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GIS support of forming spatial decisions on land use

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Abstract: The possibilities of designing complex geoinformation model of land use that can provide systematization and accumulation of spatial and attributive data have been shown in the research. As a result of the research, models were developed, which allow make spatial and temporal analysis for solve the problem of optimizing the rational use and protection of land.

KEYWORDS: GEOINFORMATION MODEL, LAND MANAGEMENT, RATIONAL USE OF LAND, PROTECTION OF LAND

1. Introduction

In the modern world, the important task is to create efficient land use and, at the same time, a harmonious combination of land use with the location of infrastructural asset, production facilities and housing. Establishing the location of these objects requires processing of spatial and attributive data about land plots, as well as time changes. Therefore, to provide adequate information support of creating spatial decisions on land use is necessary to develop an information structure that can provide construction of spatial solutions based on spatial-temporal analysis.

An important role in the development of information support for forming spatial decisions on land use is played by geographic information systems that are a powerful tool for collecting and modeling data, realization geospatial analysis and, also, for visualization. At the same time, geoinformation modeling by means of the created model describes the basic principles of the organization and integration of systems for forecasting, management and making decisions.

2. Prerequisites and means for solving the problem

2.1. Analysis of recent researches and publications.

The development of a problem of creating decision support system has been covered in papers [1-4]. The research [1] presented applying a GIS assisted community participatory approach to detect land use and land cover changes. In the article [2] the features of the selection of the area for placement of apiaries are analyzed, which provide a sufficient forage base and productivity of apiaries and safe for the life of bees. The paper [3] presents method integrates a different land-use and landscape planning approach in order to support decision maker actions for towards a new hybrid landscape. The article [4] describes research on the establishment of GIS-based Decision Support Concept to planning of land acquisition for realization of urban public projects that can be useful to project managers.

The article [5] analyzed problems in conducting land management in agricultural enterprises

Many developed techniques take into account only one type of land use. However, the problem of structuring information for making land management project for forming spatial decisions on land use was not covered in the works listed.

2.2. Statement of problem.

The objective of the research is to substantiate the geoinformation model for increasing the efficiency of forming spatial decisions on land use.

To achieve the objective of the research, the following tasks were used: (i) to determine the general structure of geoinformation model for forming spatial decisions on land use; (ii) to present an implementation of make analysis for solve the problem of forming spatial decisions on land use; (iii) to demonstrate physical implementation of the test version of geoinformation model of land use of the studied area.

2.3. Research methodology.

The geoinformation modeling approach provides interaction of attributive with spatial data from the geodatabases for study the components of land use and objects connected with them that based on ordering and transformation of information about these objects. The models were developed using a unified modelling language (UML). Geoinformation modeling includes use of spatial analysis based on tools such as overlay, buffers and classification.

The part of Obukhiv Rayon of Kyiv Oblast was chosen as a modeling object.

3. Solution of examined problem

When studying the issues of forming spatial decisions on land use the simulation modeling approach was used. At the first stage of the research, this approach allows to identify the most significant features of the system and its interaction with the external and internal features.

For the support of the formation of spatial solutions for land use there is a need collect and analyze many different information such as soils, different types of coverage, norms and rules, infrastructure facilities, type of land use, relief, human economic activities, etc. All these elements are input data for making analyzes (fig. 1).

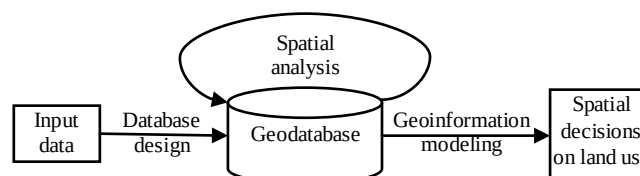


Fig. 1. The process of making spatial decisions on land use.

The main types of tasks for planning land use include: study of the territory, analysis of the requirements for the location of the object (positive and negative), finding the optimal location of the new object. The study of the territory involves the research of all objects located in the study area: settlements, types of coverage, infrastructure, types of soils and their quality, etc. Requirements analysis involves determining the recommended parameters for the location of the object and the determining of harmful factors for the object (which are incompatible for placement). The optimal location of the object allows achieving profitability with the least damage to the environment.

The UML Data Flow Diagram is used to represent the data accumulation process, which shows the data processing stages processes and the main repositories (Fig. 2).

The Land Cadaster, landowners and land users are entities which gives of obtaining data: area of land parcel, type of land use, purpose of land, type of economic activity, etc. Other external entities are specialists, which focused on process conducting surveys of the land condition (soil conditions, humus content, pollution level, area protective forests, etc). All data is accumulated into the geodatabase. From geodatabase data are flowed to Spatial

analysis modules and then they flow to data accumulation and to the geodatabase.

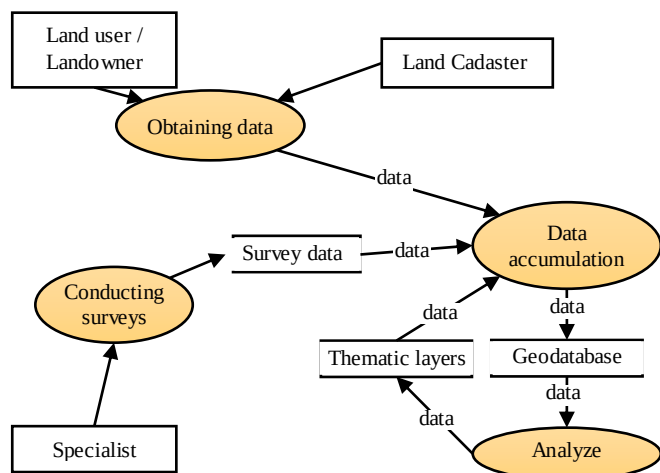


Fig. 2. The data accumulation process of forming spatial decisions on land use.

The Land Cadaster, landowners and land users are entities which gives of obtaining data: area of land parcel, type of land use, purpose of land, type of economic activity, etc. Other external entities are specialists, which focused on process conducting surveys of the land condition (soil conditions, humus content, pollution level, area protective forests, etc). All data is accumulated into the geodatabase. From geodatabase data are flowed to Spatial analysis modules and then they flow to data accumulation and to the geodatabase.

The functional model of the algorithm for geoinformation modeling for forming spatial decisions on land use is shown in Fig. 3.

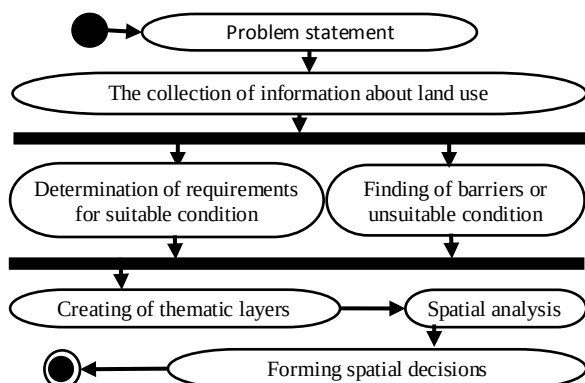


Fig. 3. Model of the implementation of steps for solving the problem.

In the first stage of the functional model should take into type the direction of land use and its economic activity. During next stage has been collected of information on the land resources and soils within the studied territory, the input data and their integration are researched.

The next stage of the solution task are two parallel processes: determination of requirements for suitable condition and finding of barriers or unsuitable condition. The determination of requirements for suitable condition is influenced many factors for instance: area, relief, aspect and slope, etc. The finding of barriers or unsuitable condition is influenced many factors, such as: soil type, proximity to other objects, etc. Thus, for different objects of land use it is necessary to consider a different set of factors, which collected in the geodatabase.

In the following stage has been created of thematic layers of the study area. During next stage is spatial analysis that allows to find optimum land parcels for all criteria of requirements.

The last stage is forming spatial decisions based on spatial data for making land use or management decisions, that supported maps results of analysis.

In order to make a decision, it is necessary to accumulate and process heterogeneous data, which collected in the geodatabase.

Developing the structure of the geodatabase was performed in several stages. At the conceptual modeling stage it was defined the main classes, relation and attributes of the geodatabase. The main classes are: Land Parcel, Land Use, Land Type, Agrosoil, Object, Restrictions, Encumbrances Land Rights, Slopes, Aspect, Types Zones, Wind Direction, Infrastructural Asset, Production Facilities, Housing, etc.

At the logical modeling stage (Fig. 4), it was defined relation cardinality, keys for classes and data types for attributes of the geodatabase.

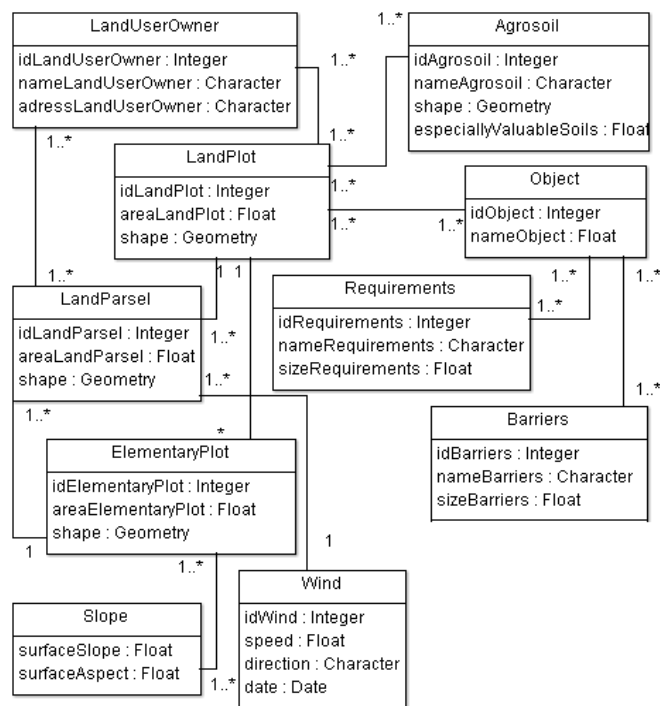


Fig. 4. The fragment of logical model of geodatabase.

The next stage is physical modeling that was realizing in ArcGIS 10.4. The test version was realized on the use of attribute and spatial data of the studied area (fig 5).

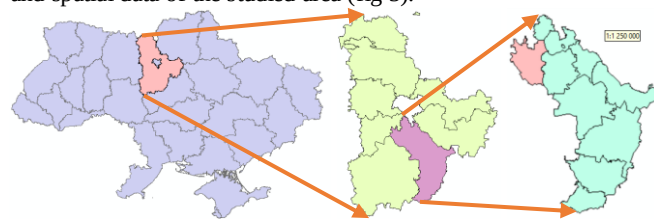


Fig. 5. The studied area

Restrictions and encumbrances on land rights must be analyzed before placing a new facility, as well as, analyzed requirements for suitable condition and barriers/unsuitable condition.

When forming a spatial decision on land use for the location of farmsteads, livestock farms or infrastructure facilities, it is necessary to take into account the requirements for the location. For each object the set of requirements will be different. Thus, for livestock farms, the requirements include: type of land, distance to housing, no sanitary protection zone and protection zone of historical and cultural monuments, no pollution. At the same time, there are criteria that affect the increase or decrease in the distance to housing [6]. All this data was collected in the geodatabase and used for spatial analysis.

The thematic layers were created based on the results of the analysis (fig 6-8).

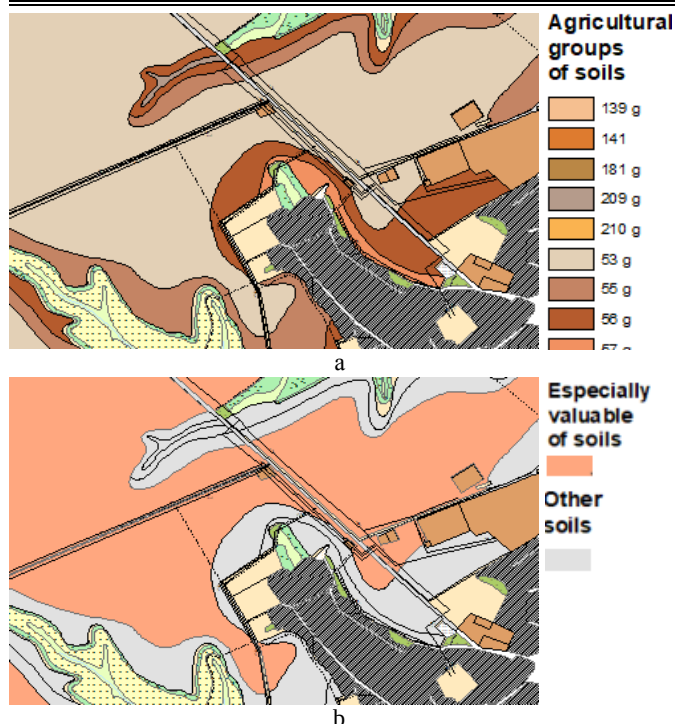


Fig. 6. The fragment of thematic layers of the study area soils: a – agricultural groups of soils; b – especially valuable soils.



Fig. 7. The fragment of thematic layers of the study area – different protection zone around objects.

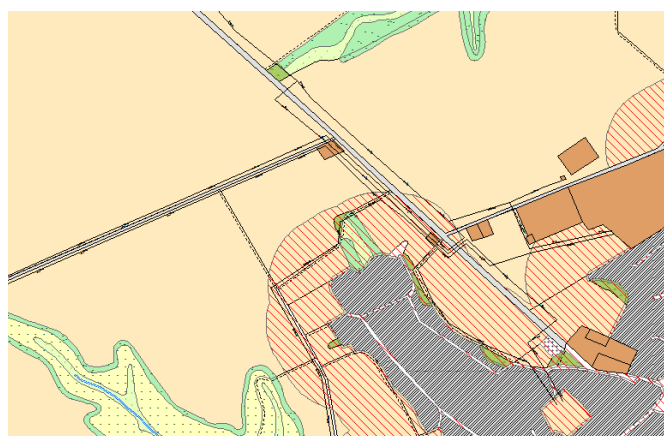


Fig. 8. The fragment of thematic layers of the study area – unsuitable land for animal farm around settlements.

A cartographic material was formed to making the support of spatial decision on land use.

4. Result and discussion

When developing the designing complex geoinformation model of land use the main types of tasks necessary for increasing the efficiency of forming spatial decisions on land use were identified. On this basis functional models as the UML Data Flow Diagram was designed that shows the movement of data values from their sources to their repository and as well as the UML activity diagram that show modeling the sequential workflow of activity.

The conceptual, logical models and physical implementation of the geodatabase of forming spatial decisions on land use were developed. The geodatabase includes data on land parcels, land type, soil type, especially valuable soils, establishment of restrictions, encumbrances on land rights, slopes, aspect, types of protection zones, wind direction, infrastructural asset, production facilities and housing.

The implementation of complex geoinformation modeling approaches to forming spatial decisions on land use gives one or few possible places for location needed object based on set of thematic maps. Thematic layers showed the factors of influence for planning objects of land use. These layers provide information due to a coding system that does better the observation of data. Spatial analysis allows combine thematic layers and find one or few pieces of land for planning objects location.

GIS allow forming spatial decisions based on combining spatial and attribute data for making land use or management decisions.

5. Conclusion.

The study reflects an approach of forming spatial decisions on land use. The data set that is necessary for planning land management measures for the formation of spatial decisions on land use was determined.

The structure of the geodatabase of forming spatial decisions on land use was developed. It is based on the conceptual and logical models and their physical implementation in the test version in the study area. A set of thematic layers has been created that have to visually present the influence of some factors on land use decisions.

The results of the study allow to use more factors when planning the development of land use in the region.

The prospect of further research is to develop algorithms to automate the support of spatial decision on land use.

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Advantages and vision for the bulgarian economy in rural areas after 2021

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Abstract: *The purpose of this study is to indicate the competitive side of the Bulgarian rural areas and municipalities until 2021 and in the long run and in parallel to derive their real competitive advantages within the EU after the pandemic of COVID19.*

KEYWORDS: AGRICULTURE, OF THE RURAL ACTION PLAN, RURAL AREAS, SUSTAINABLE RURAL AREAS, PROSPEROUS RURAL AREAS, COVID-19 PANDEMIC

Scientific studies of the perspectives for the development of rural areas in Bulgaria after overcoming the pandemic of COVID19 are important for the national economy. The results will allow the competent institutions in the field of agricultural policy for effective and rational decisions, while developing a scientifically sound strategy and establishing the sustainable agricultural advantages of the Bulgarian economy after 2021. This would become an initial stage for the preparation of a unified national doctrine for the development of agriculture in rural areas and the country as a whole.

According to the results of a Eurobarometer¹ survey conducted in April 2021 to assess the priorities in the long-term outlook for rural areas, it is established that:

- 79% of EU citizens support the idea of the EU taking rural areas into account in public spending decisions;
- 65% of all EU citizens believe that the local area or province should be able to decide how to spend EU investment in rural areas;
- 44% point out transportation infrastructure and transport interchanges as a basic need of rural areas.

The agricultural sector has been declining more and more in recent years as part of EU's gross domestic product (GDP), but remains a major export source and an important generator of employment in the Union. It also remains one of the EU sectors with the most significant level of regulation and financial support. Since the establishment of the European Economic Community (EEC) to support and regulate the agricultural sector of the member states, a single policy has been developed, including a system of measures, mechanisms and tools for influencing agricultural production, namely the CAP.

A different segment of the EU agricultural legislation, which has recently become particularly relevant, is related to consumer protection and food safety. Structurally, this part of the agricultural legislation also includes veterinary and phytosanitary issues².

The institutional provision of the implementation of the CAP in Bulgaria is no less challenging. This requires the establishment of a Payment and Intervention agency, an integrated system of administration and control, the creation of a land cadaster, the establishment of a body for registration and control of

geographical indications and foods with traditional characteristics, as well as others, some of which are currently established and functioning.

The second most important thing, is the challenge that poses even bigger problems and it is to show what will be the results of the implementation of the CAP for Bulgarian agriculture - from optimistic to denying the benefits of implementing this type of policy for Bulgarian agriculture. Carrying out economic research on the advantages of Bulgarian agribusiness in the period immediately after our acceptance in the EU will allow to establish as reliably as possible the potential and real results of the implementation of CAP measures after the COVID19 pandemic. Establishing the results of the implementation of the CAP measures to Bulgarian agriculture and rural areas requires both a qualitative assessment of the national conditions under which this policy will be applied and a quantitative measurement of the potential results.

The most significant qualitative factors that influence the possibilities for implementation of the CAP and the potential results of its implementation are:

- the level and dynamics of development of the agricultural sector and rural areas in the country;
- the influence of the existing production structures;
- the applied national agricultural policy, based on the group of national laws in this area: law for support of agricultural producers; law on rent in agriculture; food chain management law; law on property, land relations and protection of agricultural land.

The purpose of this study is to indicate the competitive side of the Bulgarian rural areas and municipalities until 2021 and in the long run and in parallel to derive their real competitive advantages within the EU after the pandemic of COVID19.

The objective of the study covers the competitive side of the Bulgarian rural areas and municipalities until 2021 and in the long run, and the objectives of the study address the following issues:

1. What will be the main **sectoral proportions** after overcoming the economic crisis of the COVID 19 pandemic in the EU and worldwide.

What are the local opportunities for increasing the **competitiveness** of farms by sectors, as prerequisites for entering and obtaining market shares in new markets (including agricultural, regional and global) for the period 2 021 – 2 027.

The new common agricultural policy 2 023 - 2 027

2. Identifying some of the perspective directions for development, the needs and the national priorities of the Bulgarian agribusiness.

On one hand, it is necessary to find an answer to the question whether Bulgarian agricultural exports are **competitive** on the world and European post-crisis market and if not - what are the reasons and how can its competitiveness be improved?

On 0.06.2021, the European Commission presented a long-term vision for the EU's rural areas, outlining the challenges and concerns they face, and at the same time highlighting some of the most promising opportunities facing these regions. Based on a forecast assessment and extensive consultations with citizens and other participants from rural areas with today's vision are offered:

- **Pact for the rural areas;**
- **An action plan for rural areas** that aims to make our rural areas stronger, more connected, sustainable and prosperous.

¹ Since 1973, the European institutions have commissioned regular opinion polls, from the so-called Eurobarometer, in all EU Member States. In 2007, the European Parliament launched its own series of Eurobarometer surveys. These surveys cover a wide range of issues, focusing on citizens' perceptions and expectations of EU action and on the main challenges it is facing.

² The main laws in the agricultural legislation of Bulgaria during the past Program period 2014 -2020 are: Amendments to the Law on Implementation of the Common Organization of the Markets of Agricultural Products of the EU, Law on Food, Law on Excess Stocks of Agricultural and Sugar Products, Amendments to the Law on animal husbandry, Law on fodder, Law on sowing and planting material, Law on fisheries and aquaculture, Amendments to the Law on Veterinary Medicine, Law on Oil Rose, Law on Genetically Modified Organisms, Amendments to the Law on Wine and Spirits, Law on the Bulgarian Food Safety Agency, Law on the Center for Risk Assessment in the Food Chain, Law on Management of the food chain and the accompanying regulations).

- **This pact for the rural areas** aims to mobilize the efforts of entities at EU, national, regional and local levels, in order to support the common goals of the vision, to promote economic, social and territorial development, cohesion and to proactively respond to the common aspirations of rural communities. The Commission will facilitate this framework through existing networks and encourage the exchange of ideas and best practices at all levels.

In order to successfully respond to the leading trends and challenges posed by globalization, urbanization and population aging, and to reap the corresponding benefits of the environmental and digital transformations, local policies and measures are needed, which will take into account the EU diversity, their specific needs and relative strengths.

The population in rural areas of the EU is on average older than in urban areas, and will slowly begin to decline over the next decade. Combined with a lack of connectivity, underdeveloped infrastructure, and lack of diverse employment opportunities and limited access to services, this makes rural areas less attractive to live and work in. At the same time, rural areas are also active participants in the ecological and digital transformation. Achieving the EU's ambitious digital targets for 2030 can provide more opportunities for sustainable rural development in sectors other than agriculture, farming and forestry, thus opening up new growth opportunities for the manufacturing sector and especially for the services sector, which in turn will contribute to improving the geographical distribution of services and the various industries.

This long-term vision for EU rural areas aims to address these challenges and concerns by exploiting **new opportunities resulting from EU's environmental and digital transformation and the lessons learned from the COVID-19 pandemic**, and identifying ways to improve the quality of life in rural areas, achieving balanced territorial development and stimulating economic growth in rural areas.

The Action Plan proposed by the European Commission (EC) aims to promote sustainable, coherent and integrated rural development. Several EU policies already support rural areas and contribute to their balanced, equitable, environmentally friendly and innovative development. Among them, the Common Agricultural Policy (CAP) and cohesion policy will play a key role in supporting and implementing the current action plan. Some other EU policy areas will be added, which together will make this vision a reality. EU's Long-Term Rural Vision³ [1] and Action Plan⁴ [3] identify the following four key areas, supported by flagship initiatives:

- **Stronger:** focus on empowering rural communities, improving access to services and facilitating social innovation;
- **Connected:** improving connectivity both in terms of transport and in terms of digital access;
- **Sustainable:** conservation of natural resources and greening of agricultural activities in order to combat climate change, while ensuring social sustainability by offering access to training courses and a variety of opportunities for quality jobs;
- **Prosperous:** diversification of economic activities and improvement of the added value of agricultural and agro-food activities and agricultural tourism.

The Commission will support and monitor the implementation of the EU Rural Action Plan and will update it regularly to ensure that it continues to be tailored to their needs. It will also continue to liaise with Member States and local rural players in order to engage in dialogue on rural issues. In addition, a "rural impact assessment" will be introduced, in which EU policies are reviewed through the prism of rural areas. The aim is to better identify and take into account the potential impact and possible

consequences of a Commission policy initiative on jobs, growth and sustainable development in rural areas.

Finally, **an observatory for rural areas** will be set up within the Commission to further improve the collection and analysis of rural data. It will provide factual data to guide the development of rural development policies and will support the implementation of the Rural Action Plan.

With the announcement of the long-term vision for rural areas, the EC marks the first step towards achieving the goals of stronger, better connected, sustainable and prosperous rural areas by 2040. The Rural Pact and the EU Rural Action Plan will be the main components that will make it possible to achieve these goals.

By the end of 2021, the Commission will liaise with the Committee of the Regions to explore how to achieve the goals set out in the vision. By mid-2023, the Commission will review actions funded by the EU and Member States that have been implemented and planned for rural areas. A public report, to be published in early 2024, will identify areas where increased support and funding is needed, as well as future actions, based on the EU Rural Action Plan. Discussions on the report will serve as a basis for the preparation of proposals for the programming period 2028-2034. Recently, on 30th of June 2021, a **Long-Term Vision for EU's rural areas until 2040**⁵ [2] was announced. It is estimated that over the next 20 years, the attractiveness of rural areas will depend to a large extent on the availability of digital connectivity (93%), services and e-services (94%) and by improving the climate and environmental performance of agriculture (92%).

As for Bulgaria, we can note that:

- The rural areas and their invaluable natural resources present opportunity for many jobs related to agriculture. Farmers need machinery, buildings, fuel, fertilizers and animal health care, ie. activities of sectors higher in the hierarchy.
- There are also those engaged in downstream activities, such as food preparation, processing and packaging, as well as in the field of food storage, transportation and retail. Agriculture and the food industry provide a total of nearly 40 million jobs in the EU.
- In order to work efficiently and productively and in line with the current trends, farmers, as well as upstream and downstream sectors need direct access to up-to-date information on issues related to agriculture, agricultural practices and market development. In the period 2014-2020, the CAP funded the provision of high-speed technologies and better internet services and infrastructure for 18 million people in rural areas - 6.4% of the population in rural areas of the EU.

The European Commission, in its long-term vision for EU's rural areas, outlines the challenges and concerns they face and, at the same time, highlights some of the most promising opportunities facing these regions.

EU's long-term vision for rural areas is an initiative of the European Commission to develop a common European vision for 2040. In shaping this vision, the Commission has gathered the views of rural communities and businesses through public consultations and stakeholder events. Through this process of cooperation, the Commission is creating a broad vision and a comprehensive action plan for rural areas to help rural communities and businesses reach their full potential in the coming decades. The Commission envisages the emergence of **four complementary areas** of action by 2040, including a long-term vision through **stronger, connected, sustainable and prosperous rural areas**.

Stronger rural areas

Rural areas should be home to empowered and viable local communities. Empowering both women and men to participate actively in policy-making and decision-making processes involving

³ A vision for rural areas towards 2040. EC

⁴ The Easy Guide to Developing an Effective Action Plan Updated on: EC, 26 July 2021

⁵ Long-Term Vision for EU's rural areas until 2040, 30th of June 2021

a wide range of stakeholders and networks, as well as all levels of government, is key to developing specific conditions oriented to local specifics and integrated policy decisions and investments.

Innovative service delivery solutions should be developed, making the most of the opportunities offered by **digital tools**, and strongly promoting social innovation.

Connected rural areas

The further development of rural areas depends on them being well connected to each other and to suburban and urban areas. This makes them easier to reach, while improving access to a wider range of services for local communities.

Maintaining or improving **public transport services** and connections, as well as further developing **digital infrastructures**, are essential to ensure better connectivity in EU rural areas.

More sustainable rural areas, encouraging wealth

The conservation of natural resources, the restoration of the landscape, including cultural landmarks, the greening of agricultural activities and the shortening of supply chains will make rural areas more resilient to climate change, natural hazards and economic crises.

As service providers that protect ecosystems and carbon neutrality solutions, rural areas will play a key role in a sustainable bio- and circular economy.

Prosperous rural areas

Rural areas can become more prosperous by diversifying economic activities in new sectors with a positive impact on employment and improving the added value of agriculture and food industries.

The diversification of economic activities should be based on sustainable local economic strategies, including measures that make their environment attractive to businesses and expand digital literacy. This will help maintain a fair share of the value generated by agriculture in rural areas.

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Development in the educational process and research and production activity of modern technologies and technical means of field irrigation

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Summary. The main condition for the effective use of existing reclamation systems in Ukraine is to increase the productivity of reclaimed lands along with improving their ecological condition. This is emphasized in a number of state documents, namely: Presidential Decrees, Resolutions of the Verkhovna Rada, Laws of Ukraine. One of the main reasons for the weak dynamics of the revival of the domestic reclamation complex is the lack of qualified management and technological staff in the infrastructure that provides reclamation agriculture. Therefore, in the educational process these issues are given more and more attention. Reclamation agriculture is considered by scientists as a complex technology for sustainable development of production in the agricultural sector of the economy.

There is a systematic approach to the development of modern technologies and technical means of irrigation for the sustainable development of agricultural production, obtaining quality products, preserving the fertility of lands, fauna and flora that inhabit it with important conceptual tasks of the educational process and research and production activities. Current strategic issues include: the formation of water policy in Ukraine in view of the availability of water resources and the development of adaptation measures in the context of climate change; development of conceptual bases of restoration and development of irrigation and drainage in Ukraine. And also - water resources of Ukraine and modern methods of research of aquatic ecosystems; scientific bases of formation of sustainable bioenergy agroecosystems; system of laboratory diagnostics of water-physical properties of soils; scientific and methodological bases of organization and conduct of ecological and reclamation monitoring; water and ecological risks of transformation of reclaimed lands and ways of their minimization; information technologies in scientific research in the field of agricultural reclamation, etc. Important issues in the development of modern technologies and technical means of irrigation also include: conceptual principles of irrigation management; features of designing irrigation systems; method of setting watering dates - the basis of irrigation regimes; use of the method "Penman-Monteith" for irrigation management; irrigation management based on phytomonitoring; use of remote sensing data for irrigation control; Irrigation management information system "Irrigation online"; operation of irrigation systems; technologies of repair and restoration works on hydraulic structures of irrigation systems, etc.

KEYWORDS: DEVELOPMENT, WATER RESOURCES, DESIGN, SOIL PROTECTION, RESEARCH, PRODUCTION ACTIVITY, MODERN TECHNOLOGIES, TECHNICAL MEANS, FIELD IRRIGATION

1. Introduction

The formation of water policy [1] water supply and adaptation measures in the context of climate change are important issues of reclamation measures in agro-industrial production. As you know, land reclamation is the science of ways and methods of land improvement in order to increase their fertility and create optimal conditions for growth and development of crops [2]. In this regard, it is necessary to reconsider the conceptual principles of irrigation systems management, some restoration and development of technical means of water regime optimization, to increase the quality of agro-industrial production, professionally competent agro-engineering personnel. The developed pedagogical technology of training of professional agroengineering personnel should provide continuity of educational process in the study of soil and water resources, their protection and preservation [3].

2. Prerequisites and means for solving the problem

Modern technologies of training future agricultural engineers [4] involve the study of problematic issues of soil and water resources. As noted in throughout the study period, students systematically study these topical issues. In lectures students receive information about the general theoretical features of the use of soil and water resources in agro-industrial production, and in practical and laboratory classes they study the mechanical and technological properties of soils, interaction with them of working machines, features of irrigation systems design. In the process of formation of professional competencies in the project activities of future agricultural engineers, during the research to optimize the parameters of the sprinkler positional action DDN-70 studied agrochemical, mechanical and other characteristics of agricultural materials. According to special methods, the main parameters of the sprinkler were calculated - irrigation radius R_d , nozzle pressure P , nozzle diameter d , watering time at one position t , distance between positions b and C - depending on soil moisture, type and phase of plant development [5]. In the educational process, the purpose of research is to expand and deepen the knowledge of future agricultural engineers on the basics of theory, calculation and design of agricultural machinery, the formation of competencies on the interaction of working bodies with soil, irrigation systems and more. The purpose of the course and diploma design of work on agricultural machinery is the technological development of the

design of the machine or its components or improvement of existing mechanization for irrigation, etc.

Future agricultural engineers [6, 7, 8], should have a general understanding of erosion processes and prevent them from occurring. For example, soil erosion is the separation and movement of the upper most fertile soil layers from one place to another under the influence of water or wind. The process of water erosion consists of three steps: 1) separation of soil particles; 2) soil transfer – movement of soil particles from the site of erosion; 3) deposition of soil particles in a new place. Water erosion is appearing mostly when the effect of rain is exacerbated by the action of water flows: rain drops are separated by soil particles, and their flows are swept away.

Many scientific conferences have addressed the issue of soil and water protection. For example, at the II International Scientific Conference "Protection of Soils and Water Resources", the report was presented – «The main components of studies and research of conserving soils and water in technologies of agroengineers training» [Pr.The main]. This report partially discloses the scientific and methodological bases for soil and water exploration by future specialists in agroengineering in higher education institutions. Innovative pedagogical technology of development of project activity is developed in the form of a method of a consistent cross study of the material based on the objective relationship of disciplines and provides a qualitatively higher level of formation of professional competencies of agroengineers on the basis of preservation and even multiplication of natural resources. The report of states that the current issues of soil science are devoted to many works by well-known scholars, for example, P. Zaicka, M. Manojlovič, R. Meissner and others. A particularly important scientific and production problem is the optimization of the nutrient and water regimes of the soil on the slopes. A number of scientific works are devoted to the features of soil preparation for sowing crops on sloping lands, optimization and management of technological processes in these conditions.

The role of science in the educational process is growing significantly. Classical, practically oriented, as well as the most modern developments of scientists in the form of didactic materials are covered in textbooks, manuals, methodological developments and are used in the educational process of agricultural engineering.

It is worth to mention that due to the considerable scientific contribution of scientists, agroengineering pedagogical science and educational practice have great achievements. Significant contribution to the development of the theory and methods of vocational education were done by I. Bendera, V. Duganets, V. Man'ko and other.

These accents of scientific problems are prerequisites for solving urgent problems of soil and water conservation in pedagogical technologies for the formation of professional competencies of future agricultural engineers in higher educational institutions.

3. Results and discussion

The development of theoretical preconditions for some technological processes of agro-industrial production and the functioning of technical systems contributed to the optimization of the parameters of special agricultural machines. In addition, the results of scientific research have shown that the high quality of the educational process is achieved when future agricultural engineers conduct in-depth theoretical calculations of machines, participate in experimental laboratory and field research. Here is an example of the use in scientific and technical activities and technologies of preparation of agricultural engineers for innovative design activities of the elements of the algorithm of the theory and calculation of nozzles and devices of sprinklers and installations.

In fig. 1 shows a scheme of a deflector nozzle used in sprinklers and installations.

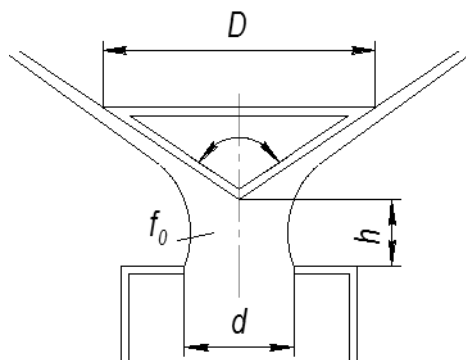


Fig. 1. The scheme of the deflector nozzle

Usually take the following ratios: $h = d$; $D = 2d$; $2\theta = 120^\circ$ (Fig.1).

Irrigation radius R can be determined by the following formula:

$$R = \frac{H}{0,43 + 0,0014 \frac{H}{d}}, \quad (1)$$

where H – pressure in front of the nozzle hole.

(Fig. 2) there is their simplicity

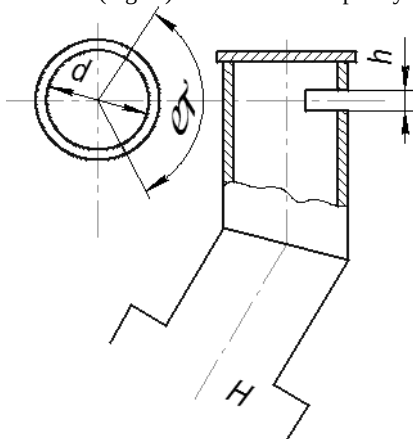


Fig. 2. Scheme of a slot nozzle

Such a nozzle can be obtained by sawing on any pipe. Spray torch angle φ_p determined from this ratio:

$$\varphi_p = (0,7-0,9)\varphi.$$

Smaller values of the numerical coefficient correspond to smaller values of the angle φ . The radius of the irrigated sector is determined by the formula:

$$R = \frac{H}{1,15 + 0,0003 \frac{H}{h}}. \quad (2)$$

The recommended ratio of the length of the slit to its width 1:5, 1:10. The irrigated area has the shape of a sector with an angle φ_p . Approximately at a distance $1/5R$ from the nozzle irrigation does not occur.

Medium-jet sprinklers are used on most modern sprinklers and installations. Their designs are mostly the same type, although they have some significant differences.

The principle of operation is approximately as follows. The jet flowing from the barrel meets on the way a rotary deflector and a reflective blade. The front end of the rocker arm is pushed to the side, and the rocker arm is turned. When leaving the jet, the deflector rotates relative to the rocker arm. The rocker arm, twisting the spring, rotates at an angle of about 90° , then under the action of the spring returns to the previous position.

After reaching the initial position, the rocker strikes the tide on the barrel with its tide and turns it at an angle of $2-5^\circ$ in the course of movement. The jet at this point hits the back of the deflector and returns it to its original position. Then the front end of the rocker is pushed out of the jet again and the process is repeated.

The barrel performs a continuous rotation. The jet irrigates the circular area. The design can work without a chopping blade. In this case, more precise adjustment of the position of the deflector relative to the jet is required.

With the conditional replacement of the action of the jet on the curved rotary deflector and the blade by the action of only one blade located on the middle radius, according to Fig. 3, a) and b) the value of the angular velocity of the rocker arm after the deflector exits the jet will be

$$\omega = 2\sqrt{\frac{pfr\varphi\sin\alpha}{J_\kappa}}, \quad (3)$$

where J_κ – the moment of inertia of the rocker arm;

φ – the angle of rotation of the rocker arm at which the jet affects the deflector,

$$\varphi = (2-3)\varphi_n;$$

p – pressure in front of the nozzle.

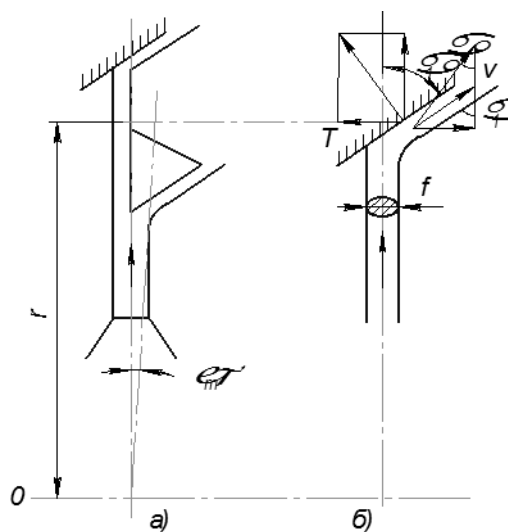


Fig. 3. Scheme of the deflector of the medium-jet sprinkler

Due to the fact that the flow is not completely deflected by the deflector

$$\alpha = (0,7 \div 0,8)\alpha_1 \quad (4)$$

The maximum angle of rotation of the rocker arm

$$\varphi_{\max} = \frac{2pfr \sin \alpha}{M_n}, \quad (5)$$

where M_n – the average value of the moment created by the spring during the rotation of the rocker arm.

The angle of rotation of the device in one stroke of the rocker arm

$$\psi_a = \frac{8pfr\varphi \sin \alpha}{M_T} \left[\frac{me^2}{J_\kappa} + \cos^2 \theta \right] \cos^2 \theta, \quad (6)$$

where M_T – the moment of friction which brakes rotation of the device and is equal to the sum of moments of friction in the bearing and a rubber cuff.

The full travel time of the rocker arm in both directions

$$t = 4 \frac{\sqrt{J_\kappa pfr\varphi \sin \alpha}}{M_n}. \quad (7)$$

Long-jet sprinklers are used in cases when it is possible and expedient to create a pressure of 4-6 atm in the pipes.

Common devices with worm or toothed mechanisms of rotation, which are driven by a small turbine, which rotates under the action of the energy of the main jet, which is formed by the device with a turbine drive.

Mechanisms are often introduced into the structure to provide the apparatus of reverse rotation within the sector of the irrigation circle in the sector in a given direction. The angle of the sector is usually adjustable.

The jet of water flowing from the nozzle rotates the turbine. On the axis of the turbine is a worm that rotates the worm gear. The gear through the shaft transmits rotation to the worm connected to the worm gear. There is an eccentric finger on the axis of the gear, which makes the frame swing. The ratchet mechanism consisting of two hinged rods, a spring and a dog is established on a frame. Under the action of a compressed spring, the dog is pushed away from the stationary gear on one side, due to which a slow intermittent rotation of the sprinkler around the vertical axis is carried out. The fixed gear has a series of protruding fingers. At an emphasis of a shank of a dog in one of them its position changes, its other party starts to work and the direction of rotation of the device changes. Thus it is possible to carry out watering on sector. The number of revolutions of the turbine per minute is determined by the formula:

$$n_T = \frac{60u}{\pi D}, \quad (8)$$

where u – circular velocity of the ends blades m / s;

D – diameter of the turbine at the ends of small blades, m

The circular speed of the ends of the blades can be determined by the formula

$$u = k_0 v, \quad (9)$$

where k_0 – wheel speed ratio, $k_0 = 0,7-0,8$;

v – fluid velocity in the jet, m / s.

The velocity of the liquid in the jet is determined by the formula

$$v = \varphi \sqrt{2gH}, \quad (10)$$

where φ – speed factor, $\varphi = 0,97$;

g – free fall acceleration $g = 9,8$ m/c²;

H – pressure in front of the nozzle, m of water column

The number of revolutions of the long-jet sprinkler is equal to:

$$n_a = \frac{n_T}{i}, \quad (11)$$

where i – the total gear ratio between the turbine and the body of

the apparatus.

The range of the jet for medium and long-jet nozzles can be determined by one of the following empirical formulas:

$$R = 0,42H + 1000d \quad (12)$$

or

$$R = \frac{H}{0,5 + 0,25 \frac{H}{d}}. \quad (13)$$

The formulas are valid for the angle of inclination of the jet to the horizon of 30°, ie for the angle corresponding to the longest range and the ratio

$$\frac{H}{d} \geq 800, \quad (14)$$

where H – pressure in front of the nozzle, m of water column;

d – jet diameter, m

The range of the jet can also be determined using the experimental graph shown in Fig. 4. For different diameters of the jets, a series of curves is constructed that determine the relationship between H and R . The decay of the jet into droplets is determined by the ratio H/d .

The range of the jet, defined on the graph (Fig. 4), can be obtained only with a properly designed barrel and non-rotating sprinkler.

The range of the jet during the rotation of the apparatus around the vertical axis with a speed of 0.3–1 per minute decreases by 10-15% compared to the range of the jet without rotation of the apparatus. The rational shape of the trunk is shown in Fig. 5. A larger angle of inclination to the horizon is selected at a pressure of 1.5–3 at, a smaller - at a pressure of more than 6-8 at. Essential for the formation of the initial section of the jet is a sedative 1, which consists of a series of partitions parallel to the axis of the barrel, dividing its living section into a number of narrow channels.

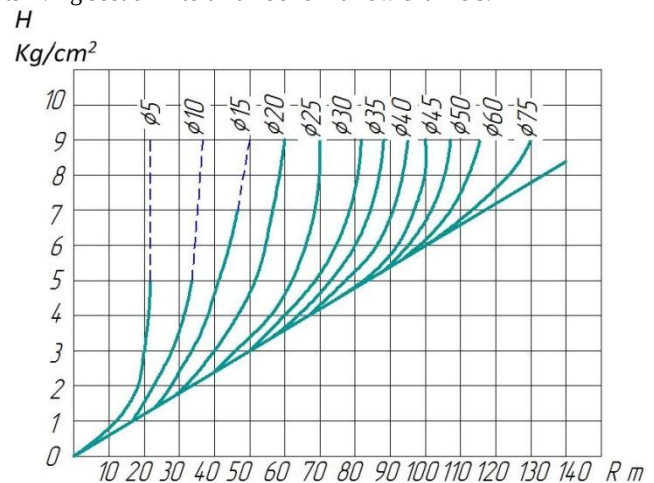


Fig. 4. Schedule to determine the range of the jet

The length of the cells of the sedative should be 12-15 times greater than their width. The diameters of the barrel and the silencer should be 3-4 times larger than the diameter of the nozzle. It is necessary to install ribs 2 in the knee, which prevent the occurrence of transverse circulation of velocity in the flow. In medium-jet and some long-jet barrels, the cone 3 is not placed, and the nozzle 4 is located directly behind the output end of the sedative. The rational shape of the nozzle is shown in Fig. 6, a.

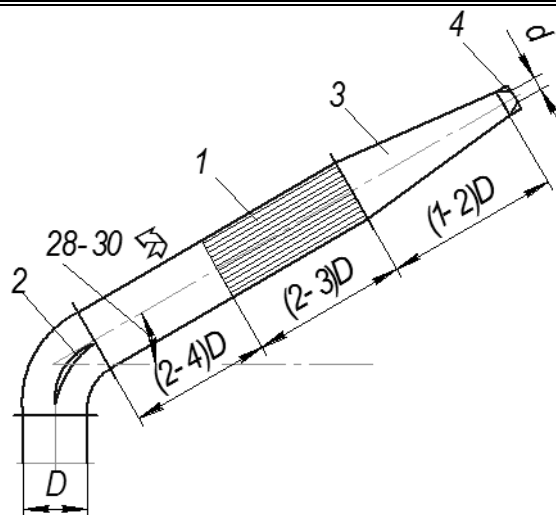


Fig. 5. The scheme of a long-jet trunk:
1 - sedative; 2 - rib; 3 - cone; 4 - nozzle.

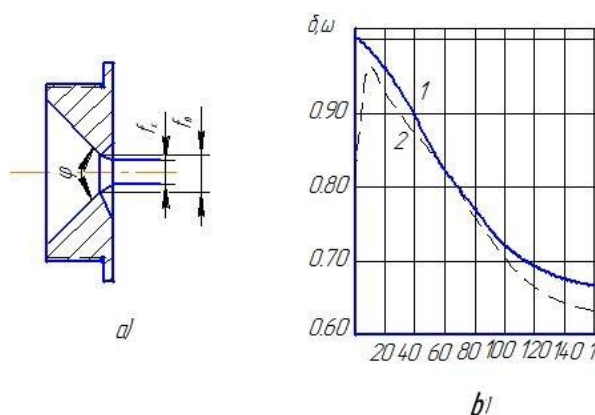


Fig. 6. Rational shape of the nozzle

Water consumption through such a nozzle is determined by the formula:

$$Q = \delta \sqrt{2gH}, \quad (15)$$

where δ – flow rate, which is determined depending on the angle of conicity of the nozzle φ on curve 2 (Fig. 6, b).

Curve 1 gives the value of the compression ratio ε of the jet:

$$\omega = \frac{f_c}{f_0}. \quad (16)$$

This factor determines the diameter of the nozzle required to create the desired jet.

5. Conclusions

As a result of conducted all the scientific research work and using the fundamental mathematical analysis we can get the theoretical basis which will help to improve the development of the educational process and research and production activity of modern technologies and technical means of field irrigation.

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Gis of crop monitoring remote sensing system

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Abstract: We aim to develop a GIS to provide agricultural crop monitoring based on heterogeneous data. The GIS integrates multi-source data (space, air-born and ground-based data, meteorological, plant and soil agrochemical data and other data) as well as up-to-date research on crop modelling to support decision making in the management of crop status. Various geospatial input data are taken a view of as a source of information for crop monitoring system. The structure of the GIS, the components and their relations of crop monitoring system based on remote sensing data are described in this paper.

KEYWORDS: CROP MONITORING, GIS, REMOTE SENSING, HETEROGENEOUS DATA, CONCEPTUAL MODEL

1. Introduction

Up-to-date digital technologies and technological basis for obtaining and data processing are widely used in monitoring systems. Remote sensing data and ground-based observations of high-level accuracy are integrated into the crop monitoring systems and agricultural lands state monitoring systems.

Application of heterogeneous data improves the quality of agricultural lands monitoring and accuracy of criterion assessments of parameters of crop condition growth and development.

2. Prerequisites and means for solving the problem

Agricultural monitoring systems aim to provide up-to-date information regarding agricultural crop status, food production, soil quality and soil conservation. Many monitoring systems now exist. An overview of the main global and some regional scale agricultural monitoring systems and mapping cropping practices is presented in [1-5]. These papers show input data and models used, and the outputs produced. Despite improvements in access to multi-source remotely sensed data, the use of numerous remote-sensing based products by the different systems as well as monitoring systems are still to be improved, in particular spatial knowledge of cropping systems and agricultural practices. The increasing availability of various geospatial data and remote sensing data, the emergence of new data processing techniques foresees to improve designing of GIS structure for the crop monitoring system.

The purpose of the study is to substantiate the conceptual model of the GIS crop monitoring system using heterogeneous data to improve the efficiency of decision-making management of crop growth and development.

The development of the monitoring system involves a systematic analysis of the aim and purpose, types of input and output data, components of the system and functions. Conceptual modelling of GIS is performed using both the structural-functional method and a unified modelling language (UML).

3. Results and discussion

When monitoring crops, it is necessary to process heterogeneous data and perform geoinformation analysis and modelling to manage their productivity. In many researches, scientists argue that high-quality monitoring of crops should be performed based on heterogeneous data. Accordingly, the applied crop monitoring GIS should integrate spatial and non-spatial data of different data models and formats, be able to import and export data of various information systems, perform complex analysis and visualize data from ordinary tables to complex reports. Figure 1 shows the proposed structural and functional model of the GIS crop monitoring remote sensing system.

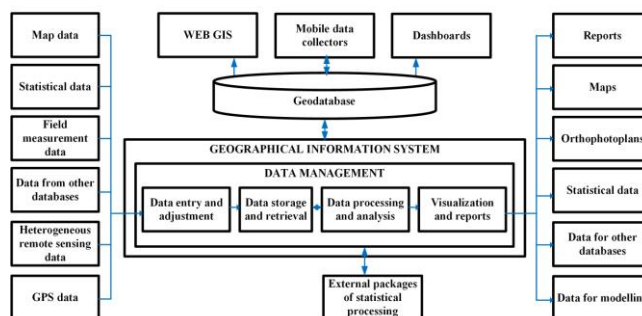


Fig. 1. Structural-functional model of GIS crop monitoring remote sensing system

It is proposed that GIS will process data in several stages:

- collection and quality control of heterogeneous data;
- the ability to optimally store and quickly search for data;
- data preprocessing and thematic processing and geoinformation analysis;
- data visualization and creation of various reports.

The input data of the proposed GIS should be: cartographic data from external databases and historical cartographic and statistical data within the fields; data of current field measurements, data of external databases (meteorological, agrometeorological, soil quality data, information on biological properties of crop cultivar etc.); heterogeneous remote sensing data and GPS measurements. Since part of the data is expected to be obtained within the field, the use of mobile GIS is proposed. Such a GIS will allow to link the input data to the sampling points, identify problematic zones, connect to the Internet, and immediately transfer to the server.

For the functioning of the system, the creation of a geospatial database is provided. This database will allow to integrate data into a single environment and quickly exchange data between different information systems and web services.

Figure 2 shows the proposed structure of the GIS crop monitoring remote sensing system in the form of a UML deployment diagram of its components.

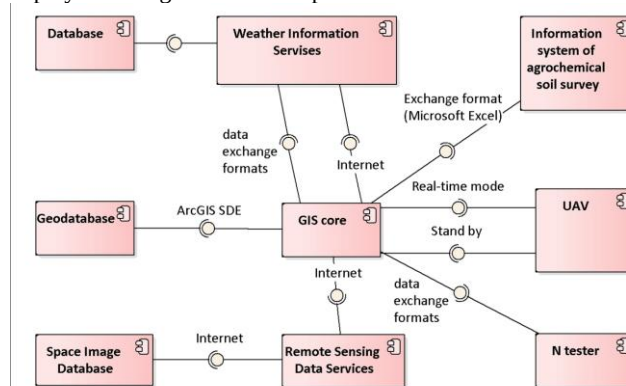


Fig. 2. Structural model of system components

The central constituent of the system is GIS, which is implemented using modern technologies. The GIS core consists of

a server and a desktop part and it also can support mobile and web GIS. The basic part of the geospatial data is created in the following components. Weather data are obtained through Meteorological Data Services via exchange data formats or, preferably, online. Data of different imagery of remote sensing satellites are downloaded via the Internet. UAV data are also used, where, depending on the model of the vehicle, they are loaded into the GIS in real-time or after flights. Ground control of crop state is carried out using N-tester data. And accordingly, the data of agrochemical soil properties are uploaded through exchange formats. In the future, the structure of the system will expand due to new components. Figure 3 shows the proposed data structure of GIS.

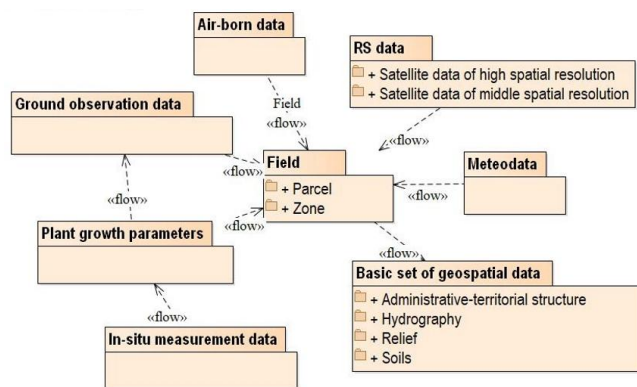


Fig. 3. GIS Data structure

First of all, the data structure consists of a basic data set for the area where the agricultural land is located. It is formed by data on the administrative structure, hydrography, relief and soils. Within the territory, the data of the boundaries of the fields where the products are grown are determined. Other data are used for geoinformation analysis and modelling of crops.

4. Conclusions

The study reflects the approach of decision-making to develop an applied GIS crop monitoring remote sensing system. A number of tasks that could be performed by GIS to support decision-making to monitor the conditions of growth and development of crops and yield prediction are observed. Also, the structure of input and output data for analysis of the state and development of prognostic models of crops is shown. Conceptual models of GIS structure have been developed, which allow to understand how heterogeneous data will be integrated in system.

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Methodical approach for assessing the quality of storage of grain harvesters

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Summary

The specificity of agricultural production implies several months of intensive use of the majority of equipment and a long storage period. Checking the quality of storage of agricultural machinery, controlling all operations, is economically impractical. It is necessary to select the main (key) operations from the whole list of operations, ie. those that provide a reliable assessment of the quality of storage of machinery.

The proposed methodology makes it possible to streamline the assessment of the quality of storage of machinery in agriculture, choosing the main operations, without losing information from the fact that the operations that contain a small amount of information are not controlled.

The specificity of agricultural production implies several months of intensive use of the majority of equipment and a long storage period. Maintaining reliability and performance even in this "dead" period has always been seen as a reserve to improve usage and reduce maintenance costs. Therefore, manufacturers of agricultural machinery develop storage rules, as a separate section to the maintenance of the machine and propose that this be done by the relevant company service. The more expensive the equipment, the stricter these rules are, with the aim of reducing the speed of the so-called harmful processes - corrosion, fatigue of materials, aging and destruction. This is especially true for harvesting equipment - different types of combines. Constructively, due to their large size and free spaces between their units, assemblies and details, these processes take place with increased intensity.

The rate of corrosion processes is influenced by the corrosive activity of the atmosphere and the aggressiveness of the environment, namely: temperature, humidity, amount and duration of precipitation, air pollution with gases, salts, dust, etc. The influence of the various factors on the durability of the elements of the machines, as well as the places of storage is different.

Under the influence of the sun, air, precipitation, temperature amplitudes and mechanical load, the details of non-metallic materials (rubber, plastics and textiles) change their physicochemical properties significantly faster due to the ongoing processes of destruction. When the action of the listed factors is simultaneously several types of destruction occur: photochemical - under the influence of light, thermal - under the influence of heat, hydrolytic - under the influence of moisture and oxidative - under the influence of oxygen (ozone).

In the case of polymeric materials and coatings, there is an additional factor accelerating the destruction, namely the different coefficients of thermal expansion of the materials.

The harmful effect of high static loads is not the least important when storing combines. Headers placed on uneven platforms or stands are under the influence of bending and torsional static loads, which increase further with snowfall and large snow cover. The most sensitive to deformations are the gears, bearings and cutting devices. The deformations obtained during their subsequent work cause undesirable and dangerous dynamic loads.

Manufacturers recommend a number of works to reduce the speed of harmful processes - corrosion, fatigue of materials, aging and destruction during storage of combines. In summary, the operations of the so-called. post-season or storage maintenance, for combines "NEW HOLLAND", "CASE", "KLAAS", etc. are given in Table 1.

Checking the quality of storage of combine harvesters, controlling all operations, is economically impractical, as it takes a lot of time to perform the control operations themselves by experts. In order to minimize the control time, it is necessary to select the main (key) operations from the whole list of operations, ie. those that provide a reliable assessment of the quality of storage of machinery. For this

purpose, the methodological approach presented in the literature is used [3]. The essence of this approach consists in the following - each machine, which is subject to storage and control, is composed of many elements (parts, assemblies and units). The sequential inspection of all elements of the machine is characterized by the evaluation of the parameters $W_1, W_2, \dots, W_i, \dots, W_m$, which characterize the quality of preparation for storage of the elements of the machine. The methodology provides for the control of all the main elements that provide a reliable assessment of the quality of preparation for storage of tractors in agricultural machinery.

The value of the information obtained during the control of the i -th parameter φ_i can be represented as a function of two vectors - the amount of information that carries the parameter J_i , and the time for its measurement t_i , ie.

$$\varphi_i = f(J_i, t_i).$$

It is known from information theory that the amount of information after measuring the i -th parameter can be measured by the magnitude of the reduction of the uncertainty about the storage quality of the machine by the following dependence:

$$J_i = H - H_j,$$

where:

H is the a priori (to the experimental) uncertainty;

H_j - is the a posteriori (after the experimental) uncertainty of the quality of the preparation of the storage machine.

If the probability of good preparation of the storage machine is taken as a measure of the uncertainty of the quality of preparation of the storage machine, then expression (2) can be written as follows.

$$\Delta P_i(A) = P_i(A) - P(A),$$

where:

$P(A)$ and $P_i(A)$ are the a priori and a posteriori probability of good storage of the machines.

Thus, the greater the value of $\Delta P_i(A)$, the more informative the W_i parameter is. The time for checking the i -th parameter for assessing the quality of storage preparation is limited and should not be excluded when choosing the main operations that are the basis of the methodology for assessing the quality of storage of machinery. Therefore, the value of the information obtained from the control of the W_i parameters can be defined as the ratio of the increase of the a posteriori probability for good preparation of the storage machine to the duration for checking the given parameter (t_i), ie.

$$\varphi_i = \frac{P_i(A) - P(A)}{t_i}.$$

It follows from the formula that in order to select the main (key) operations for assessing the quality of storage of machines, it is necessary to take into account the increase in the a posteriori probability of good storage condition of the machines, ie. the informativeness of the i -th parameter and the time for control of the i -th parameter (operation).

In the practical implementation of the formula, difficulties arise, which are mainly related to the calculation of the a

posteriori probability, as the a priori probabilities are not known in advance. Therefore, it is proposed to use an approximate dependence to determine the value of the information obtained when measuring the i-th operation for the quality of storage of the machine, which can be recorded as follows:

$$\varphi_i = \frac{(Q - q_i)}{t_i},$$

where : Q is the value of the resultant performance of the machinery, provided that all operations in preparation of the machinery for storage have been performed and controlled;

t_i – the value of the resultant performance of the machine in case of non - performance of the i - th storage quality control operation.

The reliability of the elements of the machines, the productivity of the machines, the degree of corrosion of the elements of the machines, technical and economic and other

indicators can be considered as effective indicators. The object of research in our case is to take into account the influence of the quality of preparation of the elements of the storage machines, as a result indicator relative losses q are selected for each operation, related to the total losses, provided that these operations are not performed. According to our data, the value of the information obtained when controlling the quality of storage of combine harvesters, taking into account the time spent on checking each operation, are shown in Table 1.

Based on the values of the significance of the information obtained during the control of each of the i-th operations, it is necessary to determine the main (key) operations that will be included for controlling the quality of storage of the combine harvesters. For this purpose, the Pareto principle is used [2], which allows from the whole set of operations operations to choose which are the most valuable, ie. most informative.

Table 1. Significance of the information in the operation for quality control of storage of grain harvesters

№	Basic storage operations	Size of relative losses q_i	Time to check the i-th operation t_i , h	significance of operation , $\varphi_i = \frac{q_i}{t_i}$
1.	Cleaning and washing the combine	0,131	0,18	0,727
2.	Removal, cleaning and lubrication of the sieves	0,060	0,12	0,425
3.	Drain the oil. Pouring oil with anti-corrosion additive	0,013	0,65	0,020
4.	Disassemble all safety connectors. Checking their condition, lubrication and assembly.	0,003	0,60	0,006
5.	Lubricate the combine according to the table or lubrication card	0,26	0,70	0,373
6.	Lubricate all unprotected parts with paint except the pulleys and variator discs.	0,155	0,58	0,267
7.	Return and lubrication of the hydraulic cylinder rods.	0,158	0,40	0,255
8.	Belt cleaning, adjustment check.	0,028	0,15	0,187
9.	Cleaning the filter element of the air cleaner.	0,079	0,65	0,123
10.	Cleaning the engine radiator.	0,040	0,50	0,080
11.	Check the antifreeze content of the coolant.	0,008	0,12	0,067
12.	Refueling.	0,050	0,60	0,083
13.	Remove all chains, clean, lubricate and install the combine.	0,135	0,32	0,422
14.	Closing all openings of the engine elements.	0,028	0,15	0,187
15.	Installation of wooden supports for unloading the tires.	0,012	0,10	0,100
16.	Removing and cleaning the batteries.	0,002	0,35	0,050
		$\sum q_i = 1,000;$	$\sum t_i = 6,32;$	$\sum \varphi_i = 3,514$

According to the Pareto principle, the function of the accumulated values of the analyzed indicator (the value of the information in the control of the operation φ_i)

$$\Delta_i \leq \varphi_i = \frac{100}{m},$$

where:

Δ_i is the increase of the i-th value of the analyzed indicator,%;

φ_i - average value of the analyzed indicator;

m - the total number of operations;

100 - the total value of the analyzed indicator,%.

The determination of the main operations for quality control of storage of grain harvesters according to the Pareto principle (according to data in Table 1) is shown in the figure.

It shows that the main operations will be 10 of those listed in Table 1.

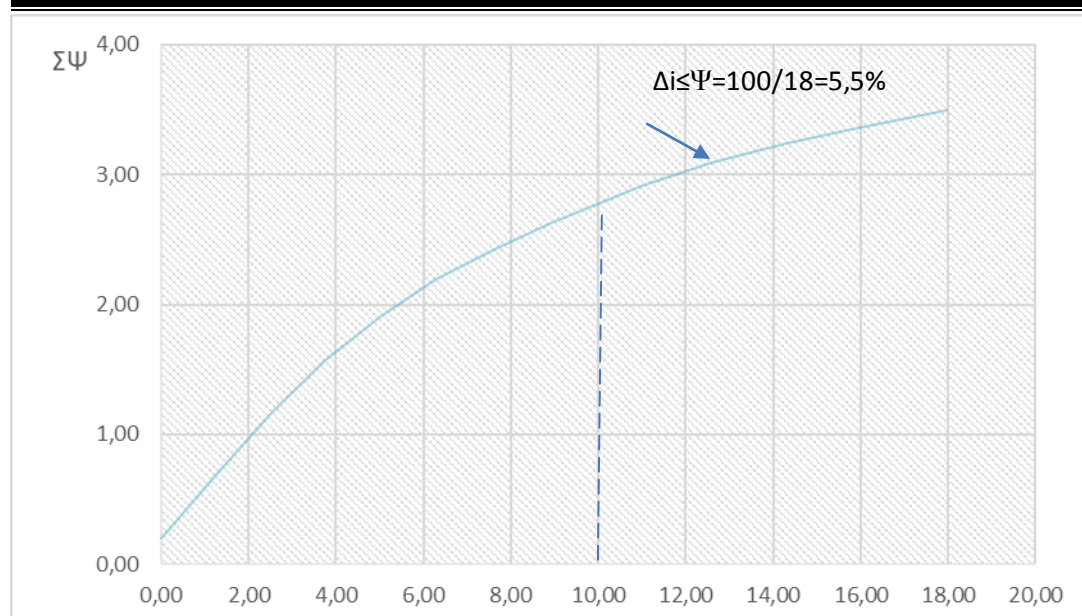


Figure 1. Determining the main operations for assessing the quality of the preparation of grain harvesters for storage

Table 2. List of basic operations for quality control of storage of grain harvesters

Parameters (operations)	Significance of the operations φ_i	Check time t_i
Cleaning and washing the combine	0,727	0,18
Removal, cleaning and lubrication of the sieves	0,425	0,75
Remove all chains, clean, lubricate and install the combine.	0,422	0,61
Lubricate the combine according to the table or lubrication card	0,373	0,15
Lubricate all unprotected with paint parts except the pulleys and variator discs.	0,267	0,58
Return and lubrication of the hydraulic cylinder rods.	0,255	0,40
Belt cleaning, adjustment check	0,187	0,45
Closing all openings of the engine elements.	0,187	0,55
Cleaning the filter element of the air cleaner.	0,123	0,20
Installation of wooden supports for unloading the tires	0,100	0,10
	$\sum \varphi_i = 3,066$	$\sum t_i = 2,93$

From the analysis of the data in Table 2 it follows that the total value of the main operations is 91.3% of the total value of all operations that are included in the control of storage of combine harvesters (Table 1). The time for performing the storage quality check was reduced from 6.32 to 2.93 h, i.e. about twice

Conclusions

The proposed methodology makes it possible to streamline the assessment of the quality of storage of machinery in agriculture, choosing the main operations, without losing information from the fact that the operations that contain a small amount of information are not controlled.

The use of the basic operations for quality control of the storage of the equipment allows to shorten the time for performing the quality check with guaranteed reliability of the received information.

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How do manage water resources more productive in water scant agro-zones?

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Abstract: Irrigated agriculture with a world average of 70% withdrawal is the largest fresh water user among all- consumptions and is even higher than 80% in some regions such as semi-arid Konya plain of Turkey. It is impossible to make economic crop production in such environments without irrigation especially for summer crops. Over water abstractions from the groundwater reservoir is inevitable for meeting whole current crop water requirements so this situation may result serious environmental problems such as formation of sinkholes in some places. Following necessary precautions can be taken into considerations for sustainable usages of current water supplies in water shortage ecosystems like Konya plain of Turkey; 1- Crop pattern should be redesigned in accordance of safely available water supplies, 2- Implementing deficit irrigation program. In that regard, up to 25% deficit irrigation can be suggested for some crops, 3-Developing and widely planting drought resistant cultivars, 4- Improving irrigation areas of practicing pressurized irrigation technologies, 5- Replacement of open channels water delivery systems to the pipe networks, 6- Farmers should be trained about correct agro-water management at farm level with rich visual documents, and 7- Rain-fed farming system could be done for some crops.

KEYWORDS: AGRO-WATER MANAGEMENT, SUSTAINABLE IRRIGATION, PRESSURIZED IRRIGATION SYSTEMS, WATER PRODUCTIVITY.

1.Introduction

Water is the backbone of the irrigated agriculture and direct effect on both crop yield and quality. The agriculture or irrigation is the major fresh water user sectors as 70% world general [1], greater than 40% in OECD countries [2], and over than 80% in some parts of the world such Konya Plain of Turkey and in those water scant environments it is not possible to obtain economical returns without irrigation. Due to the negative effect of climate change, even winter cereals are growth under two or three irrigation practices for facilitating enough yields in Konya Plain.

In water poor ecologies, it is urgent to attempt practical solutions for water productivity. Konya Plain is about 10% of farming land with only 2.5% fresh water resources. Fortunately, it has rich of groundwater supply and has consumed plenty due to the absent of surface water resources in most periods of crop growth cycle. The water depths of groundwater are getting decrease due to the current agricultural system and lack of rainfall resulted from recent climate changes. This has caused some ecological problems such as formation of sinkholes in some areas. Farmers in such region are rich experiences about all farming activities including irrigation and follow the latest advants about agriculture. They have used pressurized irrigation systems with an increase rate due to the causing water savings. Sprinkler irrigation technology is the most common irrigation method and are used for irrigation of most crops such as sugar beet, carrot, dry bean, vegetables and so on. Due to the introducing drip irrigation system, maize production has increased sharply in last 10-15 years in region.

Utilization of pressurized irrigation systems is around 15% through the world and well-known benefits of such system are best suited for different soil, plant and topographic conditions [3-4]. The only way for improving water saving is to increase the irrigation efficiency [5]. This can be overcome by efforts such as applications high efficient irrigation technologies like drip irrigation, and adopting other farm practices resulting water saving [2]. Another option is deficit irrigation practice and is highly recommended for water shortage ecologies for putting more lands into production [6]. In accordance of research at Gansu Province, China for maize crop [7], deficit irrigation with a certain level in seedling stage of maize

may result better water economy and notable increase in water use efficacy particularly water poor zones.

As known that pressurized irrigation systems have also led to optimal water distribution uniformity a cross the whole irrigation areas under well management. The benefits of equal water distribution are leading to minimize losses in both the plant nutrients and irrigation water consequently maximal crop yield [8-11]. Proper management in general means to improve of water allocation and water use productivity. Water allocation is closely relevant to the reliable pricing and water use profitability highly depends on the irrigation systems, and climate conditions [1]. In definition of well agricultural water management [12] is that providing of water amount for both the crops and animals they demand, enhancing water productivity, and protecting ecosystems for the benefit of downstream users and natural resources services.

The aim of the present study, therefore, is to give the practical recommendations for sustainable agricultural water managements in water scant climate regions.

2. Impacts of drought on wheat production in Turkey and Konya province

Efficient water utilization is necessarily prerequisites in arid or semi-arid regions of Turkey since they may expose to the drought problem in some periods. Drought has lots of negative effects on all sectors mainly on agricultural productions. The reason of drought is less rainfall than the normal precipitation amount and its none uniform distribution through the year.

Cereals are the backbone food security crop for the nations and their reduction may have great adverse effect on human health.

There was a severe drought at 1970, 1973 and 1989 in Turkey with a reduction of wheat yield about 42%, and the productions in those periods were around 1160 kg/ha, 1130 kg/ha, and 1730 kg/ha, respectively. Fortunately, after the 2002 it increased gradually and reached up to 2840 kg/ha in 2013 [13].

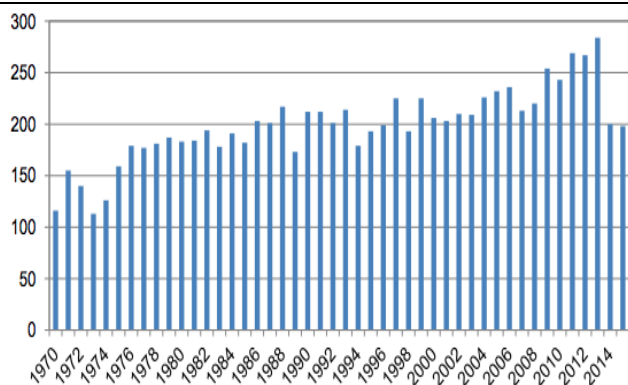


Fig. 1. Wheat yields of Turkey as kg/da [13].

There was a notable decrease in wheat yield in Konya province of Turkey, and grain yields of wheat were 1010 kg/ha, 850 kg/ha, 730 kg/ha, and 1390 kg/ha, respectively in the years of 1970, 1973, 1974, and 1989.

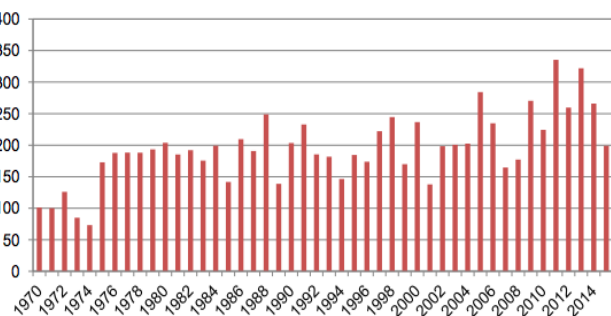


Fig. 2. Wheat yields of Konya province as kg/da [13].

This year, 2021, is also very dramatic in accordance of cereal production. Almost none wheat yield was obtained at rain-fed farming areas. In result, possibly agriculture is the most affected sector from the climate changes.

3. Efficient water saving practices in agriculture for water shortage ecosystems: Sample of Konya Plain

Following water productivity strategies can be addressed in areas having limited water supplies such as Konya plain of Turkey:

Changes in crop patterns: In Konya plain, there is over water extraction from the ground water resources. In that regard, ground water resources are not sustainable by this current utilization. There are two main reasons in reduction of groundwater level at Konya plain general. First, due to the high economical benefit some high water consuming crops such as corn have growth with an increase rate. Second is increase of irrigation areas without control. There is no doubt that irrigated agriculture has very important role to play for increasing the crop production. Particularly increase of farmlands with high water consuming crops has led to more water extraction from the groundwater reservoir. As a result of that there is a gradual depletion in groundwater level in basin general. Possibly current crop pattern is the first rank resulting over water extraction from the groundwater reservoir [14].

Diverting subsidize to less water consuming crops: There is obvious that the reason behind increase of the cropped lands in favor of high

water consuming crops is resulting better economical return in region. Corn and sugar beet production have caused high income for farmers. Farmers think their economical gains instead of environmental protection. Due to the government subsidize and well market price, corn production is very satisfactory since farmers get high benefits from such farming activity. This region is known as cereal store of Turkey. The climate is very favorable for cereal production and those crops are within group of the low water consuming crops. In recent years, there is a dramatic reduction in farming areas of cereal production in region due to the not resulting economical return. The crop pattern of those crops was about 35-40% in the past but there is gradual reduction recently. The cereals particularly wheat is vital important for food security in the world so they must be growth for both meeting the food demand of the nation and conserve the water resources. The practical solution is subsidizing of cereal production. In addition, other low water consuming crops such as sunflower, lentil, chickpea and pumpkin should be growth more for sustainable water resources particularly at water poor ecologies like Konya plain, Turkey.

Awareness of public for environmental problems resulted from over water pumping from groundwater resources: There is direct relationship between agricultural activities and efficient water use and environmental protection. Agro-practices likes soil tillage, irrigation, fertilizer uses, disease as well as pest control are relevant to sustainable agricultural water management and conserving of environment [1]. There are some environmental problems associated from the over water pumping from the groundwater supply in our region. The rainfall amount and its distribution are poor in most part of Konya plain. The irrigation process is the main contributor of high crop yield and consequently better incomes for farmers. Due to the reason of increment in irrigation areas of high water consuming crops, we have witnessed some sinkholes in some parts of Konya plain. In that regard, safely available water amount must be used for irrigation at region. In addition, following environmental problems could be observed under intensely use of groundwater [15]: inevitable aquifer depletion resulted from rapid groundwater withdrawal than its recharged by precipitation; during the groundwater pumping process, sinking or collapse (subsidence) of the groundwater; introducing of salty water to the freshwater aquifers at the seaside areas, and; contamination of groundwater reservoir by people activities. In accordance of information [2], over-use of current water supplies particularly by irrigation in some regions leads to deterioration of ecologies by declining water flows below the critical flow regimes in surface water bodies such as rivers, lakes and wetlands which is also damaging to recreational, fishing as well as cultural utilizations of those ecosystems.

Rain-fed farming: The farmland size is large in Konya plain and is impossible to irrigate whole areas by using current water resources. In addition to the low water consuming crops into the current crop pattern, rain-fed farming system is a viable solution in some parts of the region. In that regard, productions of chickpea, lentil, and some cereal cultivars could be growth under rain-fed systems.

Practices of deficit irrigation or pressurized irrigation systems: Deficit irrigation is an applicable practice in sustainable water management in areas with water scant climates. In accordance of our findings of drip-irrigated potato, sugar beet, maize, sunflower and so on [16], up to 25% deficit irrigation resulted none significant yield reduction so that level can be recommended for water shortage regions like Konya plain. Deficit irrigation during the crop growth stages is well meaningful for detection of crops in which stages are

more critical to water stress conditions. In that point of view, deficit irrigation has led to both water and energy savings so it can be taken into considerations in agro-water management works to increase the areas bringing under irrigation with same amount of water utilizations. In order to minimize the pressure on over water usages from the ground water supplies, it is a friendship irrigation program. In one research [1], improving irrigation water use efficiency and usage of marginal waters such as saline, drainage and reclaimed in irrigation are highly recommended for overcoming water scarcity for irrigation. Similarly Seid and Narayanan [17] studied the different water regimes effects on water use efficiency, WUE, and grain yield of maize with various furrow systems under clay-loam soil in Awash Melkassa, Ethiopia. They stated that deficit irrigation increased WUE and it is possible to cultivate additional farmlands having water shortage zones by application of deficit irrigation with great care.

The main target in irrigation for particularly water poor zones is to improve the water savings. In that regard, pressurized irrigation methods are superior over other irrigation techniques under well management. In study [18], drip irrigation resulted great water application efficiency that is very important particularly in water-limited environments. The finding of such study showed that lateral design was also significantly important to obtain satisfactory wetting in soil profile or yield so one lateral use for each crop row led to maximum water productivity for drip-irrigated potato.

Development and introducing of crops having tolerant to the water stress conditions: One of the most important issues in agriculture is selection of crop cultivar best suited to the current environments. Therefore, development of new crop cultivars in which are very resistant to the arid and semi-arid climates is very important to improve agro-production as well as sustainable water management in water shortage ecologies. Those developed crop cultivars will have positive contribution on water productivity in such climate zones. In accordance of report [2] encouraging wider adoption of drought-resistant plant cultivars is viable solution for minimizing adverse effect of climate change on agricultural production in water shortage zones.

Education of farmers about water management at farm level: Efficient water use in farm levels is great interests in water scarcity regions to maximize the water profitability. In that regards, farmers should be educated with rich visual technologies about agricultural water management. In addition, one of the practical ways is to organize farmer's day at farm levels to inform them about efficient water usages in agriculture. Modern irrigation systems have to be introduced to the farmers. In the light of the study [9], education about agriculture is very important role to play for improving water management in farm level and it is very beneficial to train farmers and make them aware about importance of water management in agriculture.

4. Conclusion

Irrigation is the greatest contribution on crop yield and quality in water scant climates. Following practical recommendations can be presented for sustainable agricultural water management in water shortage agro-zones: Increase of farm lands with low water consuming crops, subsidize of low water consuming crops, practicing up to 25% deficit irrigation for some crops likes sugar beet, maize, potato, dry bean, pumpkin, directing of new studies about development of new crop cultivars with resistant to the dry

zones, night irrigation practices, and education of farmers about efficient water uses.

Conflict of Interest

The authors declare that there is no conflict of interest.

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Influence of urease inhibitor on mineral nitrogen content in soil and productivity of winter wheat

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Abstract: The research was performed in 2019–2020 LAMMC at Rumokai Experimental Station of the Lithuanian Research Centre for Agriculture and Forestry. The soil was calcareous luvisol, the granulometric composition was a silt loam on clay. Winter wheat, after resumption of vegetation fertilized KAS-32 and Leader 24-6. Nitrogen active substance: 60 + 60 + 30. In I and II fertilizations, these liquid fertilizers were used in combination with a urease inhibitor. Mineral nitrogen in the soil was investigated twice: during the grain milk stage of wheat and after harvest. In the grain milk stage in 2019 the urease inhibitor increased mineral nitrogen by 25.8–30.0%. In 2020 the effect of a urease inhibitor on the mineral nitrogen content of the soil has not been found. After the harvest in 2019 in the fields where nitrogen fertilization with urease inhibitor was applied in the 0–30 cm layer of nitrate nitrogen was significantly lower than in the control fields. The effect of the urease inhibitor on winter wheat grain yield was not found in the study years.

KEY WORDS: SOIL NITROGEN, UREASE INHIBITOR, WINTER WHEAT, GRAIN YIELD.

1. Introduction

Only in the 20th century the world's population has grown from 1.65 billion up to 6 billion. This number is predicted to increase in 2057 and should rise to 10 billion people (<http://www.worldometers.info/world-population>). So, the demand for food is growing, the need for food production is increasing. Synthetic solid and liquid mineral fertilizers are increasingly being fertilized in order to achieve higher yields and improve plant supply of easily obtainable nutrients (Zhang X., 2019).

Nitrogen fertilizers consumption is 44–48% of total resource consumption in agricultural production. (<http://www.fao.org/3/ca6746en/ca6746en.pdf>). Thus, the use of these fertilizers is associated with many negative effects on the environment and is a major source of gas that causes a greenhouse effect (Byrne et al., 2020). The higher nitrogen losses are when is higher amount of mineral nitrogen in the soil and higher nitrogen fertilization rates. Higher precipitation leaches this nitrogen into deeper soil layers, especially when 30 mm or more of precipitation falls in a short time (Staugaitis et al., 2008). Nitrogen is then lost, and groundwater is polluted. (Čermák and Kubiuk, 2009).

Nitrogen (urea) in amide form is mainly used in commercial farms worldwide. It accounts for about 40% of nitrogen consumption (Daigh et al. 2014; <http://www.fao.org/3/w6928e/w6928e06.htm>). However, this form of nitrogen on the soil surface is rapidly hydrolyzed (decomposed into ammonia and carbon dioxide) by the enzyme urease (an enzyme secreted naturally by microorganisms, fungi and plants in the soil). Studies have shown that up to 70–75% of nitrogen is lost to the environment from urea (Modolo et al., 2018; Sigurdarson et al., 2018; Sun et al., 2019; Klimczyka et al. 2021). 1926 the urease enzyme was discovered in bean seeds (Baiq et al., 2020) and its existence in the soil was proved in 1935 (Dhanker et al., 2021).

Thus, the use of urease inhibitors in agricultural practice has long been studied as one of the strategies to reduce nitrogen losses from mineral fertilizers and to allow more nitrogen in unchanged form to reach the plant root zone (Del Moro et al. 2017, Klimczyka et al. 2021). The most common chemically stable and non-toxic compounds are N - (- butyl) thiophosphoric triamide (NBPT) and N - (- propyl) thiophosphoric triamide (NPPT) (Klimczyka et al. 2021). Urease inhibitors used in conjunction with nitrogen fertilizers do not modify their granules either chemically or physically and do not modify the structure of nitrogen molecules (Folina et al., 2021). These substances only temporarily reduce the activity of urease enzymes, slow down the rate of urea hydrolysis, during which the amide nitrogen NH₂ decomposes to ammonium NH₄⁺ and reduce the evaporation of ammoniacal N-NH₃ nitrogen from urea-containing fertilizers (Klimczyka et al. 2021). As urease inhibitors reduce the formation of ammonium NH₄⁺ and nitrate NO₃⁻ nitrogen from amide nitrogen fertilizers, the risk of nitrogen leaching to groundwater is also reduced.

The aim of the study was to determine the effect of a urease inhibitor used with a fertilizer containing amide nitrogen on the mineral nitrogen content of the soil in a winter wheat crop.

2. Objects and methods

The field experiment was conducted in 2019–2020 at the Rumokai Experimental Station of the Lithuanian Research Centre for Agriculture and Forestry. Winter wheat (*Triticum aestivum* L.) cultivar ‘Janne’ was growing, it was sown on 11 09 2018 and 18 09 2019. Winter wheat was fertilised complex fertiliser NPK 5-21-36 was used, treatment rate – 300 kg ha⁻¹. In spring the winter wheat in that plot was fertilised UAN-32 (N total 32 % including N-NO₃ – 8 %, N-NH₄ – 8 %, N-NH₂ – 16 %) and Leader 24-6 (N total 24 including N-NO₃ – 8 %, N-NH₄ – 5 %, N-NH₂ – 11 %. S – 6 %) Fertilizer rates were N₆₀₊₆₀₊₃₀. In I and II fertilizations, these liquid fertilizers were used in combination with the urease inhibitor Limus Clear (188 g l⁻¹ N-(-butyl) thiophosphoric triamide (NBPT) + 87 g l⁻¹ N-(-propyl) thiophosphoric triamide (NPPT)).

The plants were fertilised in spring following the renewed vegetation at growth stage BBCH 25–27 (tillering phase), for the second time at BBCH 30–31 (beginning of the stem elongation), and for the third time at BBCH 39 (flag leaf stage). Plant protection products were used as needed.

In 2019, the winter wheat was harvested on 30 July. In 2020, it was harvested on 10 August.

Before harvesting, crop samples were taken from four spots of each plot within 0.25 m² area for determination of biometric indicators: plant density, total number of productive stems, straw and ear length, number of grains per ear, and 1000 grain weight. During harvesting, the grain collected from each experimental plot was weighed separately, grain moisture content and cleanness were determined. Winter wheat grain yield was expressed in moisture of 14% and absolutely clean mass. The crude protein content in grain was determined using the Kjeldahl method – it was obtained by multiplying the total nitrogen by 6.25, starch content was determined using a polarimeter, wet gluten – by washing the dough using the Perten Instruments' Gluten Index method (Glutomatic System specified in EN ISO 21415-1), sedimentation – by the Zeleny test (ISO 5529), mass per hectolitre was determined by means of a HLM device compliant to ISO 7971-2.

The experiment was conducted on the Calcaric Luvisol (according to WRB, 2014). Soil texture was silt loam on loam and heavy clay loam. The pH_{KCl} value in the 0–20 cm soil layer was 5.9–6.4, humus – 1.91–2.33%, i.e., the values were low and average. The content of P₂O₅ was 148–165 mg kg⁻¹, which was average, and that of K₂O was 200–216 mg kg⁻¹ – high.

Soil pH_{KCl} was determined in 1 M KCl extraction using potentiometric method (ISO 10390), ratio 1:5, P₂O₅ and K₂O – by the Egner-Riehm-Domingo (A-L) method, humus – using a carbon analyser after dry combustion compliant with ISO 10694, where the organic carbon concentration was multiplied by 1.724. N_{min} content was determined in 1 M KCl extraction in air-dry samples (ratio 1:5) using flow analysis (FIA) and spectrometric. Mineral nitrogen (nitrate and ammonia) was determined at winter wheat growth stage BBCH 65 and after harvesting.

Weather conditions. 2018–2019 season. September was dry and warm. In October–November, the daily mean temperature values

were 1.4°C and 0.6°C higher than the SCN, and the soil moisture was normal due to sufficient rainfall in October. The winter in that region was warm and mild, the average daily temperature was 0.03°C in December, -4.1°C in January, 1.8°C in February, and 3.9°C in March. The mean air temperature was 8.4°C in April and 12.5°C in May and those values were favourable for plant growth. The plants survived under drought conditions from April to the second 10-day period of May, depleting moisture reserves accumulated after the winter, however, during the last week the plants felt moisture scarcity and plant leaves appeared wilted in the daytime. It rained profusely in the second half of May, and eventually the precipitation fell in the form of heavy rainfall. June was hot and not rainy. The mean daily temperature of that month was 20.4°C or 4.8°C higher than the SCN, and the precipitation was only 25.7 mm (SCN – 50 mm). During that period, the plants felt a lack of moisture again. During the first ten days of July, 60.6 mm of precipitation fell, and that was enough to restore moisture reserves in the soil. In the second and third 10-day periods, there was little rainfall, and the weather was warm which allowed normal grain ripening in ears. 2019–2020 season. It was 1–3°C warmer than usual in September–November 2019 and the monthly precipitation rate reached 44–47 mm, only in November the rainfall was lower – 13.2 mm. The sown winter wheat germinated evenly, and the plants were 8–12 cm tall by December. The moisture of the soil ploughing layer ranged from normal to dryish; however, at that time water evaporation was slow and moisture was sufficient for the plants. The winter was unusually warm: the mean daily temperature values in December–February was 2.8–2.9°C, and it was a little colder in March – 1.8°C. The winter wheat overwintered well, and its condition remained almost unchanged during the winter until the beginning of April, when its growth resumed. April and May were cool, however, the amount of precipitation varied significantly: only 2.1 mm in April and 93.8 mm in May. Dry March and almost rainless weather in April dried up the soil; therefore, the plants felt a lack of moisture and were less tillered in the second half of April. Rainy May restored soil moisture reserves, and an even rainier June, when 129.4 mm of rain fell during the month, led to excess moisture in that month and facilitated the high spread of leaf disease. July and the first 10-day period of August were cool, slightly humid and favourable to grain formation in ears. The data of the research were evaluated using the dispersion analysis method (ANOVA) with the SELEKCIJA software package (Raudonius, 2017).

3. Results and discussion

In 2019 at the milk ripening stage of wheat, the content of nitrate nitrogen in the 0–30 cm soil layer using fertilizers with a urease inhibitor was 25.8–35.0% higher than without the inhibitor (Table 1). The urease inhibitor slowed the transformation of amide nitrogen to ammoniacal nitrogen after fertilization, at the same time slowing down the nitrification process. In fields where nitrogen fertilizers were used without inhibitor, nitrogen fertilizers were rapidly transformed into mineral nitrogen and were either consumed by the plants immediately after fertilization or washed away by precipitation. Meanwhile, in the fields where inhibitors were used, the transformation of the fertilizer slowed down, spread over a longer period of time, and the plants made better use of it. A similar trend was found when studying nitrate in the deeper 30–60 cm layer. In 2020, with the use of inhibitors, no significant increase in nitrate nitrogen in the soil was observed during the wheat milk ripening stage. This may have been affected by heavy rains in June. During that period, nitrified nitrogen was leached from the soil.

Table 1. Influence of urease inhibitor on nitrate nitrogen content mg kg⁻¹ in the soil in winter wheat crop in stage BBCH 65

Treatments	2019		2020	
	0-30 cm	30-60 cm	0-30 cm	30-60 cm
UAN-32	9,12	2,30	3,36	1,56
Leader 24-6	3,20	1,49	3,29	1,18
UAN-32 + LC	11,47	4,14	3,91	2,02
Leader 24-6 + LC	4,32	2,28	3,38	1,33
LSD ₀₅	2,293	1,656	1,932	1,049

Note: LC -Limus Clear, urease inhibitor

The effect of a urease inhibitor on the amount of ammonia nitrogen in the soil during the milk ripening stage of wheat in 2019 not identified (Table 2). In 2020, with the inhibitor with UAN-32 fertilizer, the ammonia nitrogen content at a depth of 0–30 cm was 70.7% lower than without the inhibitor. The difference was significant. No significant differences in ammonia nitrogen content were observed in the 30–60 cm layer using the inhibitor.

Table 2. Influence of urease inhibitor on ammonia nitrogen content mg kg⁻¹ in the soil in winter wheat crop in stage BBCH 65

Treatments	2019		2020	
	0-30 cm	30-60 cm	0-30 cm	30-60 cm
UAN-32	3,34	1,53	6,82	1,33
Leader 24-6	2,74	1,09	2,07	1,01
UAN-32 + LC	3,27	1,56	2,00	1,23
Leader 24-6 + LC	2,19	1,44	1,87	0,98
LSD ₀₅	1,013	1,048	1,142	0,387

Note: LC -Limus Clear, urease inhibitor

From an environmental point of view, the amount of mineral nitrogen in the soil after harvest is very important. If a lot of mineral nitrogen remains, the plants do not use it, it leaches or is released into the atmosphere, then increasing environmental pollution.

In our study in 2019 in the fields where nitrogen fertilization with urease inhibitor was applied in the 0–30 cm layer of nitrate nitrogen was reliably less than in the control fields (Table 3). The same trends were observed at a depth of 30–60 cm, but the differences were not statistically significant.

2020 a significant reduction in nitrate nitrogen with the use of a urease inhibitor was found only in the 30–60 cm soil layer when the inhibitor was used with Leader 24-6 fertilizers.

Table 3. Influence of urease inhibitor on nitrate nitrogen content mg kg⁻¹ in the soil in winter wheat crop after harvesting

Treatments	2019		2020	
	0-30 cm	30-60 cm	0-30 cm	30-60 cm
UAN-32	13,78	1,88	10,62	6,85
Leader 24-6	5,11	1,12	8,83	7,92
UAN-32 + LC	11,35	1,73	10,77	7,57
Leader 24-6 + LC	2,83	0,93	9,49	3,69
LSD ₀₅	2,241	1,219	1,268	1,647

Note: LC -Limus Clear, urease inhibitor

2019 and 2020 only a tendency to decrease ammonia nitrogen content in the 0–30 cm soil layer using a urease inhibitor was found (Table 4). In the deeper layer, 30–60 cm, a reliable reduction of ammonia nitrogen was found only in 2020 using a urease inhibitor in combination with Leader 24-6 fertilizer.

Table 4. Influence of urease inhibitor on ammonia nitrogen content mg kg⁻¹ in the soil in winter wheat crop after harvesting

Treatments	2019		2020	
	0-30 cm	30-60 cm	0-30 cm	30-60 cm
UAN-32	2,43	1,37	1,48	1,71
Leader 24-6	1,99	1,05	1,44	2,65
UAN-32 + LC	1,92	1,24	1,27	2,17
Leader 24-6 + LC	1,96	1,10	1,21	1,19
LSD ₀₅	1,590	0,711	0,342	0,872

Note: LC -Limus Clear, urease inhibitor

The urease inhibitor used with UAN fertilizer reliably increased the number of productive stems (Table 5). Later nitrogen fertilizers transformation to available forms for plants improved the nutrition conditions of wheat and the plants formed more productive stems. However, the use of a urease inhibitor with Leader 24-6 fertilizer did not show the same effect. Perhaps due to the fact that the

percentage of amide nitrogen in these fertilizers is lower than in UAN-32 fertilizers.

Nitrogen fertilizers applied with the inhibitor also had a positive effect on the number of grains in the bellows. No effect of urease inhibitor was observed on 100 grain weight and grain yield.

Table 5. Influence of urease inhibitor on productivity indicators and grain yield of winter wheat

Treatments	Number of productive stems per m ²	Number of grains per ear	1000 grain weight g	Grain yield t ha ⁻¹
UAN-32	601,1	43,775	38,38	7,058
Leader 24-6	581,4	43,375	39,15	6,452
UAN-32 + LC	653,6	44,625	38,49	6,984
Leader 24-6 + LC	563,5	44,45	38,77	6,432
<i>LSD₀₅</i>	22,01	1,56	1,125	0,281

Note: LC -Limus Clear, urease inhibitor

Grain quality was better for wheat fertilization using UAN-32 fertilizer (both with and without inhibitor) (Table 6). Statistical calculations showed that the fields containing UAN fertilizers, wheat grain protein content, sedimentation and gluten were generally higher than in the fields fertilized with Leader 24-6 fertilizers.

The use of urease inhibitors in this study showed an upward trend in protein, sedimentation, and gluten, but the differences were unreliable. Only the increase in hectolitre weight using the inhibitor with Leader fertilizer was statistically significant

Table 6. Influence of urease inhibitor on grain quality of winter wheat

Treatments	Crude protein %	Sedimentation %	Gluten %	Weight per hectolitre kg hl
KAS-32	12,47	41,80	24,12	78,47
Leader 24-6	10,58	28,20	19,03	76,82
KAS-32 + LC	12,67	43,20	24,87	78,63
Leader 24-6 + LC	10,67	29,75	19,32	78,70
<i>LSD₀₅</i>	0,367	2,561	1,086	0,518

Note: LC -Limus Clear, urease inhibitor

Statistical analysis revealed that the quality of grain was influenced by the amount of nitrate nitrogen in the soil during the milk ripening stage. A reliable correlation of medium strength was obtained (Table 7). The relationship between ammonia nitrogen content in the 0-30 cm soil layer and grain quality has not been found. A reliable but weaker correlation was found between the amount of ammonia nitrogen in the 30-60 cm layer and grain quality.

Table 7. Correlation coefficients between grain quality and mineral nitrogen content

	Nitrate nitrogen content 0-30 cm	Ammonia nitrogen content 0-30 cm	Nitrate nitrogen content 30-60 cm	Ammonia nitrogen content 30-60 cm
Crude protein	0.623**	0.231	0.627**	0.525*
Sedimentation	0.676**	0.214	0.682**	0.568*
Gluten	0.619*	0.198	0.648**	0.527*
Weight per hectolitre	0.575*	-0.100	0.599*	0.412

* - P<0.05, ** - P<0.01

4. Conclusion

Urease inhibitor slowed the hydrolysis of amide nitrogen, so that in the later stages of growth winter wheat was better supplied with the nitrate form available to plants. In 2019 during the milk ripening stage the content of nitrate nitrogen in the 0-30 cm soil layer using fertilizers with urease inhibitor was 25.8 - 35.0% higher than without inhibitor. In 2020 due to the high precipitation rates inhibitor effect on nitrate nitrogen has not been found.

The retardation of amide nitrogen hydrolysis had no effect on grain yield. With the use of urease inhibitors, a tendency of increase of protein content, gluten and sedimentation was observed

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Analysis of climatic variations and the ability of organic farming systems to adapt to climate change in the Northern Western Lowlands - Shkodra area in Albania

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Abstract: The climatic performance of different ecological areas is determinant for agricultural production and its sustainability. The agriculture is closely related to climatic conditions as climate variability and climate change generate significant effects on agriculture. Analysis of climatic behavior of different ecological zones, are important to identify climate variations, but also phenomena related to climate change. The study of climate variations and the phenomena of climate change are important for agricultural activity, in order to adapt agricultural systems, implement mitigation strategies and adaptation to them. Organic farming systems offer the best solution in this regard. The northern western lowlands of Albania (Shkodra), is an area with significant agricultural activity and highly diversified, with a great potential for the implementation of organic farming systems. The analysis of the climatic variability of this area and the phenomena of climate change, will contribute to the orientation of agricultural activity towards organic systems in order to better adapt them to climatic variations and increase the sustainability of production.

Keywords: CLIMATIC ZONE, TEMPERATURE, RAIN, CLIMATE CHANGE, ORGANIC AGRICULTURE

1. Introduction

Agriculture is an activity closely related to climate and its sustainability depends on knowing the climate, its variations over time, climate change and the adaptation of agricultural systems related to them. Climate represents the community of average meteorological conditions (temperature, humidity, precipitation, wind, etc.) and environmental that characterizes a certain geographical region, estimated for a long period of time, over 30 consecutive years [1]. Global climate variations or variations of climatic parameters (temperature, humidity, precipitation, etc.) in average values represent the climate changes. Today at the global level, there is a very large number of research and studies on climate change, on the causes of change and their ecological impacts, which highlight the fact that global climate change is a phenomenon in action worldwide [2] and the impact of human activities on them is undeniable [3]. Climate change has become today a well-known and studied phenomenon by the international scientific community. It has to do not only with the increase of the average temperature, but with the modification of the whole climate system including precipitation, wind, extreme events, in different ways in different regions of the world [4]. Climate change understood as climate modification over time comes from both natural variability and human activities [2]. But the causes of climate change and global warming observed since the middle of the 20th century comes from human activities [2]. They are related to the modification of the greenhouse effect of the atmosphere, which due to the presence in the atmosphere of greenhouse gases (GHG) (water vapor, CO₂, N₂O, CH₄ and SF₆), cause the earth's surface to retain an amount of heat which enables plant and animal life. The IPCC claims that the increase in global average temperature in the second half of this century is attributed to the emission of greenhouse gases released by human activities with an increase from 66% to 90% [3], where the main gas is CO₂, the concentration of which in the last 100 years has increased by 40% [5]. The CO₂ emissions into the atmosphere come mainly from fossil fuel combustion and other processes and these are the main sources of emissions. They currently account for about 70% of total greenhouse gas emissions and are estimated at a total of 35.8 GtCO₂/year for 2016 [6]. The amount of CO₂ produced today, respectively 160 years ago is 150 times higher [3]. Currently, greenhouse gas (GHG) emissions, including land use emissions, land use changes and forests (LULUCF), are estimated at around 51.9 GtCO₂/year in 2016 [6]. Significant contribution to the release of GHG is coming by agricultural activity, which comes after the energy sector by releasing large quantities [4]. Unfortunately the agriculture uses agricultural practices associated with the release of large amounts of greenhouse gases. Globally, emissions from the agricultural sector account for about 10-12 % of total GHG emissions into the atmosphere [7], contributing to an emission rate

ranging between 5.1 and 6.1 GtCO₂ q/year in 2005. [8]. The agriculture in Europe contributes 10% of greenhouse gas emissions in 2012 [9]. Different agricultural systems contribute in different ways to the release of GHG, so conventional agricultural systems produce 40% more GHG and this is due to the fact that organic farming systems use 45% less energy respectively with conventional ones making a more efficient use of energy [10]. On the other hand, agriculture has an important role in capturing GHG especially in terms of organic carbon over time [11]. This can be made possible through the introduction of appropriate agronomic practices such as those that implement organic farming systems. Soils in bio systems have a carbon sink function estimated at about 0.5 ton/ha/year [10]. Analyses of many scientific publications show that the content of organic matter in the soils of organic systems is 7% higher than in conventional systems [12]. In conventional systems is verified the opposite process. Increased GHG emissions are the main cause of Earth's climate modification. One of the most visible indicators of climate change is the increase in land temperature (temperature of the atmosphere and oceans), which since 1861 has increased and in the 20th century, this increase has been about 0.6 °C, from the highest in the last 1000 years [13]. The European Environment Agency has made a detailed analysis and has noted that in the last 100 years the average temperature in Europe has increased by 0.95 °C (0.7 °C in summer and 1.1 °C in winter) to 0.76 °C which is recorded globally. [14]. The average surface temperature has increased by 0.6 °C in the last three decades [15]. The Mediterranean region will be one of the regions with the highest levels of vulnerability to the effects of global warming and climate change. Projections for expected temperature levels based on different scenarios, predict a significant increase in temperature in the Mediterranean basin [16]. There are also changes in the rainfall regime. According to the weather forecast scenarios, at these rates the total annual rainfall in 2100 will increase further by 20 – 25 % in Northern Europe and will decrease by about 10% in Southern Europe [17]. Changes in the rainfall regime determine significant changes in ecosystems especially in the southernmost areas, which have been accompanied by prolonged droughts. This phenomenon is most evident in agricultural areas where the lack of rainfall and drought has a direct impact on agricultural production. The area which is most vulnerable to change in rainfall regime and their reduction is the Mediterranean basin, which is increasingly more is being affected by drought phenomena which are increasing [18]. In Europe and the Mediterranean basin there is a noticeable seasonal and regional variability of precipitation and most during the winter [3]. According to studies conducted [19], Southern Europe, where Albania is taking part, is becoming drier and hotter and with less rainfall. Agriculture and rural areas will be most affected by climate change and especially by the lack of rainfall [20]. Albania will have strong restrictions on water availability for the agricultural sector. According to climate scenarios A1B [3] a

reduction between 4 and 27 % is estimated in Southern Europe and the Mediterranean region; most evident this will be during the summer season [21]. Expected climate change will further prolong the drought phenomenon which according to the NDMC [22], should be understood as an extended period with below average rainfall causing severe plant damage and declining productivity. Climate change is a complex problem that has a significant environmental impact and includes agriculture, water resources management and territory [23]. Drought is a problem for agriculture as a phenomenon, the frequency of which is fully estimated in the SREX report [24]. Undoubtedly one of the biggest impacts of climate change is in the agricultural sector. Agriculture contributes to climate change, but it in turn suffers [9]. Agriculture can be considered as one of the causes of climate change, but it is the economic sector that suffers more from the effects of climate change than any other sector. It in relation to climate change must be seen in the cause-and-effect relationship. The impact caused by climate change affects both production and food security. Agricultural production will change from year to year due to extreme meteorological events and other factors such as the spread of parasites and diseases [9]. [2] estimates that climate change will cause a reduction in agricultural production by 2050 between 9 and 21 %. For this, the impact of climate change on agriculture should be studied and adaptation measures should be proposed at local levels as agriculture represents the basis of human survival [25]. Rising temperatures (minimum and maximum) and increasing the frequency and intensity of extreme meteorological events, with a complex reduction in rainfall, risk having negative impacts on the agricultural sector, potentially reducing the production of many crops [2]. The decrease in the level of precipitation will be greater in the Mediterranean basin, in which a decrease in humidity and a greater drought will be verified in the summer period, while in other latitudes there will be an increase in precipitation in winter period [26]. Albania, which is part of the Mediterranean basin, will also have strong restrictions on water availability for the agricultural sector. In the conditions of climate change in action, intervention measures should be foreseen in all economic sectors to cope with their impacts, especially in the agricultural sector. This can be made possible through the introduction of two specific strategies, that of mitigation and adaptation to climate change [27]. These two strategies are complementary and various authors recommend that it is necessary to articulate adaptive responses to minimize the negative impacts generated by climate change and favor new economic and territorial development opportunities [28, 29].

The EU has drafted the European Strategy on Climate Change by setting concrete objectives [30]. Albania is also included in this context. Numerous factors affect the implementation of these two strategies in the territory and among these factors which affect mitigation and adaptation capacity are agricultural practices [31]. This requires the implementation of agricultural systems with great adaptability. The ability to adapt to climate change is defined as the ability of a system to adapt or recover and which can also be considered as resilience [32]. In agriculture this would require modifications to agricultural practices. According to studies conducted [33], the ability of agriculture to adapt to climate change can be increased if we implement correct agricultural practices and existing technologies. Adaptation measures in agriculture presuppose a series of interventions of different categories [34]. It is widely accepted that different behaviors can increase or maintain farm competitiveness and modify the extent of climate change impacts [35, 36]. The most promising systems that can implement good agricultural strategies and practices against climate change are those of organic farming. This is especially important for the Mediterranean area. This is due to the fact that organic agriculture has become synonymous with production systems based on sustainable ecological, economic and social management strategies [37]. Implementation of adaptation strategies to climate change in the sector agriculture would require firstly the analysis of short-term behavior towards long-term behavior of agricultural systems [38, 39] and secondly the analysis of climate data at the local level to identify climatic variations especially for the two main climatic

indicators temperature and precipitation in order to recommend adaptation measures. But the implementation of adaptation strategies would require the implementation of several sets of measures [34].

Albania, with a relatively small territory, 28,000 km², in most of the mountains with high altitude, near the Mediterranean Sea and in general with atmospheric circulation, presents different climatic conditions [40]. Albania has an average altitude of about 750 m but it varies from 0 to 2700 m above sea level. The western coastal area is flat and dominated by the Mediterranean climate, with mild winters and hot summers, with average winter temperatures around 7 °C and average summer temperatures around 24 °C to 30 °C, especially in the southwestern part. Mountainous areas, which make up about two-thirds of the territory, are most affected by the continental climate. Precipitation varies greatly between climatic zones, in coastal areas ranging from 1000 to 1500 mm and falls mainly during autumn and winter. Mountainous areas, especially in the Albanian Alps, can reach more than 2500 mm of rainfall, with 20% - 30% of it in the form of snow [41]. The area of the Western Lowlands of Albania is characterized by a moderate rainfall regime from about 650 mm to 1050 in its southern part (Vlora, Fier, Lushnje) to about 1050 mm to 1450 mm in its central area (Durrës, Tirana, Lezha) and with a larger amount in the northern part from 1450 mm to 1850 mm in the area below Shkodra. Looking at the normal course of precipitation in Albania, the drought periods are generally short, but in the conditions of climate change, according to the forecast scenarios, there will be a reduction of precipitation from their normal values, where there will be a decrease of annual precipitation (- 8.5 %), which vary from 1500 mm in the north, 965 mm in the center and 1120 mm in the south after 2050. While in 2100 the total rainfall will be (- 18.1%); in the northern part 1300 mm, in the center 860 mm and in the south 1000 mm with a variation from north to south from 1600 to 600 mm respectively [42]. This will prolong the phenomenon of drought, especially in the area of the Western Lowlands of the country. This study analyzes the climatic variability of the Shkodra area, referring to the main climatic indicators and their variations in time (temperature and precipitation), in order to identify climate fluctuations and the tendency of climate change to take measures in agriculture for the implementation of climate change adaptation strategies through the implementation of organic farming systems.

2. Material and methods

This study refers to the Shkodra area for the analysis of climate variability and verification of climate trends for which the collection of historical series of climate data has been done and their digitalization for the considered period as well as their comparison with the data of forecast scenarios, developed by the [19, 3] and data from other institutions such as the EEA (European Environment Agency), JRC (Joint Research Center) and WHO (World Health Organization) to assess the impacts of climate change in Europe through indicators [43]. The data include key climatic parameters such as temperature levels (maximum, minimum and average) and precipitation amounts. There are many studies conducted in time on the performance of historical time series of temperature and precipitation used as indicators of variation or climate change [44, 45, 46, 47]. In the Shkodra area, historical series of data were obtained for temperature indicators for the period 1951-1990 and for precipitation for the period 1970-1986 (daily data available). The data were provided by the archives of the Meteorological Stations and the Hydrometeorological Institute (data of historical meteorological series from Meteorological Bulletins) and other data, for a relatively long period of time. The processing of collected information, in order to identify climate variability and climate trends in the Shkodra area was done through climatic indicators. Their use also makes it possible to identify climate trends seen in relation to climate change.

The use of climatic indicators to identify extreme climatic phenomena has been considered and used by the IPCC [19]. The main problem regarding the use of indicators is related to determining the interval of their values or to what are considered as

threshold levels to be considered in defining a particular phenomenon [1, 48, 49, 50, 51]. For the analysis of climate variability and the determination of trends, based on the two main climatic parameters, temperature levels (maximum, minimum, average) and the sums of indicators developed by Frich et.al. [52]. Two other indicators of extreme rainfall phenomena were used in the study, indicators used by Haylock and Nicholls [53]: a) the amount of precipitation over normal climatic quantity, TEP (in mm) and the proportion of extreme precipitation, EP which is given as the ratio of TEP/TP (annual amount of precipitation), (in mm). The months with the maximum amount of precipitation (PM) were also analyzed to see the changes in the intensity of the monthly precipitation according to the respective years, drought periods of the year in order to compare drought conditions for the areas considered and to verify the changes of drought periods over time. Data processing is done with the help of Microsoft Excel software by creating a database in advance in order to facilitate the use of data by listing them as daily, monthly and annual values, which enables their use in the defined methods for processing of data. The methodology used has been that of the Global Climate Historical Network [54]. The analysis of variability and trend of indicators (intensity), which are used in the study and which also determine climate fluctuations, is done by means of linear regression test [55]; the variability of precipitation related to climate change is done by the method proposed by Osborn and Hulme [50], which analyzes the precipitation trend regarding the shape and degree of distribution to determine the precipitation days for each year analyzed and the periods of drought of the year; the change and trend over the years has been done by constructing ombrothermal diagrams [56]. The analysis of climate change changes in the considered areas was done by the method of comparing climate fluctuations from the initial conditions (from the year of reference) and the analysis of trends was done by comparing them with the data coming from the literature sources [2, 42], based on the projections of climate change forecasting scenarios which give the future climate trend. Based on the reference indicators for climate variability, recommendations have been made for the implementation of organic farming systems.

3. Results and Discussion

The Shkodra area lies in the northwestern part of Albania and is distinguished by its proximity to the Adriatic Sea. It lays from the western lowlands of Shkodra to the Alps. The Shkodra area lies in the northern Mediterranean plain, northern hilly Mediterranean and northern mountainous climatic zones. Its plain part is distinguished for mild winters, while the part of the territory that lies in the Mediterranean mountainous area is characterized by a high level of precipitation. The lowland plain area has an average annual temperature of about 11.1 °C, the hilly Mediterranean area around 9.3 °C and the Mediterranean mountainous area, which includes the Albanian Alps has an average annual temperature of about 5.3 °C. Regarding the precipitation regime, the part of the Lowlands, ie the Mediterranean plain area, is characterized by a lot of precipitation about 1750 mm, the hilly Mediterranean area about 1950 mm per year and the Mediterranean mountainous area with about 2530 mm per year. The upper part of the mountain, the Albanian Alps area is one of the areas with the highest level of precipitation in the country. In special years in the lake area precipitated up to 3000 mm per year. The average annual rainfall in the Shkodra area is about 2065 mm. Being a region which is characterized by a high rainfall regime, the largest amount of them recorded on September 26th/1952, with 291mm per day, which indicates a very high intensity. In the Alpine area rainfall reaches up to 3000 mm per year. The largest amount of rainfall recorded in this region, but also in Albania, has fallen in Boga in 1958 with 5238 mm of annual rainfall. The highest rainfall intensity (Bogë) with 420 mm for 24 hours was recorded here on December 15th/1963, a record amount for the conditions of our country. Precipitation is in the form of rain, while in the form of snow they fall during the winter and mainly in

the Mediterranean mountainous area. Shkodra has a high level of sunny days with around 2450 - 2650 hours.

3.1 Analysis of the variability of the thermal regime in the Shkodra area

For the analysis of the thermal regime in the Shkodra area, daily data were obtained from the Shkodra meteorological station for the indicators maximum average temperature, minimum average temperature and average temperature for the years 1951 - 1990, ie a period of 40 years sufficient to analyze the performance (variability), fluctuations and trends of the thermal regime in this area. The daily values for the three meteorological temperature parameters were used in the processing, while in the graph they are brought as annual average daily values.

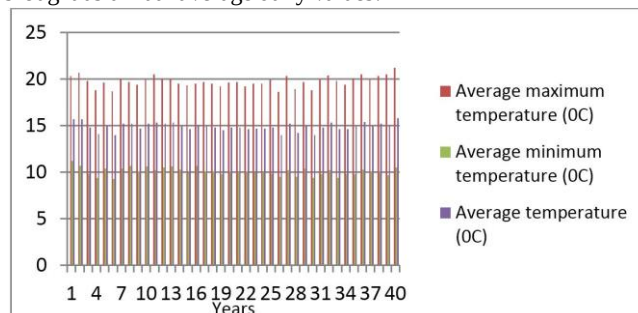


Figure 1: Thermal regime in the Shkodra area (1951-1990)

In order to determine the performance and fluctuations of the maximum average temperature, graphical analysis of data and determination of trends by linear regression test was performed [55].

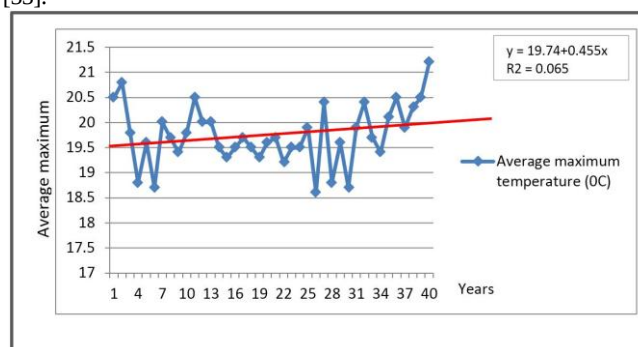


Figure 2: Fluctuations of the maximum average temperature

From the above analysis it results that in the Shkodra area there are fluctuations of the maximum average temperature values around its average values but with an increasing trend in recent years, which is given by the regression equation and the correlation coefficient and that argues the fact that the maximum mean temperature has a marked upward trend in recent years relative to the reference year (1951). This trend also coincides with the data provided by the climate forecast scenarios for the Mediterranean basin [3].

The determination of the performance and fluctuations of the minimum average temperature and the graphical analysis of the data by means of the linear regression test were also done [55].

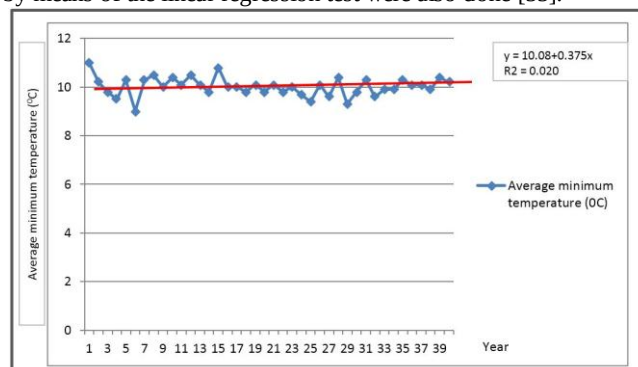


Figure 3: Fluctuations of the minimum average temperature

From the graphical analysis and from the data obtained on the basis of the equation of linear regression and correlation coefficients, it is seen that the minimum temperature in this area has a performance around its normal values, without any clear tendency expressed for its increase, in difference from the maximum temperature.

The average temperature performance and fluctuations and graphical analysis of the data were also analyzed by linear regression test [55].

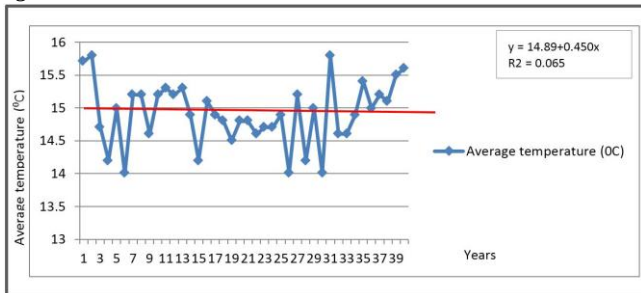


Figure 4: Fluctuations of the average temperature

From the analysis of the obtained values and on the basis of the values of the equation of linear regression and correlation coefficients, it results that the average temperature presents a significant upward trend, influenced by the performance of the maximum temperature.

For the Shkodra area, the trends of the thermal climate regime have been determined based on 40 years of data provided by historical meteorological series and their analysis has been done by indicators of [52].

From the processing of data and analysis of values for thermal indicators considered, on the basis of daily data for the period 1951-1990, for the Shkodra area result the following values.

Table 1: Analysis of thermal indicators, Shkodra area (1951-1990)

T _{max}	T _{min}	T _{average}	FD (/day)	ETR (°C)	GSL (/day)	HWDI (/day)	Tn90 (%)
19.7	10.1	14.9	16	37	245	43	8.5

From the analysis of the indicator "Fd" which determines the total number of frosty days (days with minimum temperatures < 0°C) (expressed in days) and its performance for the period considered it can be seen that in recent years it has a tendency to decrease marking relatively few days with sub-zero temperatures.

From the analysis of this indicator "ETR", which determines the radius of the annual peaks of thermal extremes, ie the difference between the highest temperatures of the year (T_n) and the lowest temperatures of the year (T_l) for the same time period expressed in °C, from its performance it can be seen that there are fluctuations in temperature amplitude, which, as we mentioned above, creates stress conditions in plants.

Regarding the GSL indicator which determines the extension of the growth period: the period between when Daily T > 5 °C for > 5 d and Daily T < 5 °C for > 5 days (expressed in days), its analysis shows that there is a tendency to lengthen the period of plant growth, as the period of the year with higher temperatures has been extended, especially during the autumn season.

The "HWDI" indicator is also analyzed, which determines the duration of heat waves: periods with a maximum > 5 days following with T_{max} > 5 °C greater than the normal value of normal T_{max} for the period considered (expressed in days), where from its performance it is evident that there is an increase of heat waves in this area although at lower levels than other areas, given that the area is characterized by higher levels of precipitation.

Regarding the determination of the progress and tendencies of the thermal regime is analyzed "Tn90", which determines the percentage of time with T_{min} > 90 % of days with minimum daily temperature (expressed in%), from which it results that this indicator has come to decrease, due to the slightly increasing tendency of the level of minimum temperatures.

From the analysis of the performance of thermal indicators to determine the tendency of the thermal regime through the linear regression test [55], for the Shkodra area it results that there is an increasing tendency of maximum temperatures, there is a tendency to fluctuation but not increasing minimum average temperatures and an increasing trend of average temperatures. The increase in the maximum temperature has led to a decreasing tendency for frosty days during the winter season.

The conclusion regarding the thermal performance in this area also coincides with the data of the forecast scenarios of climate change where it results that Albania (which includes the Shkodra area) will be warmer [42].

3.2 Analysis of the variability of the precipitation regime in the Shkodra area

For the analysis of the progress and fluctuations of the precipitation regime in the area of Shkodra, daily data were obtained for the indicator of the amount of rainfall, expressed in mm for the years 1970 - 1986.

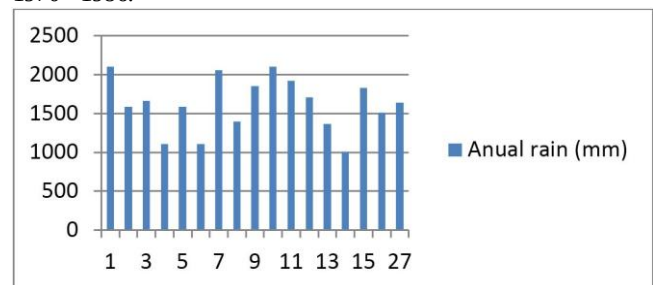


Figure 5: Precipitation regime in Shkodra area

To determine the performance and fluctuations of the pluviometric regime in the Shkodra area, a graphical analysis of the data and the determination of trends by means of a linear regression test were performed [55].

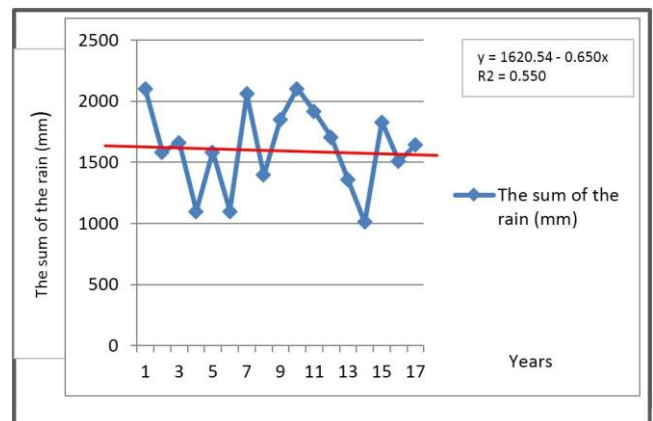


Figure 6: Fluctuations of the pluviometric regime

From the analysis of the performance of the precipitation regime in the Shkodra area and from the data obtained from the statistical analysis through the linear regression test, it can be seen that there is a downward trend in recent years, ie a decrease in the annual amount of precipitation, a situation that is also evidenced in other studied areas.

The variability and trends of the rainfall regime for the Shkodra area are based on multi-year daily rainfall data, which are analyzed by indicators of Frich et al., [52], indicators which give the trend (trend) of performance of the precipitation regime in time. From the analysis of the data for these indicators the following values result.

Table 2: Performance of the precipitation regime

TP (mm)	PM (mm)	R10 (day)	CDD (day)	R5D (mm)	SDII (mm/day)	TEP (mm)	EP (mm)
1620.5	88.9	51	120	296.3	12.2	290.6	0.19

From the analysis of the indicator "R10", which gives the number of days with precipitation $\geq 10 \text{ mm d}^{-1}$ (per day), it results that according to its values in years there is an increase in the number of days with precipitation greater than 10 mm, which indicates that the rainfall has become shorter and more intense in this area.

For the "CDD" indicator, which gives the maximum number of drought days (Daily $R < 1 \text{ mm}$) (expressed in days), from the analysis of its values it can be seen that there is an increasing trend in recent years, based on the values that gives the linear regression test indicator which determines a decrease in the level of precipitation in recent years.

For the indicator "R5d", which gives the maximum maximum precipitation in 5 days (in mm), from the analysis of its values it results that there is an increasing tendency of the amount of rain millimeters in 5 days, which indicates an increase of rainfall intensity.

For the indicator "SDII" which gives a simple daily intensity that gives the annual amount/number of days with daily rainfall Daily $R \geq 1 \text{ mm d}^{-1}$ (in mm/day), it is seen that there is an increasing trend of the values of this indicator, which proves that rainfall has become more intense in recent years.

In the analysis related to the precipitation trend, two indicators have been taken into account, which are the amount of precipitation over the normal climatic quantity, TEP (in mm) and the ratio of extreme precipitation, EP, which is given as the ratio of TEP/TP (annual precipitation amount), expressed in mm [53], where from the calculation of the values of these two indicators it results that there is an increase in the intensity of precipitation over the years and an increase in the phenomena of disorder in their distribution.

To determine the drought periods of the year in the Shkodra area, the indicators of Bagnolous & Gossen ombrothermal diagrams have been analyzed [56], in order to compare drought conditions and verify the changes of drought periods over time.

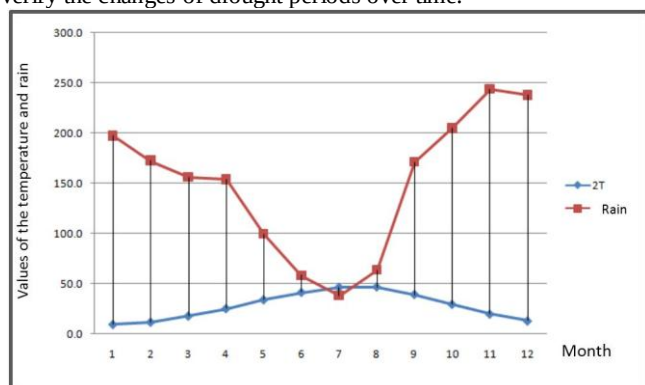


Figure 7: Ombrothermal diagrams of drought periods

From the analysis of the diagram it results that in this area there is an extension of the dry periods of the year, accompanied by a decrease in the amount of precipitation, as verified by the graphic presentation.

In conclusion, we can say that from the analysis of all indicators, regarding the progress of the precipitation regime and determining their trends in time, for the period under analysis, it is clear that precipitation in the territory of Shkodra area has a tendency to decline, there is a noticeable seasonal change in their distribution and have become more intense in recent years. This conclusion also coincides with data evidenced by other studies and data provided by the projections of climate forecast scenarios [3] and the Third National Communication of the Republic of Albania on Climate Change [42].

4. Conclusions

From the study conducted for the Shkodra area for the analysis of climate variability, thermal and pluviometric performance and the determination of climate trends over time, from the analysis of all indicators for the thermal regime shows that there is a tendency to increase maximum temperatures, there is a tendency in fluctuations

but not an increase in minimum average temperatures and an increasing tendency to average temperatures. The increase in the maximum temperature has led to a tendency to decrease the frosty days during the winter season. Regarding the progress of the rainfall regime and the determination of their trends in time, it is clear that rainfall in the territory of Shkodra area has a downward trend, there is a significant seasonal change in their distribution and have become more intense in the years of last. The results of this analysis also coincide with data evidenced by other studies by international institutions [32]. This trend of climate change raises the need for modification and adaptation of agricultural systems, through a short-term and long-term analysis of systems leading to the recommendation of measures for the implementation of organic farming systems, which demonstrate a high degree of adaptability in all contexts to climate change.

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Assessment of vegetation establishment on different tailings depot at an iron ore-mining site of Gol-e-Gohar, Sirjan, Iran, three years after depot

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Abstract- Nowadays, the ecological restoration of mining tailings has become one of the urgent tasks for mine managers and environmental engineers all over the world. The present paper aims to highlight how the reaction of different iron ore tailings to the natural revegetation process. For this purpose, three tailing forms were selected in Gol-e- Gohar mining region, Sirjan city, Kerman province, Iran. These types of mineral tailing are dry tailings depots, wet tailings, and overburden and three years passed after their depot. These three Iron ore tailing forms are the main elements of iron exploitation. For vegetation assessment, using 2m² plots in each different tailing depot, plant species were recorded. All plant data was transferred to R software. Finally, 45 plant species belong to 18 genera were recorded in the adjacent un-mine site as a control area. To evaluate the diversity of vegetation composition, the Shannon - Wiener index was performed and plant diversity was obtained for each tailing. According to the results, the Overburden vegetation with an index of 1.49 has the highest diversity after the control area (1.95) and supports a larger number of plant species (21 species). Wet tailings and un-stabilized dry tailings have the least plant diversity (0.00), while mulch-stabilized dry tailings support a larger number of plant species (Four species and 0.96 Shannon index). The results show that to restore the vegetation of different tailings, local raw materials and overburden should be used due to their nutrients and strong seed bank.

Keywords: IRON ORE, TALING, RESTORATION, SHANNON- WIENER INDEX, IRAN

1. Introduction

The resources in any form play the most important roles in civilization and human life. The imagination of a world without resources like water, soil, air, and plants is almost impossible, so attention to these ingredients of the earth is too important for any planning for the current time or future. The land in public opinion does not similar to other resources, but the growth of our civilization heavily relies upon the lands and the mining industry is one of the most important human activities to operate and maintain comfort. Industrial activities have both positive and negative consequences. Surface mining for iron, coal and other valuable geological materials has been causing severe ecological disturbances worldwide since prehistoric times. The rate of consumption of mineral resources is still increasing due to the acceleration of urbanization, population growth, and the advancement in technology and science, which has been exceptionally fast in the 20th and 21st centuries [1]. The result for mining activities on the surface is mining wastes and alteration of landforms, which is a concern to the society and it is desired that the pristine conditions be restored [2]. The mining disrupts the aesthetics of the landscape along it disrupts soil components such as soil horizons and structure, soil microbe populations, and nutrient cycles which are crucial for sustaining a healthy ecosystem and hence destroy existing vegetation and soil profile [3]. The mineral extraction process must ensure the return of productivity of the affected land and this is necessary for mine managers, which will ensure the health of ecosystems will be good at the final processing of mining. Reclamation is the process by which derelict or highly degraded lands are returned to productivity, and by which some measures of biotic function and productivity is restored. Despite common sight public opinion, reclamation of degraded lands and mineral tillage is a time-consuming process. Since soil is a living system, it has the potential to return to health over time with a regeneration program. Long-term mine spoil reclamation requires the establishment of stable nutrient cycles from plant growth and microbial processes[4, 5]. Soil provides the foundation for this process, so its composition and density directly affect the future stability of the restored plant community. Restoration of vegetation cover on mining tiling dumps can fulfill the objectives of stabilization, pollution control, visual improvement, and removal of threats to human beings. The commonly applied technique in the reclamation of derelict-mined lands, in general, involves the

reconstruction of topsoil and planting [6]. In many of the mine sites, however, availability of sufficient soil can be a constraint for such operations, so natural succession is the available method for this purpose.

Tailing, in context to mining, is defined as the waste or noneconomic by-product generated during mining activities, processing of minerals, and other materials that contain small amounts of residual valuable minerals, chemicals, water, and heavy metals [7] so the purpose of this study is to investigate the status of vegetation in mineral tailings in Gol-e- Gohar mines. These mines are one of the largest iron mines in Iran and play an important role in the development of steel industries in Iran. The whole area of Gol-e- Gohar mines has been part of semi-arid rangelands [8] that have been changed due to iron ore extraction. Since vegetation restoration is one of the long-term plans of the managers of these mines, the present study was conducted to evaluate the potentials of iron ore tailings for the establishment of vegetation.

2. Materials and Methods

2.1 Study Area

The study area

The study area is part of the Gol-e- Gohar mining area (29°05'02"N 55°20'58"E) and mining activities are currently being carried out in it. This area is a desert region with a temporal salt lake (Kavire- e- Sirjan in Persian) located in the west part of main pits nearby Sirjan – Shiraz road (Figure 1). The mean annual temperature and mean annual rainfall during 2005-2015 were 18°C and 124 mm. Rainfall regime of the study area, similar to most of the central and desert regions of Iran, is the Mediterranean so almost 70% to 80% of the annual precipitation is concentrated in the months from September to March, while less than 5% occurs in the summer.

Drought index in the study area based on available statistics and the relationship of De Martonne aridity index is equal to 4.60, which according to the climatic classification Gol-e- Gohar range has a dry climate.

The average elevation of study area is roughly 1700 meters above sea level. Much of study area covered by native halophyte, e.g., *Halocnemum strobilaceum* M.B. and non-halophyte species *Artemisia sieberi* Besser and *Zygophyllum eurypterum* Boiss. & Buhse

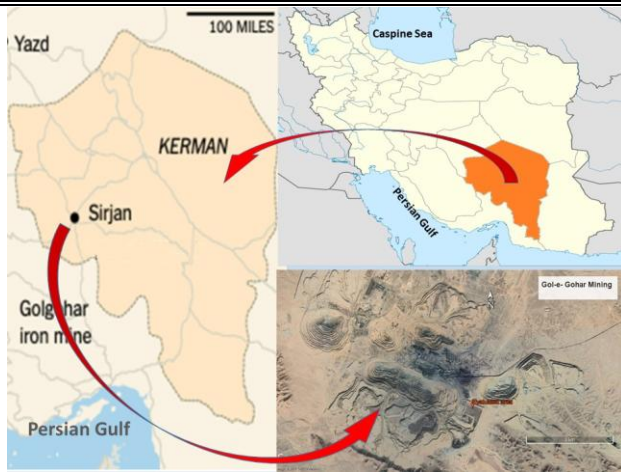


Fig. 1 Geographical position of study area in Kerman province of Iran

2.2 Methods

Three iron ore tailing forms in this study were selected from different parts that have been at least three years since their depot. the soil and vegetation have been destroyed during the Extraction of iron ore, in these parts. Three main Iron ore tailing forms are the main elements of iron exploitation are, Wet tailings collected in the form of sediments in the tailings dam, Iron ore dry tailings and finally Overburden. Three sections of masses created from different mineral tailings were selected for study.

In the case of dry tailings depots, we face two types of tailing Depots. Mulch-stabilized tailings and non-stabilized tailings. To assess the vegetation, in the first step, the natural vegetation as the control area was evaluated. To identify plant species in this area, work was done by 2 m² plots and collecting different plant species in each plot. In each treatment, 20 plots were established and evaluated separately. Unknown species were transferred to the plant herbarium at the University of Tehran for identification. The same method for collecting plants on iron ore tailings includes dry tailings depots (Mulch-stabilized and, Non- stabilized), wet tailings, and mineral overburden. The names of all plant species were entered in the form of cover percentage in R software. Then, the number of species as Richness and the Shannon - Wiener index for plant diversity were calculated in different mineral tailings and the natural vegetation.

3. Results and Conclusion

In total, 45 plant species belonging to 18 genera identified in the natural cover of the tailings depot margin, in which the Poaceae and Asteraceae genus have the highest presence in the plant species composition with 15%. After that, the Chenopodiaceae(12.5%), Brassicaceae(7.5%), Lamiaceae(7.5%), and Papilionaceae(7.5%) have the highest presence in the plant composition, respectively(Fig. 2).

The richness and diversity in mineral tailings depot vegetation and the control area shown in Table 1. According to the results, after Natural vegetation, overburdens vegetation has the highest richness and diversity, while the vegetation located on other tailings has high difference from the control area. The percentage of vegetation in different treatments also shows that it is directly related to the diversity of plant species. In fact, the high diversity indicates the potential of vegetation in the production of biomass; more biomass also leads to a higher percentage of cover.

Table 1: Plant diversity in vegetation of different iron ore tailings

Treatment	Plant Richness	Plant Diversity	Total Coverage (%)
Natural vegetation	45	1.95	25.02
Overburden	21	1.49	16.14
Wet Tailings	1	0.00	1<
Stabilized dry tailing	4	0.96	3.06
Non Stabilized dry tailing	0	0	1<

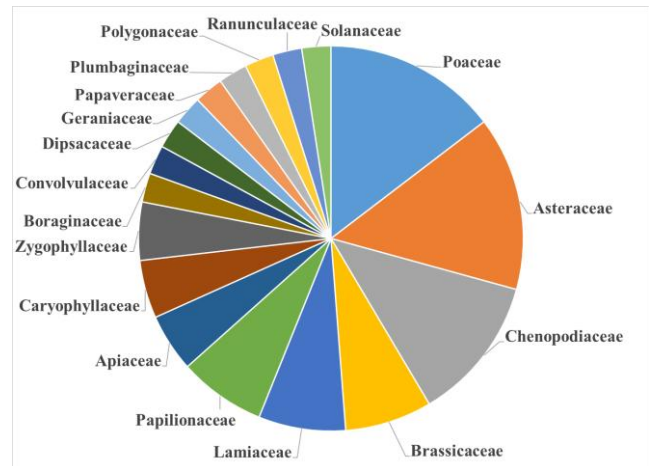


Fig. 2 Percentage of the presence of different genera in the composition of natural vegetation

Tailings stored in tailings reservoirs or depots not only occupy vast amounts of land, resulting in environmental pollution but also require special treatment in order to avoid its hazards so some practices like mulching or vegetation establishment are very important for this purpose. Since these types of practices are very complicated in every case and in each type of tailing so this not strange that tailings have become a big problem for mineral enterprises.

According to results after three years spite of the mulching operation on dry tailings depot, just a few species could establish on this type of tailing. [9] have stated some of the tailing sites, due to natural succession, can achieve plant settlement with some tolerant species, the establishment of *Salsola sp.*, *Londesia eriantha*, and *Halocnemom strabilaceum* which could tolerate severe environmental conditions confirms this consequence.

Salinity is a predominant character of dry and wet iron ore tailing. The exploitation of mines has seriously damaged the ecological environment, resulting in a sharp decline of biodiversity; hence, the total number of plants, which established on tailing, is very limited. In addition to salinity, some important reasons for the limitation of vegetation development on iron ore tailing in Gol-e-Gohar mining site are tiny particles of tailing and shortage of nutrition elements like N and P.

[10] believes the natural restoration of the mine wasteland is rather slow, some are unlikely to be restored naturally, so this can be inferred that the disturbance caused by mining operations has severe effects on the soil, and this disturbance, along with the nutritional problems of the tailings, prevents the establishment of vegetation. [10] has stated in these worst conditions, the natural restoration and revegetation often require 50~100 years, especially for the remediation of the soil, which may take 100 to 10,000 years.

As the plant diversity and richness show, the Overburden vegetation is more similar to the natural vegetation of the area and is in the same category as the natural (control) vegetation. In fact, Overburden in Gol-e-Gohar mines is the surface layer of the earth that includes soil and its biological components. Overburden is not essentially waste and its nature is different from dry and wet waste.

Therefore, after turbulence, due to the presence of soil microorganisms and a strong seed bank, it has the ability to recover and regenerate.

Capping, or covering the surface of the tailings with a layer of soil from an adjacent un-mine site is a widely accepted and effective restoration practice [11] so it seems Overburden can be used as a vital layer on the surface of other tailings for revegetation. Many studies have shown that the restoration of biological diversity is suppressed in mines without surface backfill [12, 13]; therefore, it is unlikely that ecological restoration will be carried out in the short term without topsoil. Vegetation establishment on derelict wastelands in mining area can be extremely slow by natural processes. Soil condition and soil seed bank are the key limiting factors [14, 15]. This is an important issue that the mine managers should notice and save top soil for future restoration plans. Gol-e-Gohar mining site is located in an arid area so, in addition to the tailing challenge, aridity is another change that can affect the revegetation program, so To control the destructive effects of mineral tailings, a long-term plan such as mulching and seed and shrub operations should be considered.

Acknowledgement

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Influence of the irrigation regime on the yields of tomatoes and green beans in open areas, with sprinkler irrigation

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Summary

The aim of the study was to establish the influence of the irrigation regime on the yields of tomatoes and green beans, irrigated by sprinkling in open areas.

In order to achieve the set goal on a leached cinnamon forest soil in the area of the Sofia irrigation system (experimental field Chelopechene (IHM) now ISSAPP "N. Pushkarov") a field experiment was carried out with tomatoes of Balkan variety and green bean variety "Nikos", grown at varying degrees of satisfaction of their water needs. The maximum evapotranspiration was determined by compensatory lysimeters, as in options 3 and 4 it was reduced by 20 and 40%, and in option 1 it was increased by 20%. compared to the version with 100% ETM.

Two of the years in which the field experiments were conducted in terms of the amount of precipitation are very dry with a security of 88.7% and 86.7%, and one year is an average with a security of 51.0%. The high temperatures during these years, combined with the lack of rainfall have predetermined the need for irrigation of vegetable crops.

According to the amount of precipitation during the vegetation period of tomatoes, on average for the study period 8 irrigations with irrigation rate of 373 mm were realized in variant (120% ETM), and in green beans for the same variant 6 irrigations with irrigation norm 300 were realized. mm.

The highest total and additional yield is obtained with irrigation with 120% ETM in both crops 7800 kg / dka. (tomatoes) and ETM 240 kg / (green beans) on average for the study period.

It was found that the reduction of the irrigation rate leads to a corresponding reduction, but not in proportion to the reduction of the possible maximum yield. In all cases, the reduction in yield is less than the reduction in the irrigation rate for both crops.

Introduction

Irrigation of vegetable crops is an opportunity to overcome the effects of droughts. Providing the necessary moisture in the soil helps to increase their productive capacity. It compensates for the lack of moisture and allows the realization of the full genetic potential of plants

In modern agriculture, the issues of economical use of scarce water resources for irrigation are becoming increasingly important, which requires establishing the impact of irrigation on crop yields. Characteristic of these crops is that they have a shallower root system with more low suction power, develop a large above-ground mass and form many fruits with a higher water content, which requires them to be grown mainly under irrigated conditions, providing such quantities of irrigation water at which to obtain stable yields.

The main goal of the study is to establish the influence of the irrigation regime on the yields of tomatoes and green beans, irrigated by sprinkling open areas.

Material and method

In order to achieve the set goal, a field experiment was carried out on leached cinnamon forest soil in the area of the Sofia Irrigation System with tomatoes of the Balkan variety and green beans of the Nikos variety, grown at different degrees of satisfaction of their water needs.

The research was conducted on the experimental field Chelopechene (IHM) now ISSAPP "N. Pushkarov", Sofia on leached cinnamon forest soil.

The following irrigation variants were tested in both crops:

1. variant 120% ETM (maximum evapotranspiration);
2. variant 100% ETM (maximum evapotranspiration);
3. variant 80% ETM (maximum evapotranspiration);
4. variant 60% ETM (maximum evapotranspiration).

Evapotranspiration is determined by water balance calculations based on the available soil moisture at the beginning and end of the growing season, rainfall and the number of irrigations.

The maximum evapotranspiration was determined by compensatory lysimeters, as in options 3 and 4 it was reduced by 20 and 40%, and in option 1 it was increased by 20%. compared to the version with 100% ETM.

Irrigation in all variants was carried out with an irrigation rate of 40 mm, and the water balance calculations were made for a soil layer of 0-60 cm. Irrigation is done by sprinkling. The yields of the

obtained variants were processed by the method of analysis of variance (Shanin, 1977)

The years in which the field experiments were carried out in terms of the amount of precipitation, two of the years were very dry with a security of 88.7% and 86.7%, and one was an average with a security of 51.0%. The high temperatures during these years, combined with the lack of rainfall have predetermined the need for irrigation of vegetable crops.

Results obtained

From previous studies (Delibaltov, 1980) in vegetable crops, it was found that the highest biological yields are obtained by maintaining a higher pre-irrigation humidity, which is more frequent watering. According to the amount of rainfall during the growing season of tomatoes, on average for the study period were realized 8 irrigations with an irrigation rate of 373 mm in variant (120% ETM), and for green beans for the same variant were realized 6 irrigations with irrigation rate 300 mm.

Two of the years of research were dry, which required up to 11 waterings for tomatoes and up to 8 waterings for green beans. Irrigation and rainfall during the growing season of vegetables have affected the obtained yields. On average for the study period, the highest yield of tomatoes was obtained in variant 1, irrigated on the basis of 120% ETM -7800 kg / dka.

In the variants irrigated with 20 and 40% ETM reduction, yields were 9 and 13% lower compared to variant 2 (100% ETM) (Table 1).

In the case of green beans, the highest yield was also obtained in variant 1, irrigated on the basis of 120% ETM 240 kg / dka, and in the variants irrigated with 20 and 40% reduction of EMT, yields with 5 and 15% lower yields were obtained. compared to option 2 (100% ETM). (Table 2).

Indicative of the influence of the reduction of the irrigation norm for tomatoes and green beans are the obtained results of the water-yield dependence. The results show that the reduction of the yields obtained from both crops does not correspond to the reduction of the irrigation norms. It was found that the reduction of the irrigation norm leads to a corresponding reduction, but not proportional to the reduction of the possible maximum yield. In all cases, the decrease in yield is less than the decrease in the irrigation rate for both crops (Table 1.2).

When the irrigation rate is reduced by 20%, the yields decrease from 5% (green beans) to 9% (tomatoes), and when the irrigation rate is reduced by 40%, the yields decrease from 13% (tomatoes) to 15% (green beans) (tab.1.2).

Table 1. Water-yield dependence of tomatoes on average for the study period

variants	yield		irrigation norm	
	kg/dka	%	m ³ /dka	%
120% EMT	7800	114	373	120
100% EMT	6840	100	333	100
80% EMT	6340	92	266	80
60% EMT	5970	87	219	60

Table 2. Water-yield dependence of green beans on average for the study period

variants	yield		irrigation norm	
	kg/dka	%	m ³ /dka	%
120% EMT	720	105	300	120
100% EMT	680	100	260	100
80% EMT	650	95	650	80
60% EMT	580	85	580	60

With a 20% increase in the irrigation rate for both crops, the yield increased by 14% for tomatoes, and for green beans - by 5%, which does not justify the cost of irrigation.

On average for the study period, with a reduction in the irrigation rate for tomatoes by 20%, the yield decreased by 8%, and with a 40% reduction, the yield decreased by 13%. For green beans with 5 and 15, respectively, Tables 1 and 2)

Indicative of the effect of irrigation of vegetable crops is the relationship between irrigation rate and additional production. The additional yield is compared with option 4 (60% ETM)

The irrigation rate realized in variant 1 (120% ETM) in both crops has ensured the highest additional yield, which amounts to 1830 kg / dka of tomatoes and 140 kg / dka of green beans. The higher additional yield of tomatoes shows that the production of this crop is obtained from significant amounts of water. The reduction of the irrigation rate by 20 and 40% has led to a reduction of the additional yield from 6 to 37.7% for tomatoes and from 12 to 24% for green beans (Table 1.2).

The data for both crops show that with increasing irrigation rate, yields increase, which shows that vegetable production is obtained from significant amounts of water, which is greatly influenced by the nature of the meteorological complex of the year.

The reduction of the irrigation rate by 20% in both crops leads to a different reduction in their yields. In the case of green beans, this reduction leads to insignificant yield losses of 5-6%, while in the case of tomatoes these losses are from 14 to 19%, which is due to the greater moisture content.

Conclusions from the study

Irrigation of vegetable crops is a mandatory event in countries with a semi-arid climate, such as that in Bulgaria.

The highest total and additional yield is obtained by irrigation with 120% ETM in both crops.

The reduction of the irrigation norms in both crops leads to a corresponding reduction of the possible maximum yield, but not proportionally.

The reduction of yield in both crops is less than the reduction of the irrigation rate, which in a thorough economic analysis will make these options economically viable for the consumer.

The irrigation rate realized in variant 1 (120% ETM) in both crops has ensured the highest additional yield, which amounts to 1830 kg / dka tomatoes and 140 kg / dka green beans

The reduction of the irrigation rate by 20 and 40% has led to a reduction of the additional yield from 6 to 37.7% for tomatoes and from 12 to 24% for green beans.

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Surface modified silica gels and an express method for determination of their specific surface area

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Abstract: Silica gels are one of the most widely used adsorbents. The best view of the properties of silicas as catalytic supports, adsorbents and other applications give the adsorption-texture parameters and especially the specific surface area. Hydrated silicon dioxide is amorphous ($\text{SiO}_2 \cdot n\text{H}_2\text{O}$), a reactive compound with various contains. Due to the serious practical interest of the determination of the specific surface area of materials many methods are developed and have found application. The study evaluates the impact of the surface and surface modification on the possibility of an express method for determination of specific surface areas of silica gels.

Keywords: SILICA GELS, ADSORPTION, POROSITY, TEXTURE PARAMETERS.

1. Introduction

Silica gels with high adsorption properties are widely used for humidity control, filtration of liquids and solution, separation in multicomponent solution, as a catalyst for various catalytic reactions for the manufacture of butadiene from ethanol (feedstock for the synthetic rubber production etc. The possibility of silica gel to absorb many substances from the liquid phase is used in the industrial cleaning of various oils, oil removal from polymeric and resinous substances, sulfur compounds cleaning etc.

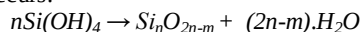
Due to the serious practical interest of the determination of the specific surface area of materials many methods are developed and have found application. Various methods are based on nitrogen adsorption, mercury porosimetry, calorimetric, gas-chromatographical, filtration, microscopic measurements etc. Modern technologies helped the development and the improvement of these methods and they have found application depending on their benefits and disadvantages [1-3]. However, the application of the adsorption methods for specific surface area determination is still the most reasonable method in the practice.

On Table 1 are given the main practically applied adsorption methods [4, 5].

Table 1: Adsorption methods for determination of a specific surface area

Most applied adsorption methods	Rarely used adsorption methods	Adsorption methods applied in some cases
Two-parametric equation of BET	Langmuir	Ross-Olivier
Empirical methods: t -, α_s -, $n(\text{C}_{\text{BET}})$ -graphics	Dubin-Radushkevich-Kaganer	Frenkel, Halsey, Hill
	Frenkel, Halsey, Hill	Huttig
	Innes	Harvey

By the mechanism of polycondensation the following transformation occurs.



The process of polycondensation leads to colloid particles formation with size between $20 \div 200 \text{ \AA}$. Drying of hydro gel of silicon acid, structural net of joining sphere particles remains. Due to the increasing of the number of particles and formation of strong chemical bonds, formation of SiO_2 skeleton of the materials occurs. During the drying process of the silicon acid the structural "network" of joined spherical particles remains.

As a result of increasing the number of particles and achieving strong bonds between them the silicon-oxide skeleton is formed.

Although the empirical methods: t -, α_s -, $n(\text{C}_{\text{BET}})$ -graphics use the best laboratory practices for the simultaneous determination of the external surface (specific surface, and the micro pores volume,

the two-parametric equation of Brunauer-Emmett-Teller (BET) theory for polymolecular adsorption is the basis of the standard methods for determining the specific surface of the materials [6].

The method of liquid phase adsorption may be used for determination of the specific surface area of the porous materials. In that case, the adsorption isotherms are obtained by subjection of the determined amount of the explored material to the solution of a well absorbing substance - adsorbent. The adsorption value is determined by changing the solution concentration. For determining the specific surface area dyes are widely used as adsorbents because of their higher adsorption possibility compared to the corresponding solvents. As a result after monolayer formation from the dyes molecules the solvent is completely displaced from the surface. A typical case is chemically modified silica surfaces or physically modified structures.

During the first half of the 20th century was shown the important role of the hydroxyl groups on the silica surface regarding the adsorption of molecules with dipole and quadrupole moments. Increasing the concentration of the hydroxyl groups on the silicas surface (by hydration) leads to higher energy of adsorption of these molecules.

All authors report that the using methods for determining the specific surface are labor intensive and are characterized by a long time of holding. The mentioned is referring to most modern automated equipment company "Micromeritics. This requires using express methods for the specific surface determination of various materials. The most difficult problem is determining the range of method validity by comparison with the received results for the same sample and widely practically used methods. In this way the influence of the specific surfaces can be evaluated as well as the influence of the modification of the surfaces, determined by the express methods. A selective toluene adsorption was used as an express method. The object of our research was silicas with different specific surfaces. A Klyachko-Gurvich method, having acceptable accuracy, was chosen as a method of comparison.

The aim of this research is to determine the specific surfaces of the silicas with different specific surfaces with or without chemically modified surfaces and also of these with physically modified structure. To compare the values of the specific surfaces with those obtained for the same samples using the "Klyachko-Gurvich" method [7]. Determine the limits of validity of the express method used.

2. Experimental

1. Samples

1.1 Silicas and carbon silica gels

Carbon silica gel product consists of silicon acid, precipitated on an active carbon with high adsorption capacity to organic materials. Five type of Russian commercial silica gels were used for the aim of our study, which differ in their particles size distribution and their porosity, denoted as KCK1, KCK2, KCK2a, KCK2.5,

KCK3 : Carbon silica gels are synthesized according to the procedure described in [8]: The samples are denoted as ACSG-1 and ACSG-2.

2. Characterization of the samples

2.1 The bulk density of the samples is determined

2.2. Measurement of the specific surfaces of the samples

2.2.1 Selective adsorption of toluene in a mixture with isooctane.

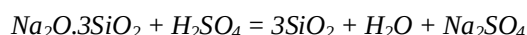
The test specimens (fraction 0.25-0.50 mm) are thermally treated at (453 - 573 K) for 2 hours, after which the specimens weighing about 1 g are placed in tubes and exactly 2 ml (mixture 40 % toluene and 60% isooctane) is poured from the microburette. The refractive index of the initial mixture determined with the Abbe refractometer must be in the range 1.4328-1.4330. The adsorption equilibrium was established after 3 hours. The refractive index of the solution is then determined. Usually 2-3 parallel measurements are performed with one sample, and then they are averaged.

2.2.2 Determination of the specific surface with Express equipment for determination by the one-point method of Klyachko - Gurvich.

For the purposes of the study, calibration on an etalon- silica gel with a surface of ~ 280 m²/g was used. Before each measurement, the samples were dried at 383 K for 2h.

2.2.3. Obtaining of the silica gels

Precipitation of amorphous silica from alkaline silicates with mineral acids. Silicon raw material is Na-silicate and sodium acid H₂SO₄. The process can be described with the following reaction:



Silica gels are characterized by a corpuscular structure: their pores are formed between their primary particles having spherical shape globules. When packed tightly the fine globules form a structure of finely porous silica gel, while the large globules in the "loose" packing have the structure of the porous silica gel. Important characteristic of the silica gels is their bulk density. In the porous cells it varies in the region between 0.4 ÷ 0.5 g/cm³, whereas for the fine porous silica gels from 0.7 ÷ 0.8 g/cm³.

Chemical modification of the surface of silica gels is one of the ways to change their adsorption properties and can be done by different groups introducing – amino, sulfonic groups, fluorine atoms, and etc. That is mainly connected with the OH- groups replacing or their combinations with different reactives, which strongly alters the hydrophilic character by replacing the OH-groups from the silica gel surface with H-atoms leading to production of hydrogen silica gel and polysiloxane hydride.

2.1. Method of preparation

Carbon silica gels were synthesized as follows: Technical water glass, diluted with 50 ml water, to 4,1% SiO₂ was mixed with 0,8 g active carbon (AC with 0,08 – 0,125mm size particles), and then dried to the constant mass at 383-388 K. The ratio permits to obtain one of the most active carbon silica gel with 10% mass of carbon black. The compound was mixed for 30 min, and then threatened with HCl to acidity pH~4.5.

Mixing continues to the beginning of coagulation. Then gel leaves to maturation in the excicator for 2-3 days. After that gel was milled into particles and dried by following conditions: 2-3 days at standard temperature 25°C and then dried at 313-393K to humidity

75-80%. After drying the sample was washed with water in order to eliminate Cl- ions, and then dried again at 313-393 K for 60-70 h. The obtained gel was activated at 513 ÷ 525 K in a porcelain crucible with a cover.

3. Results and Discussion

Table 2: Basic technological parameters of the samples

Sample	Granulometric composition, mm	Bulk density, g/cm ³	Mass, g
KCK1	0.25-0.50	0.40	1.0019
KCK2	0.25-0.50	0.40	1.0018
KCK2a	0.25-0.50	0.42	1.0027
KCK2,5	0.25-0.50	0.46	1.0040
KCK3	0.25-0.50	0.51	0.9933
ACSG-1	0.25-0.50	0.79	1.015
ACSG-2	0.25-0.50	0.79	1.038

Table 2 shows the main technological parameters and specific surfaces of the samples, determined by selective adsorption of toluene and the reference method. It can be seen from the table that the bulk density of the samples varies in a wide range of 0.40 - 0.80 g/cm³. The samples with the lowest bulk density are usually with the lowest specific surface area, and those with the highest bulk density KCK3, ACSG-1 and ACSG-2 are with the highest specific surface area 550-750 m²/g determined by the CAT method and the Klyachko-Gurvich reference method (Table 3).

The values of specific surfaces determined by the Selective adsorption of toluene (SAT) method and their comparison with those obtained by the reference method are presented in Table 3.

Table 3: Specific surface of the samples

Sample	n ₀ ²⁰	A, Gurvich-Klyachko determined	A, determined by SAT method, m ² /g
KCK1	1.4303	272	235
KCK2	1.4288	308	281
KCK2a	1.4298	338	349
KCK2,5	1.4290	373	379
KCK3	1.4270	473	553
ACSG-1	1.4263	758	612
ACSG-2	1.4264	742	603

The sample KCK3 characterized with a bulk density of 0.51 g/cm³ has a specific surface area of 473 m²/g, sample ACSG-1 and ACSG-2 with a bulk density of 0.79 g/cm³ and specific surface area of 758 m²/g and 742 m²/g, respectively. From the data obtained it was established correlation between the bulk density and the specific surface area for the silica gels and carbon silica gels samples, determined by the Klyachko-Gurvich method.

The specific surface differs for the samples KCK2, KCK2a and KCK2,5 from those determined by Klyachko-Gurvich method and the difference is less than 10%. They have a typical bulk surface in the range of 0.40-0.46 g/cm³ and a specific surface area between 300-400 m²/g. It can be noted that, with one exception of KCK1 sample, the difference is as much greater as the highest specific surface area was determined (Table 3) by the Klyachko-Gurvich method (KCK3 ACSG-1, ACSG-2). For these samples, the bulk density is the highest (0.5-0.8 g/cm³) compared to those of the other samples. Sample ACSG-1 (characterized by the highest bulk density) has the highest specific surface area.

3. Conclusion

As a results of our investigation and the results obtained of the specific surface determined by Klyachko-Gurvich method, it can be concluded that for the samples with specific surface area over 500

m²/g, for all chemical modified samples the selective adsorption method of toluene with isooctane is practically inapplicable. So we consider that a definitive conclusion can be drawn after further studies on a large group of modified silica gels with a very low and very high specific surface area with different types of porous texture.

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Microbiological properties of Alluvial-meadow soil on flooded and non-flooded river terrace

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Abstract: Soil properties and hydrological regimes of flooded and non-flooded terrains create different conditions for soil microbial activity. The aim of this study was to characterize the microbiological properties of two profiles of Alluvial-meadow soil, situated on flooded and non-flooded terrace of the Maritsa River and to relate them to some soil physical properties. The main groups of soil microorganisms and the enzyme activity (β -glucosidase and phosphatase) of the soil were determined. It was found that soil characteristics and vegetation cover cause differences in microbiological properties. The soil profile from the first flooded river terrace of the Maritsa River was characterized by the largest amount of cellulolytic microorganisms. The heterotrophic microorganisms, mineral nitrogen-utilizing bacteria, microscopic fungi and actinomycetes prevailed in the soil profile on non-flooded terrace. Higher enzyme activity was also observed in this profile.

Keywords: ALLUVIAL-MEADOW SOIL, SOIL MICROORGANISMS, ENZYME ACTIVITY, FLOODED AND NON-FLOODED RIVER TERRACE, SOIL PHYSICAL CONDITIONS

1. Introduction

Soil fertility includes three interrelated components: physical, chemical, and biological fertility. The biological fertility and the microorganisms that live in the soil and interact with other components, vary considerably depending on the soil type, physical and chemical conditions. (Johns, 2017; Perfanova and Donkova, 2017). Soil properties, vegetation cover, land use, interactions of the soil organisms, and hydrological regime affect microbial indicators (Nannipieri et al., 2011).

The Alluvial-meadow soils are young soils formed on alluvial terraces and valleys that may develop in the absence or presence of continued flooding and deposition of recent alluvium materials under conditions of irregular river flow. Kercheva et al. (2017) found that the difference in soil physical properties between non-flooded and flooded profiles is well expressed by the available water storage, volume, and mean radius of pores which were higher in the surface horizons of frequently flooded Fluvisols.

The aim of the present study was to characterize and compare the microbiological properties of the Alluvial-meadow soils on flooded and non-flooded terraces of the river Maritsa.

2. Material and methods

Two soil profiles of Alluvial-meadow soil were opened along the Maritsa River on the territory of Tsalapitsa village, Plovdiv region, Southern Bulgaria. The studied soil was classified as Haplic Fluvisol according to WRB (IUSS Working Group WRB, 2015; Kercheva et al., 2017).

The first soil profile was on the first flooded terrace of the Maritsa River (24.5559E; 42.1538N, altitude 182 m a.s.l.). The second one was located on non-flooded terrace (24.5428E; 42.1808N, and altitude of 192 m a.s.l.) on the territory of the meteorological station at the experimental station of the ISSAPP “N.Poushkarov”. The vegetation cover of both profiles was grass association.

Undisturbed and disturbed soil samples were taken from topsoil layers in the spring (18 May 2018). The performed physical and chemical analyses included determination of soil organic carbon content, pH in H₂O, particle size distribution, soil bulk and particle density, soil water retention curve. The particle-size distribution was determined by sieving and the pipette method (ISO 11277, 2009) and the fractions of sand (2-0.063 mm), silt (0.063-0.002 mm) and clay (<0.002 mm) were used for the textural classification according to IUSS Working Group WRB (2015). Total soil organic carbon content (SOC, %) was determined by the modified Tjuri's method (Filcheva and Tsadilas, 2002; Kononova, 1963). The acidity of soil was measured by pH meter (ISO 10390: 2011). Vertically oriented intact soil cores were sampled in 4 replicates in 100 cm³

metal cylinders for determination of bulk density (Db) (ISO 11272:1998) and water retention by the suction type apparatus (ISO 11274:1998). Particle density (Ds) analysis was carried out in water with 100 cm³ pycnometers. Total porosity (Pt) was calculated using the measured bulk density (Db) and particle density (Ds):

$$Pt = (1 - Db/Ds) \times 100\% \quad (1)$$

Soil water retention at matric potential pF 2.0 (-10 kPa) was determined using a suction plate method similar to ISO11274:1998 using Shot filters G5 connected to hanging column as described by Kercheva et al. (2019). Soil water retention at suction 1500 kPa (pF 4.2 – Wilting Point, WP) was determined in three replicates using pressure membrane apparatus (ISO 11274:1998). The field capacity (FC) was estimated by the water content retained at pF 2.0. The plant available water capacity (PAWC) was estimated as the difference between water retained at pF2.0 and pF4.2:

$$PAWC = W_{pF2.0} - W_{pF4.2} \quad (2)$$

Air capacity, AC was calculated as difference between total porosity (Pt) and volumetric water content corresponding to FC ($\theta_{pF2.0}$):

$$AC = Pt - \theta_{pF2.0} \quad (3)$$

The amount of the main groups of soil microorganisms was determined by sowing ten-fold diluted soil suspensions on selective agar media (Grudeva et al., 2006). The following physiological and taxonomic groups of soil microorganisms were determined: heterotrophic microorganisms - on meat-peptone agar (MPA) after three days of incubation; microscopic fungi - on acidified Chapek's medium - after seven days of incubation; actinomycetes and mineral nitrogen-utilizing bacteria - starch-ammonia agar (SAA) - after seven days of incubation and cellulolytic microorganisms - on Hutchinson's medium - after fourteen days of incubation. The activity of the acid phosphatase and β -glucosidase soil enzymes was determined. The analyses were performed by introducing an appropriate substrate and reading the product of the enzymatic reaction by colorimetric methods (Alef and Nannipieri, 1995).

The obtained experimental data were statistically processed using Statgraphics 2.1.

3. Results and discussion

Soil physical conditions of the profiles on flooded (F) and non-flooded (NF) terraces were characterized by the parameters presented in Table 1. The soil on flooded terrace had higher content of soil organic carbon content and coarser texture than the non-

flooded soil. As reported in other studies (Rawls et al., 2003; Kercheva et al., 2019), the increase of SOC in coarse texture soil lead to increase in water retention properties. Fluvisols on flooded terraces of Thrace plain are with optimal physical status of humic horizons and structureless subsoil layers which make these younger soils very vulnerable to soil physical degradation (Kercheva et al., 2017).. The region is one of the driest and hottest in Bulgaria. The soil moisture regime is Xeric. The ground water table of F soil was high (80 cm). The microbial production of nitrate is reduced when the soil water or air is insufficient. As reported by Reynolds et al.

(2009), optimal physical conditions can be created when relative filed capacity ($\theta_{pF2.0}/Pt$) is in the range 0.6 to 0.7.

During the sampling the water content of NF soil was higher than of the F soil.

Table 1. Main characteristics of the studied surface soil layers.

Parameters	Depth, cm	Flooded terrace		Non-flooded terrace	
		0-5	10-15	0-5	10-15
SOC, %		3.16	1.37	2.51	0.75
pH H ₂ O		6.05		6.2	
Sand (2000-63 μ m), %		59.2	60.6	30.4	35.8
Silt (63-2 μ m), %		17.4	19.0	21.5	20.2
Clay (<2 μ m), %		23.4	20.4	48.1	44.0
Texture class		Silt Loam	Silt Loam	Loam	Loam
Soil bulk density, g.cm ⁻³ (Db)		0.99	1.30	1.32	1.57
Soil water content at sampling %wt (Ws)		15.1	9.8	20.0	13.8
Total porosity, %vol (Pt)		63.1	51.4	49.2	40.8
Air filled pores at pF2.0, %vol (AC)		18.9	10.9	15.3	10.8
Water content at pF2.0, %wt (FC)		42.6	31.1	25.7	19.0
Plant available water capacity, %vol. (PAWC)		27.7	27.2	21.5	16.8
Relative field capacity ($\theta_{pF2.0}/Pt$)		0.69	0.79	0.69	0.73
Water content at pF4.2, %wt ($W_{pF4.2}$)		14.6	10.2	9.5	8.3

The number of heterotrophic microorganisms was high, what showed that during this period of the year intensive mineralization of the hardly decomposable organic substances - humus – had taken place

in the soil (Fig. 1). There was no significant difference between the amount of microorganisms, except for the 0-5 cm of the NF soil where the soil moisture content was near to the field capacity.

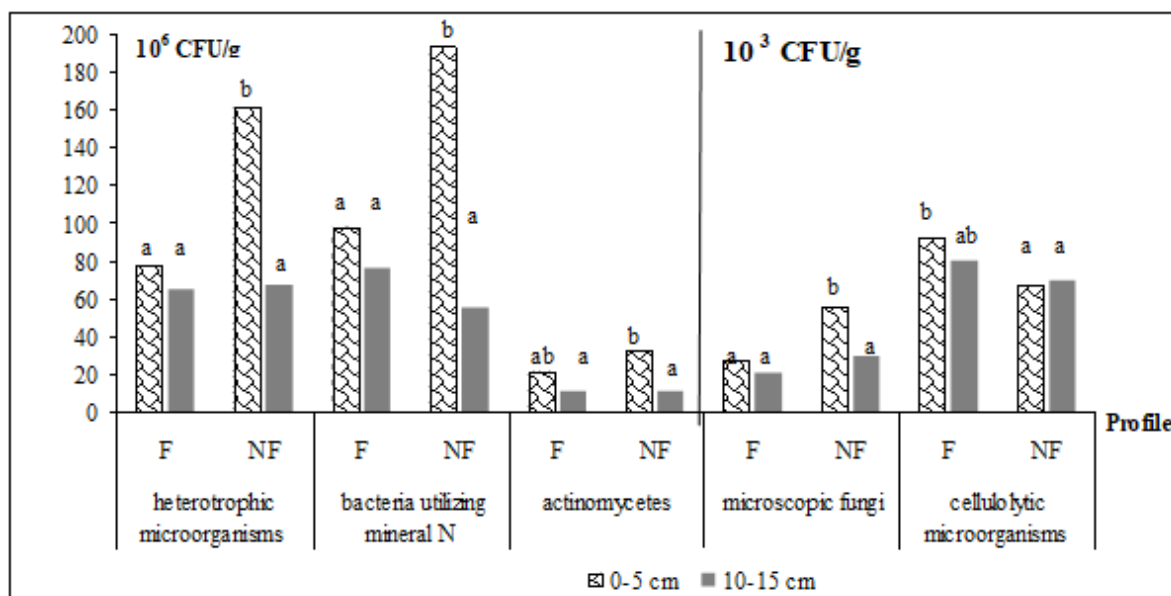


Fig.1. Number (CFU/g) of the microorganisms in the studied flooded (F) and non-flooded (NF) top soil layers. Values above the bars, followed by different letters are significantly different at $p \leq 0.05$

A similar study was conducted by Sal'nikova et al. (2009), which determined the number of microorganisms in the upper humus horizon (0–20 cm) of the main types of Alluvial soils in the Volga River delta. No significant seasonal dynamics in the number and biomass of microorganisms in the Alluvial soils has been established. The reported total carbon content was 1.4–2.3% in the spring. They found that high mineralization coefficients characterize the processes of decomposition of organic matter in the Alluvial soils.

The distribution of mineral nitrogen-utilizing bacteria was similar to that of heterotrophic microorganisms (Figure 1). Mineral nitrogen-utilizing bacteria are involved in the mineralization of organic nitrogen compounds and in biological immobilization of available nitrogen.

In both studied profiles, a larger amount of actinomycetes was observed in the surface horizon, compared to the lower soil layers. (Fig. 1.) This shows that, more active processes of decomposition of plant and animal residues occur at a depth of 0 - 5 cm than at depth 10-15 cm. The optimal growth of actinomycetes occurs at low acid reaction of the soil. Zakalyukina et al (2002) found that actinomycetes predominated in soils whose pH (H₂O) did not exceed 6.8.

The amount of microscopic fungi was greatest at NF soil at depth of 0 - 5 cm. It has been statistically proven that the main groups of microorganisms (heterotrophic microorganisms, mineral nitrogen-utilizing bacteria, actinomycetes and microscopic fungi) were most widespread at 0-5 cm depth of the NF soil.

The distribution of cellulolytic microorganisms was greatest in the F soil profile from the first terrace of the Maritsa River at both depths (Fig. 1). Physical analyzes of the soil showed the highest values of total porosity, water content and available water holding capacity, in this profile, at a depth of 0 - 5 cm. Perhaps these soil components influenced faster biodegradation of cellulose. Decomposition of cellulose is one of the main microbiological processes, as it plays a major role in the carbon cycle. Plant residues in the soil contain 20-30% cellulose, which contains important polysaccharides (Štursová et al, 2012).

Soil enzymes play a significant role in the mineralization of organic matter. The two studied enzymes (β -glucosidase and phosphatase) had greater activity in the flooded soil than in the non-flooded soil. The physical properties of flooded soil create more favorable conditions for the development of both the microflora, with the exception of cellulolytic microorganisms, and for greater enzyme activity. In both soils, a higher enzyme activity was observed in the surface horizons, compared to the depth of 10 - 15 cm. According to Sardans and Peñuelas (2005), the enzyme activity of the soil strongly decreased in the depth of the profile and is greater in spring than in autumn.

Table 2. Enzyme activity in the surface soil layers.

Variants	Depth, cm	β -glucosidase $\mu\text{mol NP/g/h}$	Phosphatase $\mu\text{mol NP/g/h}$
Flooded terrace	0 – 5	1.89	4.42
	10-15	0.73	2.11
Non-flooded terrace	0-5	2.44	4.69
	10-15	1.57	3.59

The correlation analyses revealed that the enzyme activity especially of the phosphatase had a strong negative correlation ($r = -0.99$) with the relative field capacity (Table 3). Most microbial groups depended on current soil moisture conditions as can be concluded from the high correlation coefficient with soil moisture content at sampling and what explained their higher amount in the surface non-flooded soil (Table 1, 3). The cellulolytic microorganisms had a strong negative correlation with silt content and a positive with field capacity. The higher water retention properties, SOC and better soil structure in the surface layer of flooded soil were more favorable for the activity of these bacteria.

Table 3. The most significant correlation coefficients (r) between microbiological and physical parameters

Microbiological parameters	Physical parameter	r
heterotrophic microorganisms	W at sampling	0.89
bacteria utilizing mineral N	W at sampling	0.85
actinomycetes	W at sampling	0.92+
microscopic fungi	W at sampling	0.93+
cellulolytic microorganisms	Silt	-0.98++
	FC	0..92+
	FC/Pt	-0.95++
β -glucosidase	FC/Pt	-0.99+++
Phosphatase		

4. Conclusions

The studied topsoil layers of Alluvial-meadow soil from flooded and non-flooded river terraces had good physical and chemical conditions for microbiological activities. The processes of mineralization, biological immobilization of nitrogen, decomposition of plant and animal residues of the finer textured non-flooded soil were more intensive, mainly because of the higher water content at sampling. The non-flooded soil was also characterized by a greater enzyme activity. In the soil profile from the first flooded terrace of the Maritsa River the processes of cellulose decomposition took place more intensively. The combined investigation of microbial and physical parameters allowed to achieve better understanding of driving factors which determine the soil quality under different environmental conditions

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