 2018, Bulgaria's total exports were EUR 28.6 billion, of which 11.8% (EUR 3.4 billion) were from the agri-food sector. While this marked a year-on-year increase of 3.8%, exports have been relatively stable over the longer term. The top agri-food exports are cereal and vegetable products, at EUR 1.9 billion, and foodstuffs (baked goods, chocolate, canned vegetables, etc.), at EUR 1.3 billion. EU countries are the main customers for Bulgarian agriculture and agri-food goods due to the more favourable trade conditions within the European Single Market. In 2018, the trade of agriculture goods with the EU increased by 5.3% compared to 2017, and accounted for 75% of Bulgaria's total agriculture exports.

The formulated measures for adaptation, activities in Bulgaria

According to a study by the European Parliament's Committee on Agriculture and Rural Development in 2019, measures are recommended to include:

- methods of genetics and selection;
- the use of crops with higher nutritional value;
- IoT (Internet of things) technologies for collecting and publishing information about production processes and the farm;

- ➢ agricultural automation;
- ➢ automatic management, monitoring and analysis of soils, areas, health status;
- ➢ optimization of agricultural processes;
- ➢ transparency, efficiency and accountability in the chain from producer to consumer.
- ➢ In our country, the efforts include blue-green government policies aimed at investing in precision research and sustainable development in the sector.

Seventy percent of the water resources are formed at higher altitudes and forest vegetation, 60% of which meet the needs for irrigation. Irrigation is an active measure of impact that is needed both in relation to drought and in general. The expected warming and reduction of precipitation amounts, especially in the warm half of the year, directly affect water quantities. Due to the condition of the irrigation facilities, irrigation is not used rationally. Several initiatives stand out in this direction:

- ➢ The main goal of the SuWaNu project is to develop technologies offering services for transnational cooperation within "research-oriented clusters", including universities, local authorities, research centers, technology companies, enterprises, farmers and agricultural associations related to waste treatment. He also leads agriculture in five different countries: Germany, Spain, Greece, Malta and Bulgaria. These services will provide and facilitate the exchange of knowledge on water and food alternatives for all project members, create business opportunities in the field of focusing and further expand the support of stakeholders from countries outside the consortium, while providing solutions to the above-mentioned problems facing Europe.

- "Project proposals from" Irrigation Systems "EAD", "Project proposals from irrigation associations and other legal entities for the restoration of existing hydro-ameliorative irrigation facilities". The first will support only projects submitted by the company. The total amount of financial assistance under this procedure is EUR 45,419,274. The maximum amount for one project is 6 million euros. The second eligible candidates are legal entities established and registered under the Irrigation Associations Act (LAA) and entered in the register of Irrigation Associations and legal entities, as well as established and registered Cooperatives Act. The total amount of financial assistance under the procedure is EUR 5,046,586. The maximum amount of eligible costs for the entire period of implementation of the RDP 2014 - 2020 per applicant is 1.5 million euros.

The National Program "Intelligent Plant Breeding", funded by the Ministry of Education and Science (MES) for a period up to 2024 and with a total budget of BGN 4.5 million provides through targeted scientific and applied research related to the application of artificial intelligence in agriculture, to reduce costs for farmers, improve soil management and water quality. The aim is to reduce the use of fertilizers and pesticides, reduce greenhouse gas emissions, improve biodiversity and create a healthier environment for farmers and citizens.

The second program "Intelligent Animal Husbandry" envisages the creation of innovative methods and tools for intelligent and efficient development of animal husbandry with reduced human resources and reduced environmental impact. Researchers and breeders will have easy and controlled online access to tools, resources and tools for collaboration, to high-performance information and communication technologies for calculations. They will have the ability to connect, to store data, to access virtual research ecosystems and client networks.

Analysis of demand for finance

The potential total demand for finance combines both met and unmet demand. The met demand consists of the value of all applications for finance which were approved by the financial institutions in the relevant year. The unmet demand consists of the assumed value of applications rejected by a financial institution, offers of credit refused by agri-food enterprises, alongside cases where farmers are discouraged from applying for credit due to an expectation of rejection or refusal.

The lending market for the agri-food sector is less concentrated than for the agriculture sector. While Unicredit Bulbank also dominates lending to the sector (around 20% share), other important players include DSK Bank, United Bulgarian Bank, Eurobank and Raiffeisenbank, each of them having around 10% of the market.

Financial products

While banks view the agri-food sector as being less risky than agriculture, the agri-food sector still receives more loan rejections compared to other sectors of the economy. This is caused by the fact that, in general, their businesses are connected to the agriculture business cycle and are therefore exposed to similar risks (e.g. weather, seasonality), although processors can mitigate these risks since they can also

Based on the Agri-food survey, the unmet demand for the agri-food sector in Bulgaria is estimated at EUR 178.5 million.

According to the Agri-food survey, most of the funding in the agri-food sector comes from own funds (87%). The importance of banks in meeting financial needs is below the EU 24 average for all loan products (Figure 35). Interviews with agri-food enterprises confirmed that the main reason why they rely on their own funds is to ensure full control over their business risk. These considerations explain why the majority of enterprises had not applied for external finance. Of the 33% of agri-food enterprises that applied for bank financing in 2018, long-term loans (17%), credit lines (14%) and medium-term loans were the most popular products.

The level of non-performing loans (NPL) in Bulgaria has been on a declining trend but remains higher than the EU average. According to figures from the National Bank of Bulgaria, NPLs as a share of total loans had decreased to 5.94% in 2019. The share of NPLs to non-financial corporations was slightly above those levels and stood at 6.8%. While the NPL ratio for loans to non-financial corporations was 17.15% at the beginning of 2016.

Large-sized agri-food firms have contributed to the high NPL ratio. Banks mentioned that not all investments made by their agri-food clients have had a positive return. Increased volatility on local and foreign markets has resulted in lower cash flows and in the crippling of the enterprises' ability to pay their instalments.

As indicated above, while interest rates have been decreasing over the last few years, they remain at relatively high levels. This is particularly the case for short-term credit. Interest rates have also been fluctuating recently, making financial planning challenging for agri-food enterprises. Long-term loans show a downward trend in interest rates and at present keep the lowest ever rates, at approximately 2.8% (for local currency loans).

Some of the small-sized enterprises are relying on informal credit providers to re-finance their debt, paying high interest rates and often being impacted by hidden terms in the contracts.

Banks require collateral for loans. They primarily accept buildings, land and facilities but, in general, all assets that can be easily converted into cash and for which the banks can have access to the legal titles are acceptable. For new entrants that are establishing their own start-ups and do not possess any assets, banks require property of the owner (real estate in urban areas) or contracted financial aid under the measures of RDP. For medium and long-term investment loans, agri-food entrepreneurs often cannot provide the required collateral. They remain interested in guarantees providing higher than the current guarantee rate and of bigger supply.

The main criteria that influence the decisions of the agri-food companies in choosing the most suitable financing partner are 96 the longer grace periods and lower interest rates they could be offered. This finding indicates that, when it comes to larger-sized enterprises, there is competition among the finance providers. This also means that large-sized agri-food enterprises can shop around for the best offers in terms of interest and fees, maturity, collateral and repayment schedule.

Product features and accompanying lending policies do not adequately reflect the business cycles of the banks' clients. Banks are often unaware of the slow ramp-up time of investments, and the subsequent returns from them, per sub-sector, because of the time needed to establish agri-food assets and production facilities.

Also, banks do not have a tailored marketing strategy for agri-food SMEs and are unaware of how to best approach this client segment, as indicated in interviews with agri-food enterprises. This means that enterprises are not being made aware of new credit products available to them. The main communication tools that banks use are personal advisors who are responsible for providing information on new products and services.

Conclusions

The main conclusions of the report are several:

First, climate change is already affecting people and ecosystems: dangerous events caused by changing weather patterns, including floods, droughts, forest fires and extreme heat, are becoming more common around the world. Climate change directly affects food and water security. Any warming can lead to reduced yields in conditions of growing demand for food and raw materials.

And secondly, among the causes of climate change are anthropogenic activities such as changes in the structure and use of land, which cause approximately a quarter (23%) of human emissions; food production, deforestation and desertification are among the causes of climate change on land; degraded lands do not have the ability to absorb carbon and can actually release carbon.

Climate change and human activities can harm the earth to the point where it becomes a net source of carbon emissions, and soil is also an element that can have a significant effect on climate change depending on management decisions. More than 2.7 billion people worldwide are affected by desertification, which means thatnearly 1/3 of the world's population has lost productive land, to be used for agricultural purposes.

Proper soil management can be applied to depleted soils in an area slightly larger than Europe, improving people's livelihoods and economic opportunities.

And third, to adequately respond to climate challenges, action is needed to protect ecosystems, because approximately 72% of the icy land is affected by human activity. Among the conclusions made is the thesis that maintaining wild and free from human pressure areas is crucial to saving biodiversity and reducing emissions.

It is necessary to change the culture and healthy diet, associated with the reduction of waste. If food waste is reduced, an additional one billion people will be provided with food. Reducing the consumption of food of animal origin can contribute to reducing pollution from livestock.

Climate change and fluctuations lead to changes in the conditions of growth and development of agricultural crops. This has a direct bearing on the way the world produces, distributes and consumes food. Climate is directly related to the way and prospects for global production needed to sustain the human population. The number of people in the world is expected to grow to 10 billion by 2050. This poses a huge challenge to the global community on how to feed an additional 2.3 billion people through environmentally friendly methods and climate change.

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TO THE FLUCTUATIONS OF THE AGRO-CLIMATIC CONDITIONS FOR THE DEVELOPMENT OF VITICULTURE IN A CERTAIN VITICULTURAL REGION ON THE BASIS OF LAND DATA

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КЪМ КОЛЕБАНИЯТА НА АГРОКЛИМАТИЧНИТЕ УСЛОВИЯ ЗА РАЗВИТИЕ НА ЛОЗАРСТВОТО В ОПРЕДЕЛЕН ЛОЗАРСКИ РАЙОН НА БАЗАТА НА НАЗЕМНИ ДАННИ

Пламен Лаков

Висше училище по агробизнес и развитие на регионите - Пловдив

Abstract: In recent decades, global warming has affected the development of agriculture, incl. and on viticulture. Vineyards and winemakers must take into account the fluctuations of climatic elements now and in the future. Based on these positions, the author believes that the topic of agro-climatic conditions for vine development are relevant, given the opportunities for production of quality grapes and wine.

The main purpose of the study is to investigate some of the main agro-climatic indicators for vine development related to air temperature and their fluctuations for different periods of time such as: duration (days) of periods with stable retention of air temperature above 10°C, accumulated temperature sums, the frost-free period, etc., in a certain geographical area.

The analysis was made on the basis of a basic period of 50 years - 1931-1980. Regarding the fluctuations of the indicators related to the main period, 30-year series have been formed for the periods 1981–2010 and 1989–2019. The respective conclusions, summaries and conclusions have been made.

Key words: climate, viticulture, agroclimatic indicators, accumulated temperature sums, frost-free period, fluctuations

Резюме: През последните десетилетия глобалното затопляне на Земята влияе върху развитието на земеделието, вкл. и върху лозарството. С колебанията на климатичните елементи трябва да се съобразяват лозарите и винарите сега и за в бъдеще. Изхождайки от тези позиции, автора счита, че темата за агроклиматичните условия за развитие на лозата са актуали, с оглед на възможностите за производство на качествено грозде и вино.

Основното цел на проучването е да се изследват едни от основните агрокроклиматични показатели за развитие на лозата, свързани с температурата на въздуха и техните колебания за различни периоди от време като: продължителност (дни) на периодите с устойчиво задържане на температурата въздуха над 10°С, набрани температурни суми, безмразовия период и др., в определен географски район.

Анализът е направена на базата на основен период от 50 години – 1931–1980. Относно колебанията на показателите, отнесени към основния период, са формирани 30-годишни редици за периодите 1981–2010 и 1989–2019 г. Направени са съответните изводи, обобщения и заключения.

Ключови думи: климат, лозарство, агроклиматични показатели, набрани температурни суми, безмразов период, колебания

Въведение

Климатът е един от основенен ресурс и същевременно е фактор за развитието на земеделието в определана територия. През последните десетилетия глобалното затопляне на Земята влияе върху развитието на земеделието, вкл. и върху лозарството. Хората и техните решения имат основна роля в изграждането на земеделската система, устойчива на климатичните промени. С колебанията на климатичните елементи трябва да се съобразяват лозарите и винарите сега и за в бъдеще.

Изхождайки от тези позиции, автора счита, че изследването на агроклиматичните условия за развитие на лозата за различни периоди са актуали, с оглед на възможностите за производство на качествено грозде и вино, включително в района на Кнежа, Плевен и Павликени. Град Плевен и неговият район от древни времена са познати като място за производството на качествени вина. В градът се намира и Институтът по лозарство и винарство като научноизследователски център на България.

В настоящето проучване, автора си поставя за цел да изследва едни от основните агрокроклиматични показатели за развитие на лозата, свързани с температурата на въздуха и техните колебания за различни периоди от време.

Теоретична основа на изследването

За определяне на *климатична система*, е приета следната постановка: „в хронологичен план климатичната система е детерминирана, но хаотична поради силната й чувствителност към началните условия, почти интразитивна със сложно апериодично поведение и ограничена предсказуемост“, **непостоянството на системата е неин атрибут**. По дефиниция „климатът е абстрактно понятие, което се описва чрез характеристиките на метеорологичните елементи, осреднени за конкретен хронологичен интервал в планетарен или определен локален пространствен обхват“, „субстанциалния носител на климата е атмосферата, заедно с контактната повърхност на системните компоненти – хидросфера, литосфера, криосфера и биосфера”[1].

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Основните климатообразуващите фактори са слънчевата радиация, атмосферната циркулация и подстилащата повърхност.

В тази връзка подходът към емпиричното изследване за района на Кнежа, Плевен и Павликени предоставя статистическо описание на „историята“ на климата.

Основните агроклиматичните показатели за развитие на лозата са както следва:

1. Средна начална дата на устойчиво задържане на температурата на въздуха над 10°C.

2. Средна крайна дата на устойчиво задържане на температурата на въздуха над 10°C.

3. Продължителност на периода с устойчиво задържане на температурата на въздуха над 10°C в дни.

4. Сумата на температурата на въздуха, набрана за периода с устойчиво задържане на температурата на въздуха над 10°C и нейната обезпеченост.

5. Средната дневна температура на най-топлия месец.

6. Последен пролетен и първия есенен мраз и средната продължителност на свободното от мраз време.

7. Годишна сума на валежите.

8. Хидротермичен коефициент на Селянинов-kSel за юни, юли и август.

9. Валежни суми за септември и октомври.

10. Валежни суми над 110 мм за септември и октомври и тяхната честота.[2]

В настоящата публикация са изследвани паказателите свързати с температурата на въздуха.

Методи

Прилагането на статистико-математически методи се обуславя от необходимостта наличната метеорологична информация да се обработи и да се получат статистически еднородни климатични редици. За хомогенизацията на статистическите редове са използвани методът на разликите и методът на отношенията. За периода 1981–2019 г. при възстановяване на месечните и годишните метеорологични данни са приложени графичният метод, методът на аналогията, както и методи на разликите и отношенията. За определяне на сумарната вероятност е P% е приложена следната

[2] Райониране на лозарството в България, научни трудове, Том III, Земиздат, С., 1960.

формула: *P=(m-0.3/n+0.4).100*, където *m* е по-редният номер на члена в подредената в низходящ ред редица, *n* е броят на годините (или на наблюденията) в редицата.

Установяване на съответствие между изходните данни и приетия тип теоретично разпределение, нормалното разпределение на Гаус, се осъществява чрез критерия за съгласие, с други думи χ^2-критерият на Пиърсън. Изходните редове на температурата на въздуха, например, се апроксимират с Гаусовото разпределение на вероятностите – за пример е представена станция Плевен. За установяване значимостта на различията, при колебанията на отделните елементи за различни периоди, е приложен t-критерият на Стюден за независими извадки.

За определяне датата на устойчиво задържане на температурата на въздуха над 10°С е приложен общоприетият графичен способ, построен по годишния ход на температурата на въздуха, въз основа на средната месечна температура, отнесена към 15-о число на месеца. Методът допуска линейно изменение на температурата на въздуха от месец в месец. На тази основа са изчислени дните с устойчиво задържане на температурата на въздуха над 10°С и набраните температурни суми. Направен е сравнително-аналитичният анализ, за да се очертаят найсъществените прилики и разлики в териториалното разпределение на режимните характеристики на климатичните елементи и явления, както и агроклиматичните показатели за развитие на лозата.

Необходимостта от пространствено представяне на резултатите от изследването налага използването на картографския метод, приложен за определяне на териториалния обхват на станциите. Извършена е съответната генерализация при оформяне на картите.

За определяне на пространствения обхват на изследването е приложен *полигонният метод*, или *методът на Тисен* с който се отчитан териториално валежите. Валежите, автора е приел, като ограничаващ териториално изследването, т.е. териториалния обхват на валежите съвпада с пространствения обхват на изследването (вж. Приложение 1, фиг. 5 и 6).

Анализът е направена на база с основен период от 50 години – 1931-1980 г. Относно колебанията на температурата на въздуха, отнесени към основния период, са формирани 30-годишни редици за периода 1981–2010 г. и 1989–2019 г. Резултатите са сравнени сравнени с тези, публикувани в *Райониране на лозарството в България*", том III (София: Земиздат, 1960) и други публикации, на базата на които са направени съответните заключения, изводи и обобщения.

Териториален обхват

Определянето на териториалния обхват е една от основните задачи в настоящото изследване. При нейното решаване се отчитат няколко фактора, които ограничават този обхват. На първо място, това е разположението на станциите, които осигуряват необходимите данни за изследването – *Кнежа*, *Плевен* и *Павликени*. Те са разположени в части от Западна и Средна Дунавска равнина. Техните географски координати са представени в *таблица 1*.

Таблица 1. Географски координати на изследваните станции

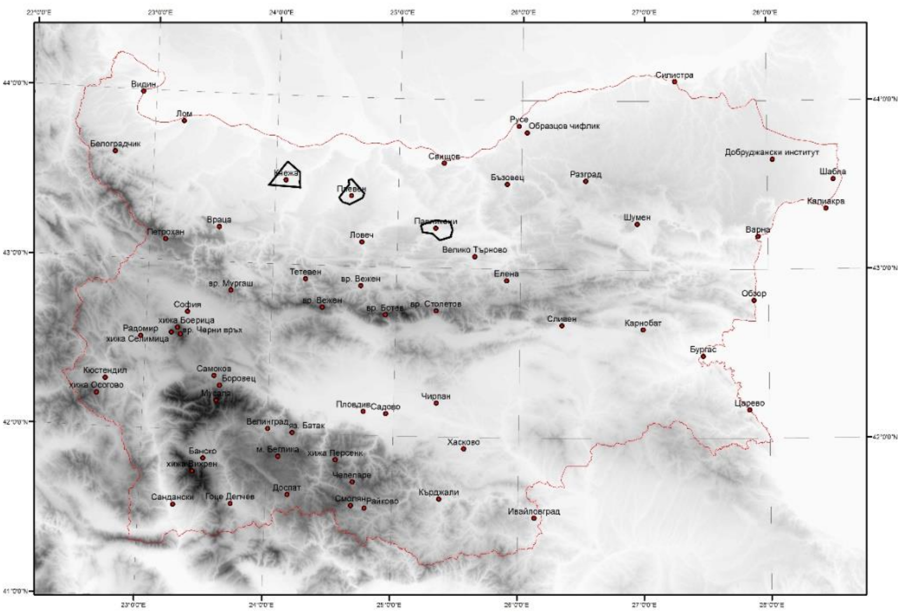
Станция	**Надморска височина (в м)**	**и.д. – λ**	**с.ш. – φ**
Кнежа	120	24°05´	43°20´
Плевен	130	24°36´	43°25´
Павликени	133	25°18´	43°14´

Най-западно се намира *станция Кнежа* (Приложение 1, фиг. 5), а общата площ се изчислява приблизително на 712 км².

Станция Плевен обхваща територия около 455 км² (Приложение 1, фиг. 5).

Най-западно е разположена *станция Павликени* (Приложение 1, фиг. 6). Общата площ се изчислява на ок. 418 км².

Разглежданият район включва териториите на трите станции и се простира приблизително между 43°09´ (Вишовград) и 43°39´ (между Селановци и Кнежа) с.ш., и между 23°51´30´´ (Соколаре) и 25°26´ (Лесичери) и.д., а общата площ е 1585 км² (виж фиг. 1).



Фиг. 1. Карта на Република Бугарија и изучениот регион Кнежа, Плевен и Павликени

Резултати от изследването

Периодите с устойчиво задържането на температурите на въздуха над +10°C са от основно значение, тъй като формират времето на т.нар. период на активна вегетация при лозата (*таблица 2*.).

Таблица 2. Дата на начало и край на периода с устойчиво задържане на температурата на въздуха над +10°C за периода 1931–1980 г. [3]

Станция	**+10°C**	
	начало	**край**
Сомовит*	2.IV.	29.X.
Кнежа	12.IV.	21.X.
Павликени	5.IV.	26.X.
Плевен	4.IV.	30.X.
Троян*	14.IV.	18.X.

** Станции за сравнение*

[3] По Лаков, П., Климатът в Централна Северна България (докторска дисертация), ВТ, 2006.

За Плевен и Павликени началото е съответно на 4 и 5 април, т.е. в първата десетдневка на април. В Кнежа обаче настъпва през втората десетдневка на 12 април. Краят на периода с температури над +10°С се установява повсеместно в края на октомври. Най-рано настъпва в Кнежа – на 21 октомври, и най-късно в Плевен – на 30 октомври.

От подробния анализ на проучените периоди се налага изводът, че устойчивото задържане на температурата на въздуха над +10°С в района е между 192 и 209 дни, което се отразява на набраната температурната сума. Тя варира между 3581°С за Кнежа, която е най-малка за разглеждания район, 3714°С за Павликени. Най-голяма е в Плевен, където достига 3845°С (*таблица 3.*).

Безмразовият период, или свободното от мраз време, е най-къс в Кнежа, където дните са 186 и се доближават по брой до дните без мраз в затворените котловини на Предбалкана и най-западните части на Дунавската равнина. В останалите две станции – Плевен и Павликени – периодът е над 200 дни, съответно 218 и 201.

Таблица 3. Продължителност (дни) на периодите с устойчиво задържане на температурата въздуха над 10°C, набрани температурни суми за 1931–1980 г. и безмразовия период[4]

Станция	**Продължителност (в дни)**	**Температурна сума**	**Безмразов период****
	+10°	**+10°**	
Сомовит*	210	3981	221
Кнежа	192	3581	186
Павликени	204	3714	201
Плевен	209	3845	218
Севлиево*	198	3414	182
Дряново*	202	3396	208

** Станции за сравнение*

*** Определен за период 1931–1970 г.*

[4] Пак там.

Колебания на устойчивото задържане на температурата на въздуха над 10°С

На основа на анализа на съответните периоди се получиха някои интересни изводи (*таблица 4*, *Приложение 2*), свързани с общоприетите агроклиматични показатели за развитието на лозата.

Средната начална дата с устойчиво задържане на температурата на въздуха над 10°С през различните периоди търпи известно изместване. За Кнежа от края на първата десетдневка на април към началната петдневка на месеца. Така за периода 1990–2019 г. средната начална дата вече е 4 април. За Плевен се е изместила с два-три дни и вече е в края на март и началото на април. Сходна е ситуацията и в станция Павликени. Налага се изводът, че устойчивото задържане на температурата на въздуха над 10°С за последните тридесет години трайно се е изместило от 2 до 3 дни по-рано, сравнено с периодите 1931–1970 г. и 1931–1980 г. Получения резултат, обаче, е в рамките на грешката на средната многогодишна стойност с обезпеченост 68%, която за станция Плевен, например е от 2 дни, както за периода 1980–2010 г., така и за 1989–2019 г.

Краят на период с устойчиво задържане на температурата на въздуха над 10°С настъпва през октомври. През всичките наблюдавани периода това е последната десетдневка на октомври.

Не се констатира съществено изменение в датите по станции. Кнежа продължава да е мястото, където краят на периода настъпва най-рано в региона – 21–22 октомври. За Плевен това е 27–29 октомври, а за Павликени – 30–31 октомври (за 1980–2010г., и за 1989–2019 г.).

Продължителността на дните в годината на периода с устойчиво задържане на въздуха над 10°C търпят известна промяна. За Кнежа от 196–198 дни за периода 1989–2019 г. те вече са 202. За Павликени от 206–209 дни за периода 1989–2019 г. те са 214 дни, а за Плевен от 205–209 вече са 215 дни.

Липсата на достатъчно данни и за трите станции за безмразовия период не позволява да се правят категорични изводи. Като имаме предвид данните за Плевен, става ясно, че не се наблюдава съществена промяна в броя на дните. За последните 30 години безмразовият период е 216 дни. За останалите периоди те са съответно 215, 218 и 213 дни. За Кнежа се наблюдава известно увеличаване броя на дните без мраз, което е благоприятно за развитието на лозата, а разликата достига 13 дни. Трябва да отбележим обаче, че нормата за последния наблюдаван период е установена от по-къса редица от 30 години – 1998–2019 г.

Колебания на първите късни пролетни и ранни есенни мразове

От съществено значение за развитието на лозата са първите късни пролетни и ранните есенни мразове.

В станция Кнежа за периода 1998–2019 г. честотата на минималните температури под 0°C през април е за различните десетдневния е както следва: през първата десетдневка на месеца честотата е 36%, т.е. на всеки десет години, през 3–4 от тях минималната температура на въздуха пада под 0°C. През втората десетдневка честотата е 22,7%, а през третата – 18%. С други думи през втората десетдневка честотата е 2 пъти на 10 години, а през третата – 1–2 години на всеки 10. Средната дата на настъпване на последния мраз с обезпеченост 50% (медианата) е 9 април, което е по-късно от началото на вегетационния период за станция Кнежа – средната начална дата на задържане на температурата на въздуха над 10 за периода 1989–2019 г. е 4 април. Като цяло честота на минималните температури под 0°C през април е значителна, на всеки 7-8 от 10 години могат да се проявят, с различна честота през десетдневията на месеца.

За станция Плевен (1990–2019 г.) честотата на минималните температури под 0°C през първата десетдневка на април е 23%, или 2 години на всеки десет. През втората десетдневка на април честотата е едва 13%, или около 1 година на всеки десет. За последната десетдневка на април вероятността е едва 3%. Средната дата на настъпване на последния мраз с обезпеченост 50% (медианата) за разглеждания период е 27–28 март, което почти съвпада с началото на вегетационния период за станция Плевен, която е 29–30 март. Като цяло честота на минималните температури под 0°C през април е 3-4 на всеки 10 години, с различна честота през десетдневията на месеца.

В станция Кнежа за периода 1998–2019 г. средната дата на настъпване на последния мраз с обезпеченост 50% (медианата) е 24 октомври което и по-късно от крайната дата с устойчиво задържане на температурата над 10°C – 22 октомври. От значение са случаите на ранни октомврийски мразове, които в първата десетдневка на октомври са с честота един случай на десет години. През втората десетдневка са 2–3 случая на 10 години. По-чести са октомврийските мразове през втората десетдневка на месеца, когато те могат да се проявят 4 пъти на 10 години.

За станция Плевен за периода 1990–2019 г. средната дата на настъпване на последния мраз с обезпеченост 50% (медианата) е 29 октомври, което съвпада с края на вегетационния период за станцията. През първата десетдневка на октомври ранните мразове са рядкост, като вероятността е под 3%. През втората десетдневка вероятността е 2–3 пъти на 10 години при периодично нахлуване на студени въздушни маси и падане на минималните температури на въздуха под 0°C. По-голяма е вероятността през третата десетдневка на октомври минималните температури да са отрицателни – 4–5 на 10 години – възможно е това да се случи, но тогава е и краят на вегетационния период. Преди него (29 октомври) вероятността за отрицателни минимални температури вече е 30%, или три пъти на 10 години.

Колебания на набраните температурни суми над 10°C

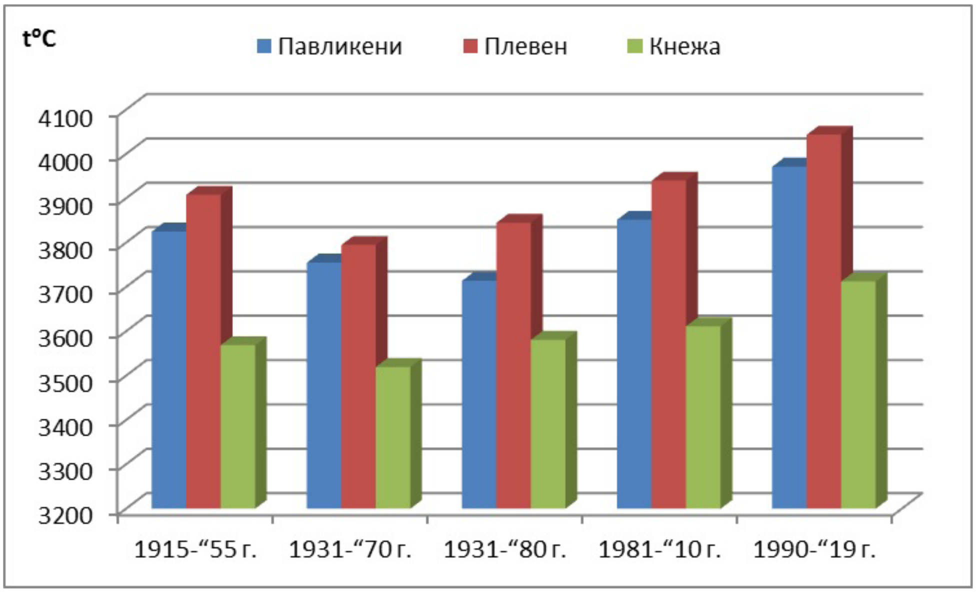
Категорично трябва да се подчертае, че набраните температурни суми над 10°C във всички периоди на устойчиво задържане на температурата на въздуха показват увеличение. Това увеличение достига абсолютни стойности от 3700°C до над 4000°C. В Кнежа сумата достига за периода 1981–2010 г. 3612°C, а разликата е 31°C и 3713°C с разлика от 132°C за периода 1990–2019 г.

За Павликени разликата е 138°C за първия период (1981–2010) и 258°C за втория (1990–2019 г.). В станция Плевен промяната е още по-изразителна. За първия период разликата достига 95°C, а за втория – 199°C, като общата сума за периода 1990–2019 г. е в абсолютна стойност 4044°C (виж *фиг. 2.*).

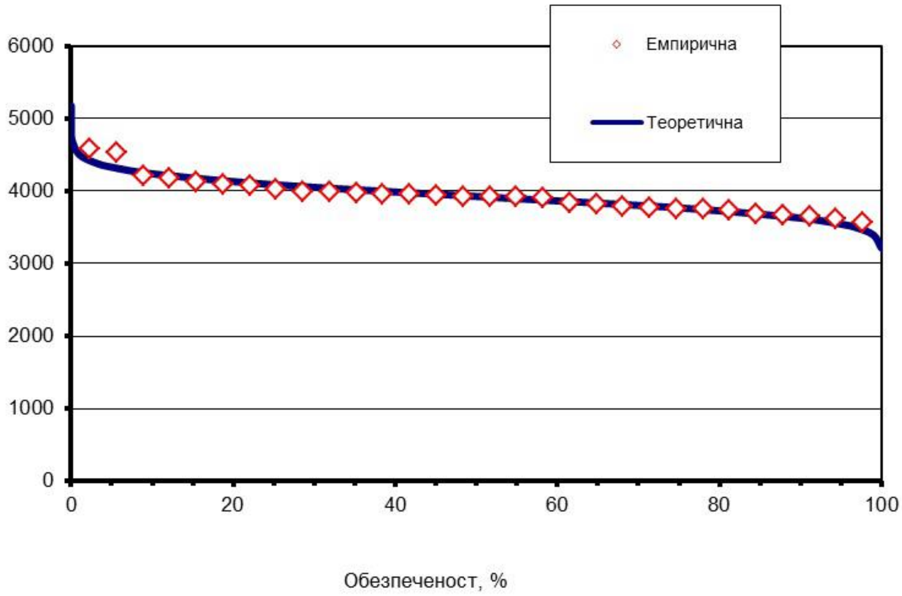
Повишаването на температурните суми се дължи преди всичко на статистически значимото затопляне през летните месеци за периодите 1981–2010г. и 1990–2019 г., сравнен с основният 50-годишен период. За краткост на изложението ще се спрем на станция Плевен за периода 1990–2019 г., където средното квадратично отклонение е 221°C, а грешката с обезпеченост 68% е 40,4°C, или 1%. Коефициентът на вариации не надхвърля 5,5%. Това ни дава основание да твърдим, че статистическият ред има нормално разпределени, т.е. получените резултати са статистически значими.

Като анализираме кривите на обезпеченост на температурните суми за двата периода за станция Плевен (*фиг.3. и 4.*), констатираме, че температурните суми над 3600°C е с обезпечение над 95%.

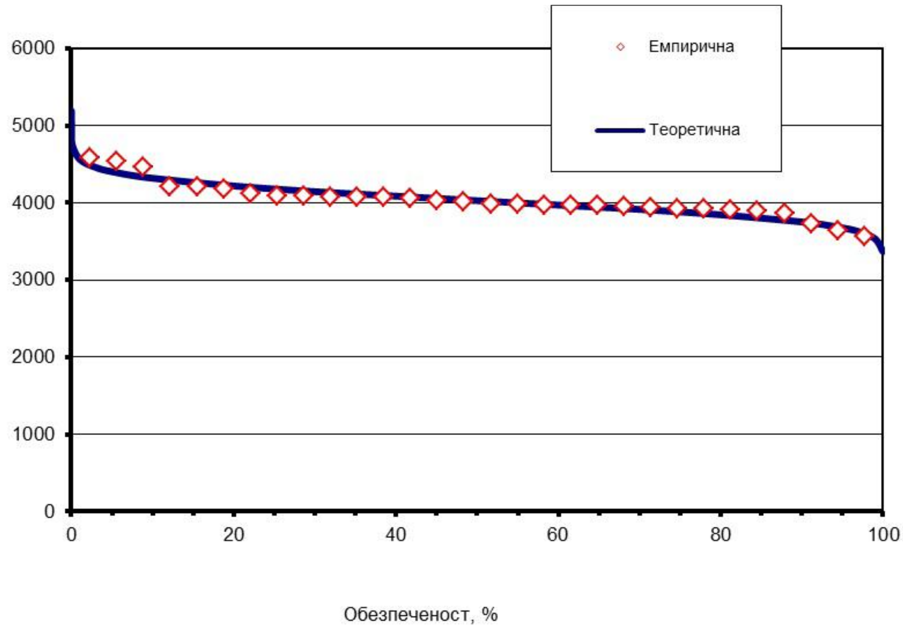
Хронологичните колебания на приземната температура на въздуха в Кнежа, Плевен и Павликени са довели до по-благоприятни условия за отглеждане на лозата в сравнение с периодите 1931-1980, 1915–1955 и 1931-1970 г.



Фиг. 2. Температурна сума за перида над 10°C за различни периоди по станции



Фиг. 3. Обезпеченост на температурната сума над 3600°C за периода 1981-2010 г.



Фиг. 4. Обезпеченост на температурната сума над 3600°С за периода 1990-2019 г.

Изводи и обобщения за хронологичните колебания на основните агрокроклиматични показатели за развитие на лозата, свързани с температурата на приземния въздуха

От направения анализ може да се направят някои изводи:

1. Средната начална дата с устойчиво задържане на температурата на въздуха над 10°С през различните периоди търпи известно изместване. Налага се изводът, че за периодите

1981-2010г. 1990-2019 г., датата трайно се е изместила с 2–3 дни по-рано, сравнена с периодите 1931–1970 г. и 1931–1980 г.

2. Краят на периода с устойчиво задържане на температурата на въздуха над 10°C настъпва през последната десетдневка на октомври. Това е характерно за всичките наблюдавани периода. Не се констатира съществено изменение на датите по станции.

3. Продължителността на дните в годината на периода с устойчиво задържане на въздуха над 10°C търпят известна промяна. За Кнежа от 196–198 дни за периода 1989–2019 г. са 202 дни. За Павликени от 206–209 дни достигат за периода 1989–2019 г. 214 дни, а за Плевен – от 205–209 вече са 215 дни.

4. В станция Кнежа за периода 1998–2019 г. честотата на минималните температури под 0°C през април като цяло е значителна, на всеки 7-8 от 10 години могат да се проявят. За различните десетдневния е както следва: на всеки десет години през 3–4 от тях минималната температура на въздуха пада под 0°C. През втората десетдневка на 2 години от всеки десет, а през третата, 1-2 години на всеки десет. Средната дата на настъпване на последния мраз с обезпеченост 50% е 9 април, което е по-късно от началото на вегетационния период за станция Кнежа.

5. За станция Плевен за периода 1990–2019 г. честотата на минималните температури е под 0°C е около 3-4 на всеки 10 години. За различните десетдневния е както следва: през първата десетдневка е 2 години на всеки десет. През втората около 1 година на всеки десет. За последната десетдневка на април вероятността е едва 3%. Средната дата на настъпване на последния мраз с обезпеченост 50% за разглеждания период е 27–28 март, което почти съвпада със началото на вегетационния период за станция Плевен, която е 29–30 март.

6. Набраните температурни суми през дните с устойчиво задържане на температура на въздуха над 10°C във всички периоди показва увеличение. То достига абсолютни стойности от 3700°C до над 4000°C. В Кнежа разликата е 132°C и достига 3713°C за периода 1990–2019 г. За Павликени 258°C и достига сумата от 3972°C (1990-2019 г.). В станция Плевен сумата за периода 1990–2019 г. е с абсолютна стойност от 4044°C и разлика от 199°C.

7. Повишаването на температурните суми се дължи преди всичко на статистически значимото затопляне през летните месеци за периодите 1981–2010г. и 1990–2019г., сравнени с основния 50-годишен период. Кривите на обезпеченост на температурната

сума над 3600°С за периодите 1981–2010 и 1990–2019 г. определят обезпечението с над 95%.

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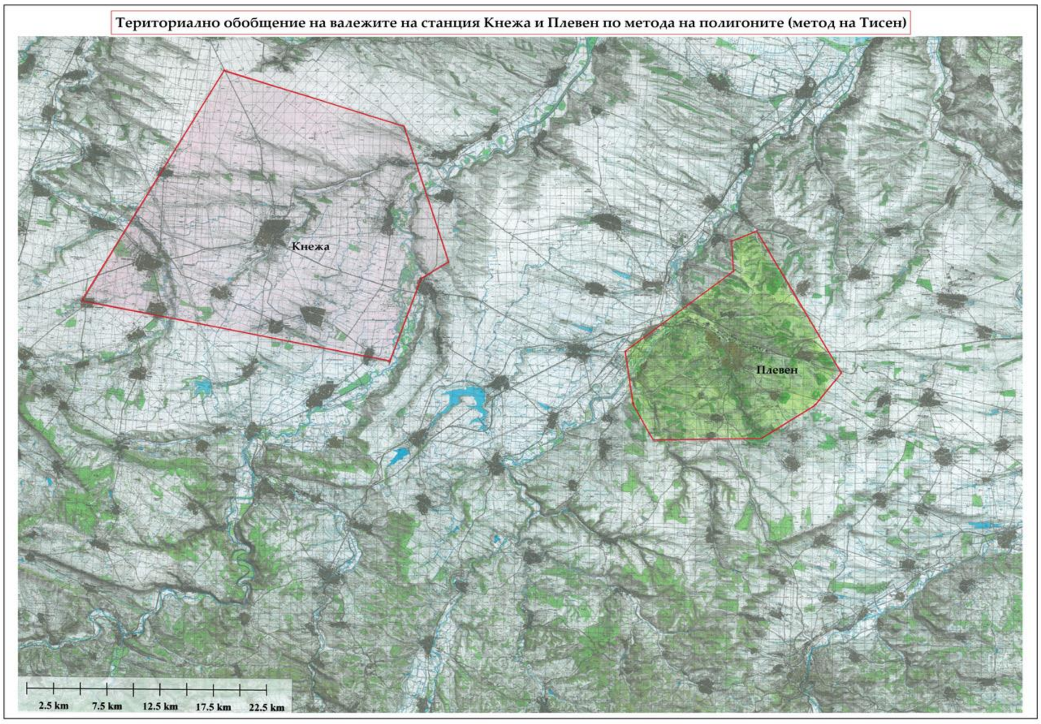
Приложение 1



Фиг. 5 Териториално обобщение на валежите на станция Кнежа и Плевен по метода на полигоните (метод на Тисен)[5]

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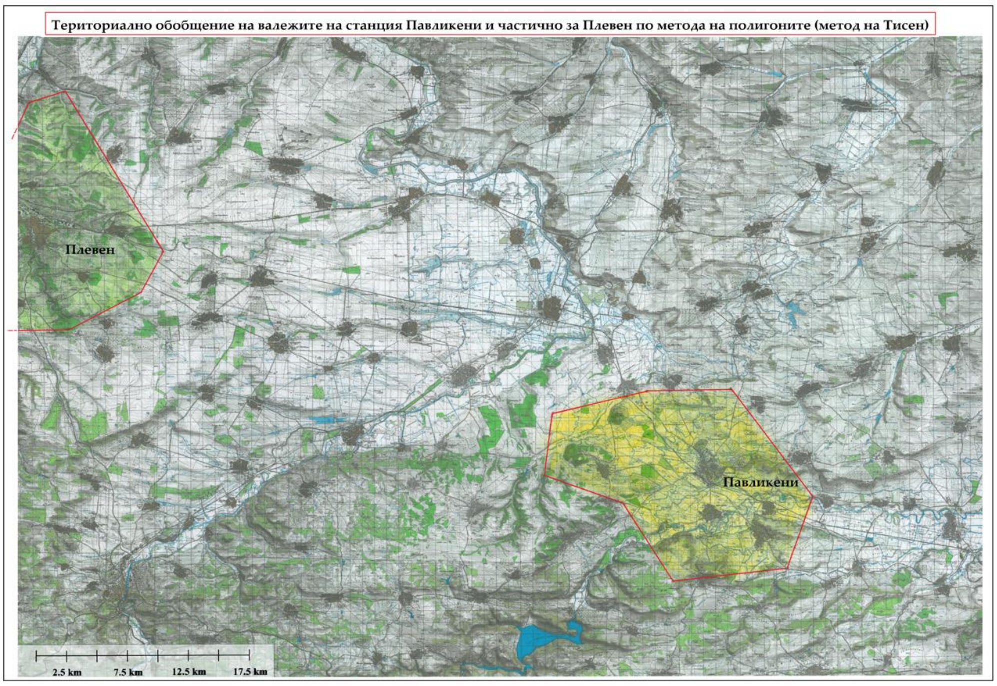

Фиг. 6 Териториално обобщение на валежите на станция Павликени и частично за Плевен по метода на полигоните (метод на Тисен)[6]

[6] Пак там.

Приложение 2

Таблица 4. Базисна статистика на основните агроклиматични показатели за лозата – температурни условия за различни периоди

Плевен					
период/ год.	**ср. нач. дата**	**ср. кр. дата над**	**дни над 10°С**	**дни без мраз**	**сума в °С над 10°С**
1915–55*	3.IV	29.X	209	213	3908
1931–70	4.IV	27.X	205	218	3795
1981–2010	1.IV	27.X	210	215	3940
1990 - 2019	29.III	29.X	215	216	4044

Кнежа					
период/ год.	**ср. нач. дата**	**ср. кр. дата над**	**дни над 10°С**	**дни без мраз**	**сума в °С над 10°С**
1915–55	8.IV	23.X	198	180	3569
1931–70	9.IV	21.X	196	186	3520
1981–2010	7.IV	21.X	198	-	3612
1990–2019	4.IV	22.X	202	199*	3713

Павликени					
период/ год.	**ср. нач. дата**	**ср. кр. дата над**	**дни над 10°C**	**дни без мраз**	**сума в °C над 10°C**
1915–55	4.IV	29.X	209	-	3825
1931–70	5.IV	29.X	206	201	3755
1981–2010	4.IV	30.X	210	-	3852
1990–2019	1.IV	31.X	214	-	3972

SUSTAINABLE DEVELOPMENT OF REGIONS AND LOCAL COMMUNITIES

УСТОЙЧИВО РАЗВИТИЕ НА РЕГИОНИТЕ И МЕСТНИТЕ ОБЩНОСТИ

MORTALITY RATE AND LIFE EXPECTANCY IN BULGARIA IN THE PERIOD 2011 – 2021. DYNAMICS AND TERRITORIAL DIFFERENCES

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Abstract: The demographic transition is an objective process taking place on a global scale. All regions and countries in the world are taking part in it, while going through its separate phases for each of them takes a different span of time. Characteristic of the last phase of the transition is the phenomenon of demographic crisis. Bulgaria is among the countries in Europe where the negative effects of the demographic crisis are particularly strong. This applies to the greatest extent to the values of the mortality rate and of the average life expectancy (Levkov, 2017).

The purpose of the study is to examine the current trends in the development of two of the main demographic indicators in Bulgaria.

The *object* of research is the population of Bulgaria.

Scope. The study analyzes the indicators of mortality rate and average life expectancy. The intra-territorial differences are revealed. A comparison with EU countries is made.

Sources and methods. Statistical data and analyses of Bulgarian and international official sources, as well as previous research of the author, are used. Quantitative methods and comparative analysis are mainly applied.

Results and discussion.

1. A continuing rise in mortality rates in Bulgaria was determined. It was most pronounced in the last two years of the period under review, coinciding with the COVID-19 pandemic.

2. During the same time, a decrease in the average life expectancy in the country was also found.

Conclusions:

1. The course of the demographic processes, in particular of the mortality rate and life expectancy, has its internal regularities which are determined by the demographic transition. It is also affected by phenomena which are difficult to predict such as the COVID-19 pandemic.

2. There are reasons to believe that the inconsistent decisions and actions of the Bulgarian governments in the management of the pandemic situation have directly contributed to the increase in the mortality rate in the country, and as a result have also contributed to the decrease in the life expectancy.

3. The deepening of the demographic crisis in Bulgaria requires a decisive change in the country's demographic policy. The demographic problem and its solution or at least alleviation requires the adoption of comprehensive measures – social, economic, educational and political. It is necessary to activate the national discussion regarding these measures

and to bring out the demographic problem as a priority in the management of the country in the coming decades.

Keywords: mortality rate, average life expectancy, territorial differences.

Introduction

The concept of the demographic transition was developed in the first half of the 20th century by A. Landry and further developed by Fr. Notestein. Later, it was widely adopted by various scientific schools. Its main points boil down to the following:

- The demographic transition is a universal regularity in the development of the population. In individual countries and communities, it starts at different times and proceeds at different speeds, passing through 4 phases.

- During the first two phases, the death rate decreases and the birth rate remains relatively high. The natural increase is increasing sharply. A demographic explosion is underway.

- During the third and fourth phases, birth rates and natural growth decline. The population is aging; its number is increasing slowly, and in some countries even decreasing. The phenomenon of demographic crisis is emerging.

These projections are still used today in the preparation of UN demographic forecasts, as well as for the purposes of demographic planning and policy in a number of countries, including Bulgaria. (Levkov, 2017)

A characteristic feature of the demographic transition in Bulgaria is its relatively late beginning (the 20s of the last century) and its relatively rapid progress. During this hundred-year period, the total mortality rate registered significant changes. It reached its historical minimum of 7.5‰ in the mid-1960s of the 20th century. In the 1980s, its values rose to 12‰, surpassing the values of the declining birth rate, and the country entered a prolonged period of depopulation. Bulgaria asserts itself among the countries with the highest death rate in Europe (Levkov, 2017).

The purpose of the study is to examine the current trends in the development of two of the main demographic indicators in Bulgaria.

The ***object*** of research is the population of Bulgaria.

Scope. The study analyzes the indicators of mortality rate and average life expectancy. The intra-territorial differences are revealed. A comparison with EU countries is made.

Sources and methods

Statistical data and analyses of Bulgarian and international official sources, as well as previous research of the author, are used. Quantitative methods and comparative analysis are mainly applied. The two main working concepts are interpreted in accordance with the NSI[7] definitions:

- total mortality – number of dead persons per 1000 people of the average annual number of the population (https://www.nsi.bg);
- expected average length of future life – the average length of future life of newborns under the hypothesis of invariance in the intensity of the observed in a given year the elderly mortality rate (https://www.nsi.bg).

Results and discussion

Table 1 presents the number of deceased persons and the values of the total mortality in Bulgaria for the period 2011 – 2021.

[7] NSI – National Statistical Institute of Bulgaria

Table 1. Number of deaths and total mortality rate in Bulgaria, 2011 – 2021

Year	**Deceased persons (thousands)**	**Mortality (‰)**
2011	108.3	14.7
2012	109.3	15.0
2013	104.3	14.4
2014	109.0	15.1
2015	110.1	15.3
2016	107.6	15.1
2017	109.8	15.5
2018	108.5	15.4
2019	108.1	15.5
2020	**124.7**	**18.0**
2021	**149.0**	**21.7**

Source: https://nsi.bg/bg/content/content/3006/умирания-по-области-общини-и-пол

It can be seen that in the second decade of the century the picture was relatively stable. Until 2019, the number of deceased persons in our country fluctuated within narrow limits and the overall mortality rate was around 14-15‰.

The COVID pandemic in Bulgaria manifested itself in 4 big waves: November – December 2020, March – April 2021, November – December 2021 and January – February 2022. In all four periods, the average daily number of infected, calculated on a weekly basis, was over 4,000. The highest values – over 10,000 per day – were recorded during the last wave at the beginning of 2022 (fig. 1).

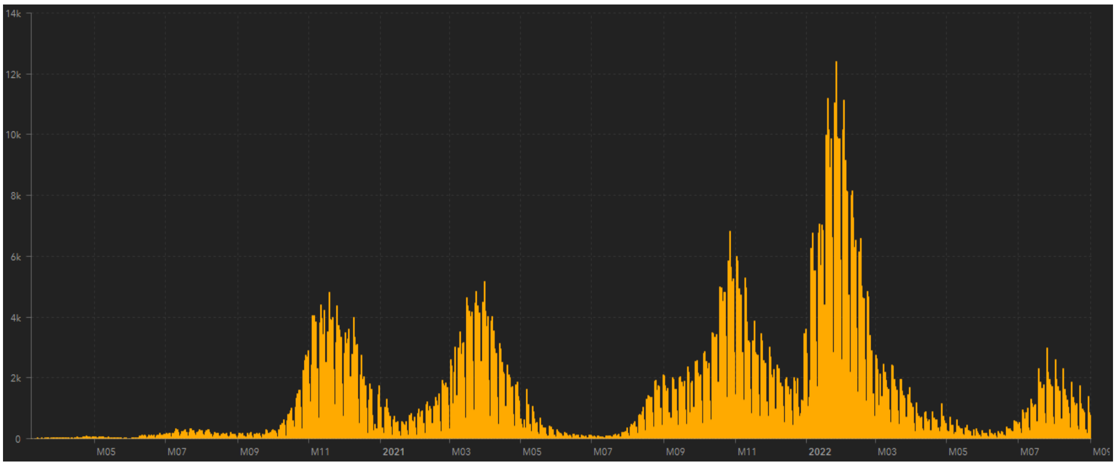

Figure 1. Daily number of people infected with COVID-19 in Bulgaria, April 2020 – August 2022

Source:

https://coronavirus.bg/arcgis/apps/opsdashboard/index.html#/cda0386944af4b81a5161aacec190f33

As a result of the COVID pandemic in Bulgaria, an extremely high growth in both the number of dead persons and the total mortality has been reported. The values of both indicators increased in two years by nearly 40%. The number of dead persons in 2020 was 125 thousand, and the total mortality rate – 18.0‰. In 2021, the number of deaths was 149 thousand, and the total mortality rate reached 21.7‰. A negative record has been set for the time since demographic statistics have been kept in the country

(https://nsi.bg/sites/default/files/files/pressreleases/Population2021_6IY8TD4.pdf.)

The phenomenon of "excess mortality" appears, which is usually associated with the consequences of epidemics, natural disasters and wars (for example, Bulgaria's participation in the First World War led to a sharp increase in the number of deaths – both military and civilian).

The comparison with the data for the world as a whole shows that the Bulgarian population is much more affected by the COVID pandemic.

According to data from the Johns Hopkins University in Chicago (JHU) as of 15/08/2022, there were about 590 million registered people infected with COVID in the world. (https://coronavirus.jhu.edu/map.html) Rough calculations show that this was about 7.5% of the world population, which at the same time is approximately 8 billion. 6.44 million deaths or

1.1% of infected persons were registered. (https://coronavirus.jhu.edu/map.html)

At the same time, the number of registered infected people in Bulgaria was 1.23 million – almost 19% of the country's 6.5 million population. The registered deaths were 37.5 thousand or 3.5% of the infected. (https://coronavirus.bg/bg/statistika/dead) In addition to deaths directly caused by COVID, there is also an increase in deaths caused by other diseases. This is due both to the commitment of a huge medical resource for the country, and to other reasons such as the postponement of a large number of planned operations.

The comparison of the number of deaths in the country by week in 2020 and 2021 with their number for the period 2017 – 2019 shows the clear impact of the pandemic on the increase in mortality in Bulgaria (fig. 2).

During each of the four waves, the weekly death rate rose sharply and from the usual 2-2.5 thousand it reached values of 3-3.5 thousand, and in some weeks of November and December 2021 it exceeded 4000.

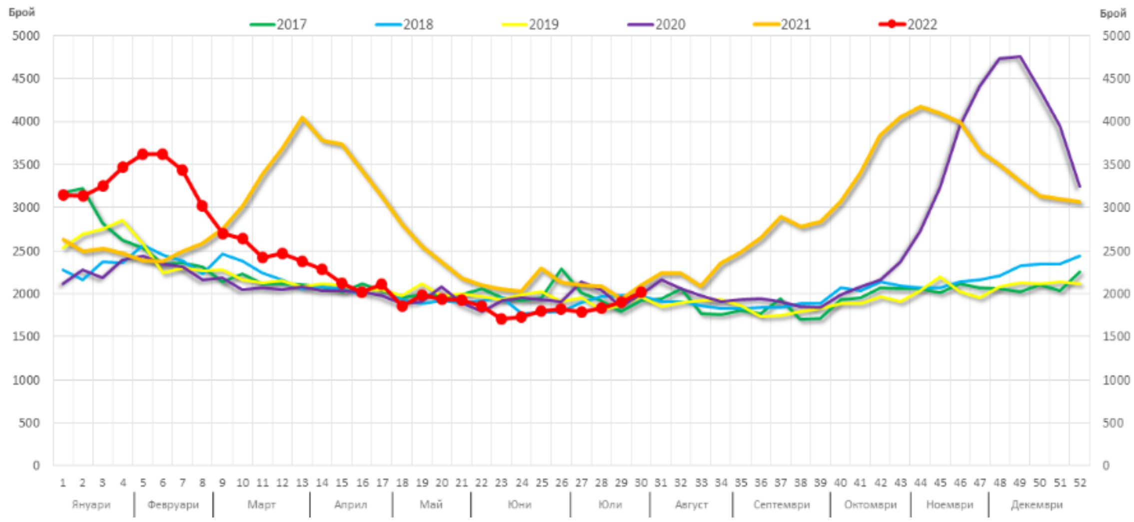

Figure 2. Number of deaths in Bulgaria by week, 2017 – 2022

Source: https://nsi.bg/bg/content/18121/basic-page/умирания-в-българия-по-седмици

There is a positive trend for the weekly mortality in the spring and summer of this year to approach the values from before the pandemic.

Territorial differences. Differences in the level of total mortality between regions in the country continue to widen. In 2021, they varied from 16.8‰ in the city of Sofia to 30.8‰ in the Montana region and 32.3‰ in the Vidin region (fig. 3).

Only in 7 districts the values of total mortality were below the national average. Critically high (over 28‰) was the death rate in two more areas along the western border of Bulgaria – Pernik and Kyustendil. This territorial feature also corresponds with the results of our previous research on the demographic situation in Bulgaria. (Levkov, Lakov and Velikov, 2020)

T. Wieland (Wieland, 2022) makes a detailed spatial analysis of excess mortality in Germany in 2020, taking into account demographic changes in the country. The territorial breakdown is at the NUTS 3 level (400 counties). The author establishes the existence of a spatial dependence between the total mortality and that caused by COVID-19. This dependence is proven only in the higher age groups of the population. Similar analyzes are lacking in Bulgaria, and the tasks of the present study are more modest.

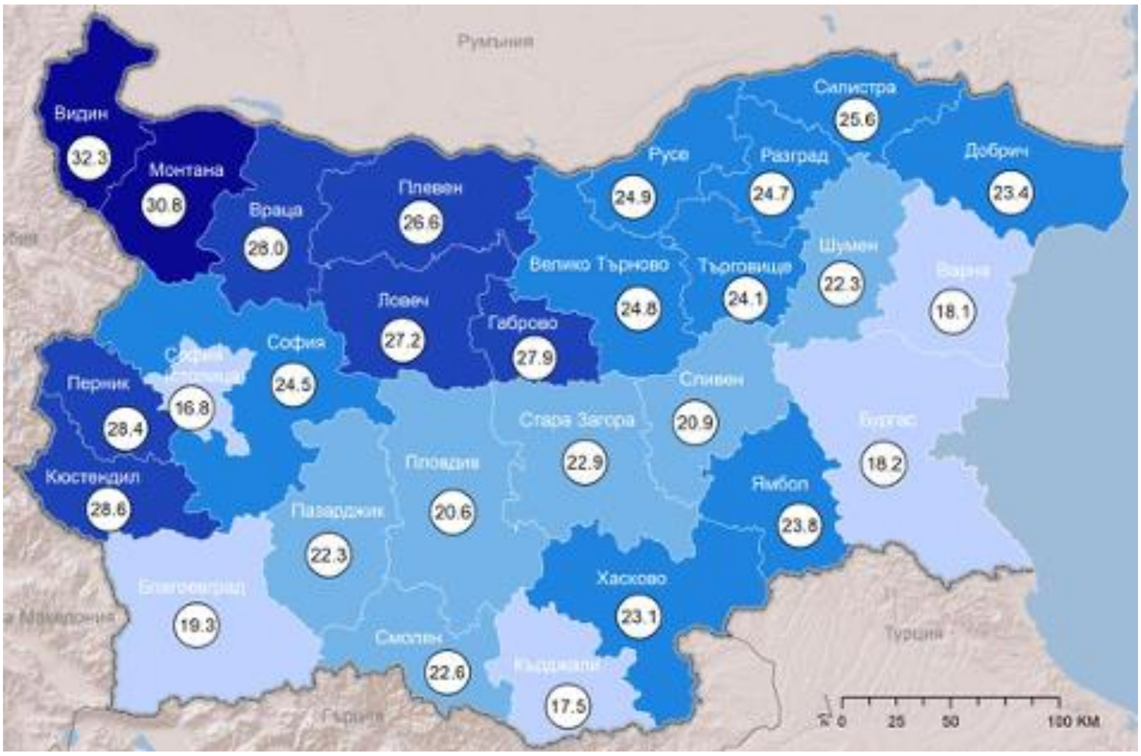

Figure 3. Total mortality rate in Bulgaria by region, 2021

Source:

https://nsi.bg/sites/default/files/files/pressreleases/Population2021_6IY8TD4.pdf. Visited on 6.07.2022

Life expectancy

The expected average life expectancy for the entire population of the country, calculated for the period 2019 – 2021, was 73.6 years, and compared to the previous period (2018 – 2020), it decreased by 1 year. The average life expectancy for men was 70.1 years, while for women it was 7.3 years higher – 77.4 years (fig. 4). Compared to 2011, in 2021 the average length of life for men decreased by 0.3 years, while for women it remained unchanged.

(https://www.nsi.bg/sites/default/files/files/pressreleases/LifeExpectancy_2019-2021_L5X5HWJ.pdf)

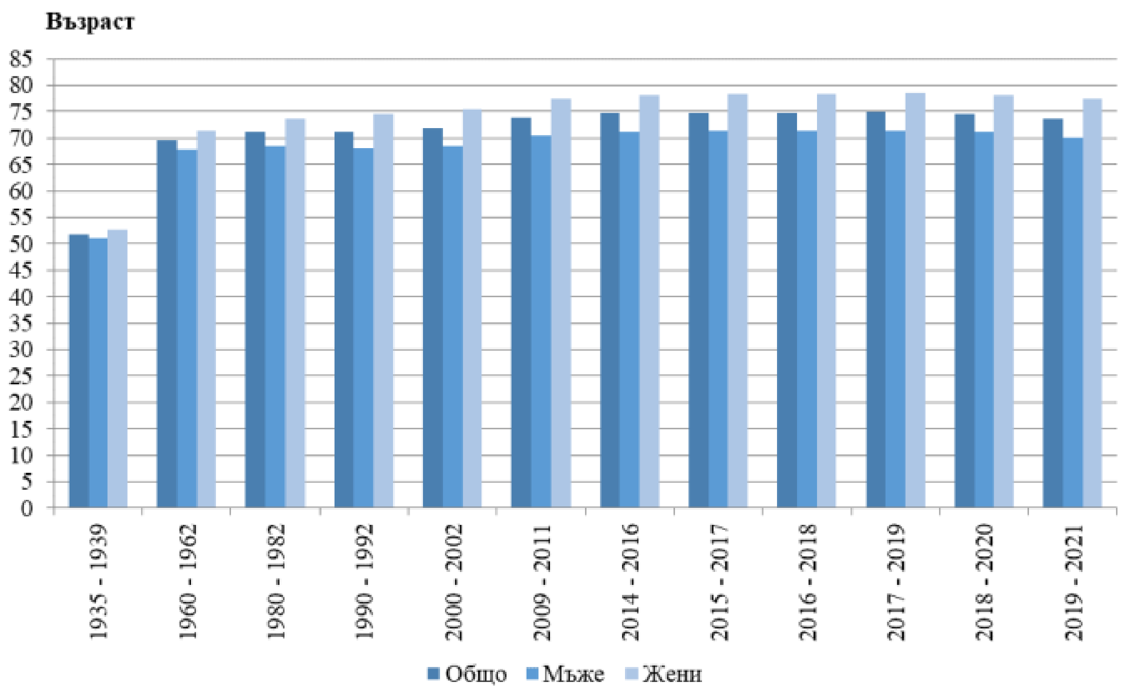

Figure 4. Expected average life expectancy by sex and periods.

Source:

https://www.nsi.bg/sites/default/files/files/pressreleases/LifeExpectancy_2019-2021_L5X5HWJ.pdf

Conclusions

1. The course of the demographic processes, in particular of the mortality rate and life expectancy, has its internal regularities which are determined by the demographic transition. It is also affected by phenomena which are difficult to predict such as the COVID-19 pandemic.

2. There are reasons to believe that the inconsistent decisions and actions of the Bulgarian governments in the management of the pandemic situation have directly contributed to the increase in the mortality rate in the country, and as a result have also contributed to the decrease in the life expectancy.

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TOOLS TO HELP ENERGY EFFICIENCY IN PUBLIC BUILDINGS

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Abstract: Energy efficiency is the goal of every investor, owner or user of buildings amid the trend of increasing energy prices worldwide. Often this understandable drive goes hand in hand with quite unrealistic expectations.

Achieving energy sustainability and efficiency in public buildings usually has a much greater social and economic impact.

Before we take the first important step towards energy efficiency, we need to know a few things: where are we on the energy efficiency scale, can we improve it and by what means? How much will it cost and how long will the investment pay for itself?

The PRO-ENERGY project aims at promoting Energy Efficiency in public buildings in the Balkan Mediterranean territory and to create a practical framework of modelling and implementing energy investments interventions, through specific ICT monitoring and control systems, as well as through energy performance contracting. The current "Joint cost-benefit analysis modeller" aims at supporting decision-making for retrofits, renovations, etc., which lead to increased energy efficiency in public buildings. It was tasted for piloting public building of UARD (University of Agribusiness and Rural Development), Plovdiv, Bulgaria.

Keywords: energy efficiency, public buildings, sustainability.

The context

In the Energy Union, five dimensions are closely intertwined to contribute to achieving greater energy security, sustainability and competitiveness:

(1) energy security, solidarity and trust;

(2) an integrated European energy market;

(3) energy efficiency;

(4) decarbonization of the economy;

(5) research, innovation and competitiveness.

European goals have been developed, which are also reflected at the national level.

Energy efficiency is the goal of every investor, owner or user of buildings amid the trend of increasing energy prices worldwide. Often this understandable drive goes hand in hand with quite unrealistic expectations.

Before we take the first important step towards energy efficiency, we need to know a few things: where are we on the energy efficiency scale, can we improve it and by what means? How much will it cost and how long will the investment pay for itself?

What does energy efficiency depend on?

Let's not forget that the energy efficiency of buildings is a relative concept. The expression itself shows a ratio between consumed energy, the costs incurred for it and the benefits received in return. The latter are individual to each business and building and are the most difficult thing to measure. But the ratio between the first two, other things being equal, can give some idea of where our existing or planned building is on the scale of energy efficiency.

In terms of technology, here are the categories that contribute most significantly to energy consumption and relate to the energy efficiency of the building.

It is evident that the largest and most expensive of these also have the greatest potential for cost savings. However, they are also the ones that are the most static and, accordingly, the most difficult subject to significant renovation and modernization in the direction of energy efficiency. Therefore, with a building already designed or built, the only system that can be integrated and change the energy picture remains the building automation system. If the existing building technical installations allow connection to a building automation system, this can seriously change the game in a positive direction in terms of efficiency.

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The common challenge of PRO-ENERGY is to improve energy efficiency of public buildings (municipal/provincial/regional buildings, schools, universities, health centers, hospitals, museums, sports facilities etc.). This is a common problem faced by the territories participating in the project characterized by old facilities, outdated/degraded building façades, materials and equipment (insulation, electrical appliances, cooling/heating systems etc.), lack of skilled civil servants, etc. all leading to high energy consumption and CO_2 emissions

Target groups/stakeholders include local/national/regional public authorities, sector agencies and regulators, infrastructure and service providers, interest groups and NGOs, higher education and research institutes, training centers and schools, business and enterprise support organizations in the project areas. They were include in the formulation of the Joint Strategy and Action Plan through public consultation and other formal/informal meetings and events.

Main activities:

- Existing situation analysis - energy efficiency
- Good practices selection and benchmarking
- Joint strategy and action plan for increasing energy efficiency through behavioural change
- Joint criteria for selecting pilot public buildings
- Energy audits in pilot public buildings
- Design and implementation of activities on Capacity Building for Energy Managers
- Installation of smart sensors in pilot public buildings
- Design and development of a joint pilot platform for monitoring and improving energy efficiency in public buildings
- Designing and implementing a joint benefit analysis mode

- Three types of pilot actions are foreseen:
- 1) Design & development of an open-source Joint ICT Platform,
- 2) The design & development of the Joint Cost-Benefit Analysis Modeller &
- 3) The joint preparation of Energy Performance Contracts.

Joint Cost-Benefit Analysis Modeller

Joint cost-benefit analysis modeller aims at supporting decision-making for retrofits, renovations, etc., which lead to increased energy efficiency in public buildings. The tool can be used in two main cases: assessment of the performance of an already existing and operating building and virtual assessment of the energy efficiency of a future building that is currently being designed, built or renovated. In both cases, the generated data can serve not only as a reference and assessment of the current state of the building, but also as a basis for making decisions about future improvements. Calculations are made on the basis of entered output data for available building systems such as heating, cooling, ventilation, lighting, etc. The assessment begins with the introduction of basic data about the user and the building, as well as a choice of currency in which the potential future investments and their benefits will be measured. The next steps require entering detailed data about the available systems in the building and the levels of automation in them. After entering all the information, the tool can generate a report. The tool has a specialized financial module that allows choosing between different energy sources and entering price information. In this way, if the value of the planned energy efficiency investment and the annual consumption of the building are entered, we will get the time for its repayment and the saved costs in 10 years. This assessment can answer the question: should we invest in a building automation system or what will we lose if we don't. Of course, this estimate is approximate, especially in financial terms, but it can give a good indicative idea of the potential for increasing energy efficiency.

The cost-benefit analysis modeller (CBA) is composed of the following key features (sheets):

• Cover: Title page, including disclaimer. It also includes four (4) buttons for navigation to the additional model sheets.

• Operating Guide: The present sheet provides a manual on using the CBA tool.

• Dashboard: A simplified and snapshot presentation of the Key Inputs inserted, the CBA Key results and the Project's Financial Structure. Furthermore, the "Dashboard" sheet presents the main Operating and

Investment Flows during both construction and operation periods, concluding to the Free Cash Flow per period examined.

- Inputs: The “Inputs” sheet has mainly to do with data entry. The user has to insert its estimations in this sheet.

- CBA analytics: It is a financials output sheet, thus presenting both the occurring financial KPIs of the analysis conducted.

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Joint CBA Modeller Inputs

The input data:

• Annual Energy Cost Savings: The estimated annual energy savings to be triggered by the project's accomplishment, in currency terms.

• Total Capital Expenditure: The amount of the total capital expenditures for project's construction, in currency terms

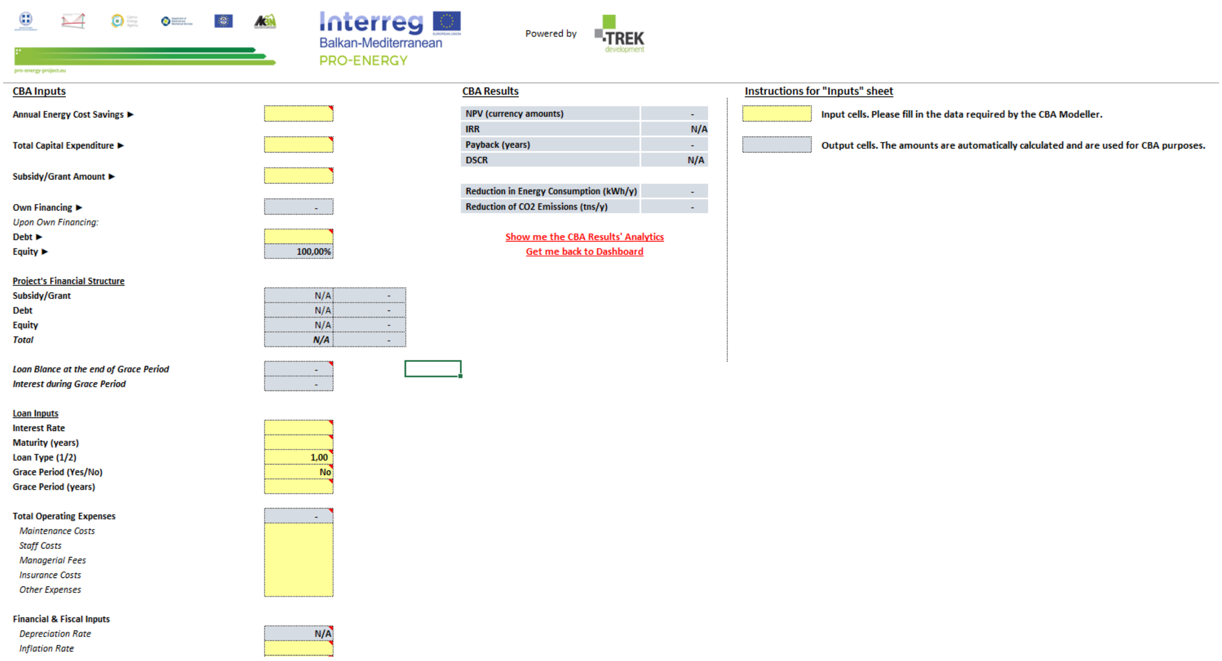
• Subsidy/Grant Amount: The grant to be received for financing the project's construction.

• Debt: The debt % to be used to cover own financing.

• Loan inputs: Interest rate (the loan's interest rate), Maturity years (the loan's maturity period), Loan type, Grace period (if applicable), Total Operating Expenses (automatically calculated the sum of total operating expenses).

• Financial and Fiscal inputs: Inflation rate (according to the national CPI index), Energy Inflation rate, Tax rate, Discount factor.

• Environmental Inputs: Reduction in Electricity Consumption (kWh/y), Reduction in Diesel Consumption (kWh/y), Operations Period (the project's estimated operational period in years).



CBA analysis

The section provides a financial output sheet, thus presenting both the occurring financial KPIs of the analysis conducted, as well as Investor's Profit & Loss statement, Investor's Cash Flow statement, Payback Analysis and Debt Service Cover Ratio Analysis. The very analysis takes place under the Discounted Cash Flows investment valuation framework.

CBA Inputs	UARD Building
Annual Energy Cost Savings (euro)	626
Total Capital Expenditure (euro)	5113
Subsidy/Grant Amount (euro)	-
Debt (%)	-
Interest Rate (%)	0.3%
Maturity (years)	-
Grace Period (years)	-
Maintenance Costs (euro)	0
Staff Costs (euro)	0
Managerial Costs (euro)	0
Insurance Costs (euro)	0
Other Expenses (euro)	-
Inflation Rate (%)	0.5%
Energy Inflation Rate (%)	-
Tax Rate (%)	-

Discount Factor (%)	0
Operations Period (years)	19

CBA Analytics UARD

Proposals	**UARD Building**
NPV: Net Present Value (€)	6781
IRR: Internal Rate of Return (%)	10.36
Payback Period (years)	9
DSCR (average)	N/A

NPV = F / [(1 + i)^n]

Where,

PV = Present Value

F = Future payment (cash flow)

i = Discount rate (or interest rate)

n = the number of periods in the future the cash flow is

NPV is calculated by taking the present value of all cash flows over the life of a project. Then, the present value of cash flows is subtracted from the investment's initial investment. If the difference is positive (greater than 0), the project will be profitable.

The internal rate of return (IRR) is a metric used in financial analysis to estimate the profitability of potential investments. IRR is a discount rate that makes the net present value (NPV) of all cash flows equal to zero in a discounted cash flow analysis.

$$NPV = \sum_{n=0}^{N} \frac{C_n}{(1+r)^n} = 0$$

Conclusions and recommendations

During the survey and analysis of the Energy agency of the pilot building in Bulgaria, two modelers were used - economic and technical. The modeler developed within the project is one and combines economic and technical indicators in one. After the comparison, we found that the results are similar. We have a recommendation to make the interface of the modeler more attractive for end users, as well as to enable graphical representations of the analyzes and the possibility of automatic generation of report forms.

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https://www.invest4excellence.eu/

INVEST FOR EXCELLENCE IN REGIONAL SUSTAINABILITY (INVEST4EXCELLENCE)

INVEST4EXCELLENCE aims at developing an integrated and long-term joint strategy on research and innovation in line with the education strategies from the INVEST EU University Alliance.

The thematic focus of the INVEST Alliance is in Sustainable development as one of the most important global challenges.

INVEST4EXCELLENCE will create the background for the development and implementation of research and innovation ideas through model development for institutional transformation at research and innovation dimension.

1. Institutional transformation at Research and Innovation Dimension

The project will deliver a model for institutional transformation.

Such model will serve as a long-term tool for integrated, systematic, structural and sustainable impact at the various levels and areas of activities in partner universities based on their strengths and potentials for synergies.

The project will provide strategies for internationalization, research and innovation and handbook of best practices in institutional transformation for policy makers.

Their creation will be divided in a process of three steps – analysis, planning and management, with the aim to create long-term plans and vision by understanding the situation, analysing the chances, setting the goals and rules to use resources.

Strategic planning process will determine the sequence of decisions that have to put into practice in the right order.

2. European Innovation Ecosystem

A set of measures and documents aimed to connect Living Labs of INVEST with European Innovation Ecosystem will be delivered, such as position papers, handbooks or proofs of concept/practice.

The project will facilitate the development of a common approach and exchange knowledge across languages and borders, disciplines and sectors, of researchers, students, regional stakeholders, entrepreneurs and community organizations.

3. Capacity Building

To strengthen the human capital enabling brain circulation and gender balance by developing research competences and skills of the INVEST RDI staff and PhD students represents the main aim of the capacity building.

The project will identify key competences and skills needed to be shared in the consortium, develop training tools to mainstream the open science practices and provide trainings for various target groups including non-academic (stakeholders).

4. Dissemination

The project will design and implement a Dissemination and Awareness Plan focused on the research and development activities within the INVEST ecosystem and the promotion of the proposed organizational and pedagogical models.

It will provide the overall design and use of strategic communication tools that will deliver the deployment of a large-scale promotion and dissemination campaigns ensuring a widespread of INVEST research and development results and its impact.

Objectives

Invest for Excellence in Regional Sustainability – INVEST4EXCELLENCE aims at developing an integrated and long-term joint strategy on research and innovation in line with the education strategies from the INVEST EU University Alliance.

INVEST4EXCELLENCE will create the background for the development and implementation of research and innovation ideas through developing the common research and innovation agenda, exchanging best practices and sharing common research infrastructure and resources.

This will lead to reinforcement of the human resources in the research and innovation of the INVEST Alliance and will contribute to achieving the knowledge-based civic society, engaged in creation and benefitting of the high quality research and innovation outputs.

INVEST4EXCELLENCE will influence the interactions between institutional adaptation and the transformation of research and innovation systems by analysing change and adjustment within the whole alliance.

INVEST4EXCELLENCE brings together a large European educational community that will actively cooperate and maximize the learning impact of the project.

The project comes with several key enabling educational and digital technologies that can optimize all research and innovation aspects promoted by the INVEST Alliance.

INVEST4EXCELLENCE is focused on achievement of its objectives that are designed to be SMART (Specific, Measurable, Achievable, Realistic and Timely), what is ensured by structured, complementary and interconnected tasks of the project work plan. The specific aims are the following:

Specific aim 1: To develop and implement the INVEST4EXCELLENCE model for institutional transformation at research and innovation dimension

Specific aim 2: To develop INVEST4EXCELLENCE European Innovation Ecosystem for Academia-Business & Society

Specific aim 3: To develop INVEST4EXCELLENCE Capacity Building Tools

Specific aim 4: To implement and promote the I-EDUC8EU tool

Specific aim 5: To set up well-functioning group of stakeholders

WP 1 Management and Coordination

Main objective: To establish a solid management structure in order to ensure the achievement of project objectives and overall successful implementation of all project activities.

Specific objectives:

- to ensure the achievement of project objectives while fulfilling all expertise, administrative, financial, legal and technical aspects;
- to implement suitable management and coordination instruments;
- to provide high-quality reporting towards European Commission (EC);
- to execute project activities while ensuring mutual understanding and proportional involvement of the whole consortium;
- to deliver high-quality project outcomes and deliverables; to fulfil properly all tasks and achieve WPs´ objectives.

WP2 INVEST4EXCELLENCE Model for Institutional Transformation at Research and Innovation Dimension

Main objective: To develop and implement the INVEST4EXCELLENCE Model for institutional transformation at research and innovation dimension as a long-term tool for integrated, systematic, structural and sustainable impact at the various levels and areas of activities in INVEST universities based on their strengths and potentials for synergies.

Specific objectives:

- identification of resources, challenges, barriers, needs, ways and good practices of cooperation in research and innovation;
- development of INVEST4EXCELLENCE joint vision and documents setting the bases for the institutional transformation in research and innovation;
- establishment of a network between “European universities”, presenting best practices in the institutional transformations in research and innovation, working on recommendations to policy making;
- setting the bases for INVEST4EXCELLENCE Open Science practices, incl. digitalization of resources.

WP3 INVEST4EXCELLENCE European Innovation Ecosystem for Academia-Business & Society

Main objective: To strengthen a European partnership on Regional Sustainable Development, the regional Living Labs of INVEST connect into a European Innovation Ecosystem, by gaining insight on diverse and shared ambitions, experiences and practices. The WP facilitates the development of a common approach and exchange knowledge across languages and borders, disciplines and sectors, of researchers, students, regional stakeholders, entrepreneurs and community organizations.

Specific objectives:

- Develop a common approach for the regionally established INVEST Living Labs, based on transdisciplinary methods for connecting applied science, education, governance, business and citizens in learning and innovation.
- Identify common aspects and criteria for the development and performance of transition pathways in the regional Living Labs.

- Create synergy on European level between the academic research practices of diverse universities, and regional Living Labs practices and experiences.
- Develop innovative and relevant applied research methods for European higher education inter-university 'campuses' to facilitate European Innovation Ecosystems.

WP4 INVEST4EXCELLENCE Capacity Building Tools

Main objective: To strengthen the human capital enabling brain circulation and gender balance by developing research competences and skills of the INVEST RDI staff and PhD students.

Specific objectives:

- Identification and description of the key competences and skills that are needed to share research resources within INVEST consortium;
- Development of INVEST4EXCELLENCE Open Science training tool and materials that enable mainstreaming the open science practises within and beyond the consortium;
- Development of INVEST4EXCELLENCE stakeholder tool for systematic involvement of the stakeholders into joint research and innovation;
- Development of INVEST4EXCELLENCE training tool providing online and on-site training camps for re- and up-skilling of the RDI staff, PhD students and stakeholders.

WP5 Dissemination, Awareness Building & Engagement for INVEST R&D

Main objective: To maximise the INVEST outcomes of research and development by disseminating and exploiting all relative results. This will include the overall design and use of strategic communication tools that will deliver the deployment of a large-scale promotion and dissemination campaigns ensuring a widespread of INVEST research and development results and its impact. Maintaining a realistic exploitation strategy focused on the research achievements of the initiative will promote the potential utilization of INVEST as the de-facto paradigm for multilingual research organization on regional sustainability.

Specific Objectives:

- Co-ordinate and promote dissemination and commercial exploitation of the scientific results obtained in the different WPs of the project
- Develop a methodological approach to support evaluation and validation proposed and communicate the project vision on extensible network service provisioning by focusing key messages and project research results to various stakeholders

- Support consortium members /organise stakeholder networking, to sustain awareness and engagement in relation to research activities
- Promote the INVEST pedagogical and organizational models via international conferences and journal special issues
- Create a communication and disseminations strategy with measurable Key Performance Indicators (KPIs)

Ambition

INVEST4EXCELLENCE has the ambition to pave the way for the exploitation of research and innovation in relation to advanced methodologies for education and academic advising systems supported by artificial intelligence, augmented reality, and revolutionary software engineering techniques. In this context INVEST4EXCELLENCE will:

Develop the first international education academic tool (called I-EDUC8EU):

I-EDUC8EU will be capable of constructing, organizing and predicting higher education student performance dynamics and be self-configured and applied in any university alliance that promotes the European University. Furthermore the proposed automation will diminish human advisor subjectivity and partiality in taking final educational decisions.

Stimulate higher education by applying innovative virtual academic advising models:

Focusing on modelling virtual academic advisors, the proposed project will provide an advising hub that will increase student educational retention, success and graduation rate. This will be achieved by reinforcing co-creation especially with the non-academic sectors while at the same time innovative methodologies will digitize all the research support processes.

Represent a breakthrough framework in the area regional ecological sustainability related to the European urban and rural development:

More specifically, the proposed project will promote a multitude of PhD programs focusing on (a) the deterioration of the European ecological environment and the threat on public safety because of the economic development, (b) assessment methodologies and introduction of carbon emission indicators from a spatiotemporal regional development perspective and (c) the development, quality and impact of environmental sustainability education in Europe as an innovative thematic research of education.

Be based on some of the most cutting-edge technology in the area of education, artificial intelligence and human-computer interaction:

In particular, the project aims to improve the role, performance and prediction capabilities of present organizational higher education systems used in the domain of personalized higher education assistance.

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The interconnection of Europe and the need for an increasingly intensive transfer of knowledge means that the further development of higher education is not possible without the development of cooperation at all levels.

Contemporary Europe is characterized by a strong knowledge community consisting of well-cooperating universities and their links with regional communities, businesses and society as such.

Increasing internationalization of higher education is therefore crucial for development of European society.

To be continuous and successful, further internationalization of higher education has to involve all its aspects and components, such as student and staff mobility, transformation of curricula and study programmes, novel forms of learning, cooperation in excellent research, creation of modern policies, developing quadruple-helix collaborations, etc.

INVEST Alliance represents the integrated platform of European universities for international, cross-disciplinary and multilingual studies and research and development activities, addressing global challenges for sustainable development.

It provides a unique platform (both in physical and virtual aspects) for enhancing the interactions and relationships between higher education institutions and stakeholders and encouraging cultural and social dialogues and understanding for fostering the broader civic engagement and entrepreneurial mind-set.

Source of the texts: https://www.invest4excellence.eu/

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SUSTAINABLE DEVELOPMENT AND COMPETITIVENESS OF REGIONS

Collective monograph

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CLIMATE CHANGE AND ITS IMPACTS ON SUSTAINABLE REGIONAL DEVELOPMENT

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