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## Social entrepreneurship development in Bulgaria

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### SUMMARY

The promotion of innovative ideas in public policy is crucial to support the values of the active and problem-oriented solving social system. These views underlie the ongoing social reforms in various countries and focus on the development of social entrepreneurship and the role of social entrepreneurs. An understanding is underlined that namely social entrepreneurs have the capability through localization of usable resources - human capital, buildings and equipment, to find flexible approaches to satisfy unmet social needs. The study presented in the article provides important implications on the state of the social entrepreneurship in Bulgaria and ways of its encouragement putting a special accent on the needed support and building capacity.

**Key words:** social economy, social enterprise, social entrepreneurship

## INTRODUCTION

al., 2016).

(Terziev et

The staging of the problem of social entrepreneurship in Bulgaria is entirely determined by economic and cultural contexts in the country (Terziev et al., 2016). It can be concluded that the concept of social entrepreneurship is a relatively young both as theory and practice. Undoubtedly there is a misunderstanding of this project, not only by society but also by the authorities of the tax and legislative regulation. In the public perception there is an underlying understanding that social entrepreneurship is a type of social labour readjustment of unprotected groups in commercial enterprises. From the legislative point of view itself law for non-profit organizations, albeit allowing the conduct of business by NGOs, is not sufficient to stimulate similar initiatives. On the one hand, the lack of explicit mention of the social enterprise category leads to a situation in which existing social enterprises are often not perceived in such a quality. On the other hand, the experience of developed countries shows that the majority of social entrepreneurs start a business with a donation of social capital in the form of networks of relationships and acquaintances linked by common values and interests. Fundraising through charity, volunteer work and corporate responsibility entails expansion of capital and thus leads to generation of new products and services (Rusanova, 2011).

(Rusanova, 2011).

Social enterprises in Bulgaria operate in several directions: delivery of social services; providing jobs for people with disabilities; mediation in finding employment of unemployed persons; provision of health services; activity in the field of education and others. In realizing these activities lead is not an end product, and the social impact on the people themselves expressed in this to obtain the necessary support to integrate into society.

2013):

(Kumanova and Shabani,,

a priori –

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Repeatedly in various acts the Economic and Social Council of the country has emphasized that social entrepreneurship plays an important role for social cohesion and the creation of growth and jobs.

Typological features of this type of entrepreneurship in Bulgaria do not differ greatly from those of similar enterprises in the rest of Europe (Kumanova and Shabani, 2013):

- There is a clear social impact – in the main activity on a balance between the pursuit of profit and direct support to the social status of certain groups.

- There is a clearly defined target group - mainly persons from socially vulnerable groups – those who need help to equalize their life or social status to that of other members of society.

- There is a specific business purpose – is aimed at improving living standards, employment, provision of services and other forms of direct support in order to overcome social exclusion of the target group.

An important feature of all social enterprises is a special symbiosis that carries a priori – between financial viability and ability to have a social impact. So they achieve simultaneous realization of economic, financial and social objectives, which become even greater value and cost to society.

Development and implementation of National Concept of social economy is a continuation of the work of the team of Ministry of labour and social policy for full harmonization of social policies with best practices in Member States on the basis of the findings and conclusions in the open method of coordination for social protection and social inclusion implementation of flexibility in the labor

market combined with security and implementation approach for active inclusion.

In the modern European context, the social economy is an established and integral part of social protection and social safety nets, which produces and successfully combines economic profitability and social solidarity. The social economy is a carrier of the democratic values that put people first, creating jobs and promoting active citizenship. Development potential of the social economy is dependent on the adequacy of the established political, legislative and operational conditions.

Actually existing entities with social economic and humanitarian activities in the country say more strongly the need for legal and institutional differentiation in the real economy to be able to fulfill their potential and interact on an equal basis for achieving synergistic social effect among themselves and in cooperation with state and corporate economy.

The following challenges facing social enterprises in Bulgaria are identified (Todorova, 2014):

1.

(Todorova, 2014):

1. Lack of legal framework relating to the definition of social enterprises in order to properly guide policies – in Bulgaria there is still no legal definition of social enterprise, but has a set of characteristics (in National Concept for Social Economy) which are the starting point for identifying social enterprise.

2.

2. The majority of social enterprises in Bulgaria are aimed at providing different types of services (passive) while social entrepreneurship should develop towards active engagement of target groups in the process.

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3. Problems encountered during the operation of social enterprises: facilities, administration, personnel, equipment;

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(Aleksieva et al., 2013).

- 4. Lack of sufficient incentives related to the supply of products of social enterprises in the market;
- 5. Interaction with other companies, organizations, administrations;
- 6. The need for training and motivation of people working in social enterprises and those who wish to take up a job there.

Social entrepreneurship is one of the most innovative ways to achieve a better quality of life, independence and inclusion in society of persons from vulnerable groups. Need to be taken key legislative changes in order set in strategic and political national documents measures to become real mechanisms to support social entrepreneurship in Bulgaria, as well as the successful development of social enterprises, requires the creation of sustainable partnerships between business, NGOs and the public sector – partnerships in which each of these actors recognizes its role to achieve socially important objectives and is willing to invest resources in that (Aleksieva et al., 2013).

The article presents a study which conducted an analysis on what extent is developed and adopted the concept of social entrepreneurship and the role of social enterprises for socio-economic development of Bulgaria by exploring opportunities to promote social entrepreneurship in the country through government policy, NGOs, business initiative, training and counseling.

## MATERIAL AND METHODS

SESBA – Social enterprise skills for business advisors (

The article presents the results of a pilot study conducted under the project SESBA – Social enterprise skills for business advisors, aimed at more qualitative research through the



professional relationships, communication with the external environment and career development. The question of personal relationships shows greater variation than the other and in averaging the marks it awarded last ranks. Placing responsibility before profit is indicative of the consensus on the need to change to new business models driven by something that is more by profit, particularly linking the activities of organizations with significant social goals (Table 1).

( 1).

1. ?”

**Table 1. Answers to the question „What should a business seek to achieve?”**

|                            | Profit      | Personal relations | Professional relations | Communication with outer environment | Responsibility | Career development | Social value |
|----------------------------|-------------|--------------------|------------------------|--------------------------------------|----------------|--------------------|--------------|
| Strongly disagree          | 0           | 1                  | 0                      | 0                                    | 0              | 0                  | 0            |
| Disagree                   | 0           | 6                  | 0                      | 0                                    | 0              | 0                  | 0            |
| Neither agree nor disagree | 7           | 34                 | 14                     | 16                                   | 6              | 22                 | 7            |
| Agree                      | 27          | 31                 | 23                     | 43                                   | 23             | 39                 | 29           |
| Strongly agree             | 70          | 32                 | 67                     | 45                                   | 75             | 43                 | 68           |
| / Total                    | 104         | 104                | 104                    | 104                                  | 104            | 104                | 104          |
| Average                    | <b>4,61</b> | <b>3,84</b>        | <b>4,51</b>            | <b>4,28</b>                          | <b>4,66</b>    | <b>4,20</b>        | <b>4,59</b>  |

( 2).

The definition of social entrepreneurship based on reinvestment of profits for social purposes is best accepted (Table 2). At the highlights of the social mission of market-oriented activities and social transformation respondents are more neutral, ie understanding is leading to denial of maximizing profit for shareholders and owners to the benefit of society. According to the respondents a unified understanding is needed on the essence of social entrepreneurship, social

enterprises, social economy, etc. Many often different concepts are confused due to ignorance of the theoretical and legal basis, ie there is a need of information and training, motivational and promotional activities. The role is highlighted of government policies and the efforts of local authorities, as well as studies on "foreign experience". Among the benefits of the development of social entrepreneurship are: an opportunity to develop socially engaged business; a good opportunity for helping people in need; satisfaction with work.

2.

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**Table 2. Answers to the question “To what extent do the following definitions reflect the principal features of a social enterprise?”**

|                            | Social enterprise is a business with primarily social objectives whose surpluses are principally reinvested for the business or in the community, rather than being driven by the need to maximize profit for shareholders and owners | A social enterprise is an organization or initiative that marries the social mission of a non-profit or government program with the market-driven approach of a business | A social enterprise is an operator in the social economy, whose main aim is to achieve social transformation |
|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| Strongly disagree          | 0                                                                                                                                                                                                                                     | 0                                                                                                                                                                        | 1                                                                                                            |
| Disagree                   | 0                                                                                                                                                                                                                                     | 7                                                                                                                                                                        | 6                                                                                                            |
| Neither agree nor disagree | 5                                                                                                                                                                                                                                     | 46                                                                                                                                                                       | 50                                                                                                           |
| Agree                      | 30                                                                                                                                                                                                                                    | 31                                                                                                                                                                       | 26                                                                                                           |
| Strongly agree             | 69                                                                                                                                                                                                                                    | 20                                                                                                                                                                       | 21                                                                                                           |
| <i>/ Total</i>             | <i>104</i>                                                                                                                                                                                                                            | <i>104</i>                                                                                                                                                               | <i>104</i>                                                                                                   |
| Average                    | <b>4,62</b>                                                                                                                                                                                                                           | <b>3,62</b>                                                                                                                                                              | <b>3,58</b>                                                                                                  |

Respondents generally show fluctuations on whether society is ready to accept and support social entrepreneurship, most are rather neutral



(34%).  
 (36%)  
 23%  
 8%,

(36%) and agree (34%). Dissenters are 8% and fully agree – only 23% of respondents. This shows the need for a more thorough study of the causes and a need to seek improvements once the answers to the above questions highlight the advantages and benefits of social entrepreneurship that respondents are well aware of and accept. Respondents indicated that the concept of social entrepreneurship is unknown to the majority of society, and information on social entrepreneurship among business organizations in Bulgaria is insufficient and needs to work systematically and consistently to raise awareness and motivation for the development of social enterprises.

( 3).

The general opinion of the respondents is that social entrepreneurship should be promoted by European programs, strategies for regional and local development and the state policy, and to ensure national funding (Table 3). The question of how it is appropriate to rely on funding provided by the European funds and programs, the national budget and the degree of state intervention, is one of the main discussed by respondents in the following open questions about opinions and recommendations. This is the key moment in the development of social enterprises – reliance on temporary financing or separately and sequentially development towards sustainability. Additions made by some, albeit inaccurate and incomplete, point to the role of civil society, public support, donations and even highlights the need to implement individual approaches.

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**Table 2. Answers to the question “To what extent do the following definitions reflect the principal features of a social enterprise?”**

|                            | Social enterprise is a business with primarily social objectives whose surpluses are principally reinvested for the business or in the community, rather than being driven by the need to maximize profit for shareholders and owners | A social enterprise is an organization or initiative that marries the social mission of a non-profit or government program with the market-driven approach of a business | A social enterprise is an operator in the social economy, whose main aim is to achieve social transformation |
|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| Strongly disagree          | 0                                                                                                                                                                                                                                     | 0                                                                                                                                                                        | 1                                                                                                            |
| Disagree                   | 0                                                                                                                                                                                                                                     | 7                                                                                                                                                                        | 6                                                                                                            |
| Neither agree nor disagree | 5                                                                                                                                                                                                                                     | 46                                                                                                                                                                       | 50                                                                                                           |
| Agree                      | 30                                                                                                                                                                                                                                    | 31                                                                                                                                                                       | 26                                                                                                           |
| Strongly agree             | 69                                                                                                                                                                                                                                    | 20                                                                                                                                                                       | 21                                                                                                           |
| <i>/ Total</i>             | <i>104</i>                                                                                                                                                                                                                            | <i>104</i>                                                                                                                                                               | <i>104</i>                                                                                                   |
| Average                    | <b>4,62</b>                                                                                                                                                                                                                           | <b>3,62</b>                                                                                                                                                              | <b>3,58</b>                                                                                                  |

The need to raise public awareness of social entrepreneurship has been adopted by respondents in respect of the preliminary versions of the awareness campaigns organized by public authorities or non-governmental organizations; brochures, books and other materials; TV spots, etc.; informal training (Table 4). The additional options given by some respondents stress on the importance of social networks and sharing good examples, as it is stated a focus on the most early school education and the need for individual approaches again.

4.

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**Table 4. Answers to the question „Ways of raising awareness at community level about social entrepreneurship include”**

|                            | Purposeful information campaigns organized by state authorities | Purposeful information campaigns organized by ngos | Brochures, books and other materials | TV spots and other promotional materials | Non-formal trainings | Other       |
|----------------------------|-----------------------------------------------------------------|----------------------------------------------------|--------------------------------------|------------------------------------------|----------------------|-------------|
| Strongly disagree          | 0                                                               | 0                                                  | 0                                    | 0                                        | 1                    | 0           |
| Disagree                   | 0                                                               | 2                                                  | 2                                    | 2                                        | 2                    | 0           |
| Neither agree nor disagree | 10                                                              | 5                                                  | 26                                   | 29                                       | 15                   | 99          |
| Agree                      | 28                                                              | 30                                                 | 37                                   | 35                                       | 30                   | 2           |
| Strongly agree             | 66                                                              | 67                                                 | 39                                   | 38                                       | 56                   | 3           |
| <i>/ Total</i>             | <i>104</i>                                                      | <i>104</i>                                         | <i>104</i>                           | <i>104</i>                               | <i>104</i>           | <i>104</i>  |
| <b>Average</b>             | <b>4,54</b>                                                     | <b>4,56</b>                                        | <b>4,09</b>                          | <b>4,05</b>                              | <b>4,33</b>          | <b>3,08</b> |

( 5).

Consideration of the most significant barriers to the development of social entrepreneurship focuses on funding opportunities and the lack of government policies pursued by the lack of knowledge and lack of legal structure (Table 5). Local business environment, credit access, public perceptions, market access and the absence of consultants also solidified their place among the major problems. The additions made focused on the heavy bureaucratic environment, the lack of desire for social entrepreneurship, lack of public interest and a lack of entrepreneurial culture.

5. „ - ?” /

**Table 5. Answers to the question „What are the most significant problems / barriers in social entrepreneurship development?”**

|                            | Local business environment | Community perceptions | Funding opportunities | Lack of knowledge | Lack of advisory services | Lack of legal structure | Lack of state policies | Credit access | Market access | Other       |
|----------------------------|----------------------------|-----------------------|-----------------------|-------------------|---------------------------|-------------------------|------------------------|---------------|---------------|-------------|
| Strongly disagree          | 0                          | 1                     | 0                     | 1                 | 4                         | 0                       | 0                      | 0             | 0             | 0           |
| Disagree                   | 6                          | 9                     | 0                     | 9                 | 13                        | 3                       | 1                      | 3             | 5             | 0           |
| Neither agree nor disagree | 24                         | 25                    | 9                     | 15                | 17                        | 25                      | 12                     | 33            | 35            | 99          |
| Agree                      | 40                         | 34                    | 33                    | 27                | 34                        | 32                      | 30                     | 35            | 30            | 1           |
| Strongly agree             | 34                         | 35                    | 62                    | 52                | 36                        | 44                      | 61                     | 33            | 34            | 4           |
| <i>/ Total</i>             | <i>104</i>                 | <i>104</i>            | <i>104</i>            | <i>104</i>        | <i>104</i>                | <i>104</i>              | <i>104</i>             | <i>104</i>    | <i>104</i>    | <i>104</i>  |
| <b>Average</b>             | <b>3,98</b>                | <b>3,89</b>           | <b>4,51</b>           | <b>4,15</b>       | <b>3,82</b>               | <b>4,13</b>             | <b>4,45</b>            | <b>3,94</b>   | <b>3,89</b>   | <b>3,09</b> |

( 6).

Among the needs and opportunities to support social enterprises the survey emphasizes on training, funding, legal framework, consulting and entrepreneurial orientation (Table 6). Good results are also acquired in terms of promoting access to public procurement and inspiration. Among the additions made possible options are those associated with public interest and support, public awareness and change of thinking.

6. ?“ ”

**Table 6. Answers to the question „What supports do social enterprises need?“**

|                            | Funding     | Training    | Advice      | Inspiration | Entrepreneurial orientation | Encouragement | Better legal frameworks | Access to public procurement opportunities | Other       |
|----------------------------|-------------|-------------|-------------|-------------|-----------------------------|---------------|-------------------------|--------------------------------------------|-------------|
| Strongly disagree          | 0           | 0           | 0           | 0           | 0                           | 0             | 0                       | 0                                          | 0           |
| Disagree                   | 0           | 1           | 2           | 0           | 1                           | 0             | 0                       | 0                                          | 0           |
| Neither agree nor disagree | 9           | 10          | 11          | 28          | 17                          | 16            | 12                      | 23                                         | 98          |
| / Agree                    | 35          | 23          | 29          | 35          | 23                          | 34            | 29                      | 27                                         | 1           |
| Strongly agree             | 60          | 70          | 62          | 41          | 63                          | 54            | 63                      | 54                                         | 5           |
| / Total                    | 104         | 104         | 104         | 104         | 104                         | 104           | 104                     | 104                                        | 104         |
| / Average                  | <b>4,49</b> | <b>4,56</b> | <b>4,45</b> | <b>4,13</b> | <b>4,42</b>                 | <b>4,37</b>   | <b>4,49</b>             | <b>4,30</b>                                | <b>3,11</b> |

Regarding the type of required consultancy services respondents strongly emphasize those in management, financing and participation in financing programs, fundraising, strategic management, legal services and access to markets.

Consulting services in the areas of business planning, technology, marketing analysis and participatory leadership also get a good score (Table 7).

Among the additions are highlighted the role of counselors in training of staff in social enterprises, establishment of contacts and lasting relationships with social partners, opportunities to develop social activities and communications. A very interesting opinion expressed by the representative of the municipal structure that consulting services should be periodic rather than constant, which draws attention to the need to build capacity and achieve self-sufficiency in various aspects – economic and governance.

7.

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?”**Table 7. Answers to the question „What kind of advisory services are the most needed in social enterprises?”**

|                            | Legal services | Technology  | /Finances   | Fund raising | Participatory leadership | Business planning | Market analyses | Participation in funding programmes | Access to markets | Strategic planning | Governance  | Other       |
|----------------------------|----------------|-------------|-------------|--------------|--------------------------|-------------------|-----------------|-------------------------------------|-------------------|--------------------|-------------|-------------|
| Strongly disagree          | 0              | 0           | 0           | 0            | 0                        | 0                 | 0               | 0                                   | 0                 | 0                  | 0           | 0           |
| Disagree                   | 0              | 3           | 0           | 1            | 2                        | 1                 | 2               | 1                                   | 0                 | 0                  | 0           | 0           |
| Neither agree nor disagree | 13             | 28          | 11          | 16           | 43                       | 22                | 31              | 14                                  | 21                | 14                 | 12          | 99          |
| / Agree                    | 50             | 39          | 41          | 35           | 34                       | 43                | 37              | 36                                  | 35                | 36                 | 37          | 0           |
| Strongly agree             | 41             | 34          | 52          | 52           | 25                       | 38                | 34              | 53                                  | 48                | 54                 | 55          | 5           |
| / Total                    | 104            | 104         | 104         | 104          | 104                      | 104               | 104             | 104                                 | 104               | 104                | 104         | 104         |
| / Average                  | <b>4,27</b>    | <b>4,00</b> | <b>4,39</b> | <b>4,33</b>  | <b>3,79</b>              | <b>4,13</b>       | <b>3,99</b>     | <b>4,36</b>                         | <b>4,26</b>       | <b>4,38</b>        | <b>4,41</b> | <b>3,10</b> |

Among respondents there is a consensus that specialized training is needed in the field of social entrepreneurship. Vocational training is proving the most appropriate according to the average estimates given by respondents, followed by formal and informal learning. In terms of higher and secondary education fluctuations are larger (Table 8). The additions made point to the dual education, individual training programs, primary school education. Assessing the need for training in different areas the respondents' answers emphasize management, strategic management, business planning, participation in funding programs, finances, fundraising, legal services and access to markets. The need for training in the field of marketing analysis, technology and participatory leadership is valued lower by respondents (Table 9). The additions are oriented towards the need of training on the very essence of social entrepreneurship, social services, soft skills, ICT and communication skills, psychological trainings.

8.

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**Table 8. Answers to the question „What kind of education / training is the most suitable according to your opinion?“**

|                            | Formal education at secondary level | Higher education | Vocational training | Non-formal and informal training | Other |
|----------------------------|-------------------------------------|------------------|---------------------|----------------------------------|-------|
| Strongly disagree          | 1                                   | 0                | 0                   | 0                                | 0     |
| Disagree                   | 8                                   | 3                | 1                   | 7                                | 0     |
| Neither agree nor disagree | 47                                  | 32               | 19                  | 18                               | 98    |
| / Agree                    | 23                                  | 27               | 25                  | 19                               | 1     |
| Strongly agree             | 25                                  | 42               | 59                  | 60                               | 5     |
| / Total                    | 104                                 | 104              | 104                 | 104                              | 104   |
| / Average                  | 3,61                                | 4,04             | 4,37                | 4,27                             | 3,11  |

9.

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**Table 9. Answers to the question “In which fields is training needed?“**

|                            | Legal services | Technology | Finances | Fund raising | Participatory leadership | Business planning | Market analyses | Participation in funding programmes | Access to markets | Strategic planning | Governance | Other |
|----------------------------|----------------|------------|----------|--------------|--------------------------|-------------------|-----------------|-------------------------------------|-------------------|--------------------|------------|-------|
| Strongly disagree          | 0              | 0          | 0        | 0            | 0                        | 0                 | 0               | 0                                   | 0                 | 0                  | 0          | 0     |
| /Disagree                  | 0              | 0          | 0        | 1            | 1                        | 0                 | 1               | 0                                   | 0                 | 0                  | 0          | 0     |
| Neither agree nor disagree | 14             | 33         | 16       | 16           | 34                       | 14                | 28              | 11                                  | 27                | 13                 | 14         | 96    |
| / Agree                    | 51             | 38         | 39       | 43           | 37                       | 44                | 39              | 40                                  | 31                | 35                 | 33         | 0     |
| Strongly agree             | 39             | 33         | 49       | 44           | 32                       | 46                | 36              | 53                                  | 46                | 56                 | 57         | 8     |
| / Total                    | 104            | 104        | 104      | 104          | 104                      | 104               | 104             | 104                                 | 104               | 104                | 104        | 104   |
| / Average                  | 4,24           | 4,00       | 4,32     | 4,25         | 3,96                     | 4,31              | 4,06            | 4,40                                | 4,18              | 4,41               | 4,41       | 3,15  |

On the type of institutions that should provide specialized training in the field of social entrepreneurship the focus in assessing by the respondents falls on organizations offering specialized consulting services and vocational training centers. Higher schools, vocational schools and colleges and

secondary schools receive less support, which is in line with the answers to the previous question about the type of education / training. Specific addition to which there are serious grounds are NGOs, primary schools (as already noted in some of the previous issues) and training within the organizations themselves.

The estimates made by respondents give reason to make an important point about the importance of vocational training, formal and informal learning, incl. by organizations outside / with main activities outside the formal education system (in particular consultancies) and training in the workplace.

The importance of informal learning stressed in the answers to the above questions is confirmed and given the highest average score for the workshop and seminars, followed by long-term courses, short courses and regular subjects / disciplines part of the curricula of formal education. In additions it is again underlined the dual education and training in the workplace (Table 10).

10. ?”

**Table 10. Answers to the question „Through which type of courses?”**

|                            | Regular courses as part of the formal education curricula | (1 - 6 )<br>Long-term courses<br>(1 - 6 months) | (1 - 2 )<br>Short-term courses<br>(1 - 2 weeks) | Workshops and seminars | Other       |
|----------------------------|-----------------------------------------------------------|-------------------------------------------------|-------------------------------------------------|------------------------|-------------|
| Strongly disagree          | 0                                                         | 1                                               | 0                                               | 1                      | 1           |
| Disagree                   | 3                                                         | 1                                               | 7                                               | 3                      | 0           |
| Neither agree nor disagree | 38                                                        | 28                                              | 31                                              | 24                     | 99          |
| / Agree                    | 25                                                        | 30                                              | 26                                              | 29                     | 1           |
| Strongly agree             | 38                                                        | 44                                              | 40                                              | 47                     | 3           |
| / Total                    | 104                                                       | 104                                             | 104                                             | 104                    | 104         |
| / Average                  | <b>3,94</b>                                               | <b>4,11</b>                                     | <b>3,95</b>                                     | <b>4,13</b>            | <b>3,05</b> |



Estimates of the form of training are again oriented towards training in the workplace, as well as blended learning, e-learning, which replace traditional full-time and part-time, providing high availability and flexibility. The additional remarks referred to the compulsory subjects in social entrepreneurship in formal education, but also to self-learning, stressing once again the importance of activities to increase motivation for developing social entrepreneurship and personal motivation for training and development (Table 11).

( 11).

11. “ ?”  
**Table 11. Answers to the question “In what form is training needed?”**

|                            | Full-time | Part-time | On-the-job training | E-courses | Blended learning | Other |
|----------------------------|-----------|-----------|---------------------|-----------|------------------|-------|
| Strongly disagree          | 0         | 0         | 0                   | 1         | 0                | 1     |
| Disagree                   | 3         | 1         | 0                   | 4         | 1                | 0     |
| Neither agree nor disagree | 41        | 35        | 14                  | 18        | 20               | 100   |
| / Agree                    | 20        | 29        | 25                  | 19        | 16               | 0     |
| Strongly agree             | 40        | 39        | 65                  | 62        | 67               | 3     |
| / Total                    | 104       | 104       | 104                 | 104       | 104              | 104   |
| / Average                  | 3,93      | 4,02      | 4,49                | 4,32      | 4,43             | 3,04  |

Answers to questions about the skills required of social entrepreneurs, showed very good and good grades all listed in the following descending gradation: management; teamwork; initiative; communication skills; openness to change; innovativeness; organizational structure and culture; independent decision-making; identify new business opportunities; proactivity; volunteer management; assessment and risk management; understanding of the motivations and views of the stakeholders; connection with local communities; cooperation with local authorities and institutions; networking;

adaptability; creative thinking in vague problems; defining the problems, opportunities and solutions to create value; participatory leadership; resistance and learning through mistakes; action after analysis; democratic governance; obtaining legitimacy; pursuit of personal fulfillment as a member of a profession that creates value.

The analysis of the questionnaires provides an opportunity to summarize the recommendations to promote social entrepreneurship in several thematic areas: conceptual base and value system, regulatory framework and institutions, support, models, training, cooperation. The pursuit of social initiatives and awareness of personal responsibility among respondents is commendable, but the responses highlight the need for raising awareness, acquiring knowledge, skills and competences for the development of social entrepreneurship. Moreover, in this regard the need for consulting services is undeniable, and the role of consultants and consultancy organizations to promote social entrepreneurship.

## CONCLUSIONS

The study presented provides important implications on the state of the social entrepreneurship and ways of its encouragement putting a special accent on the needed support and the role of training and advisory organizations in building capacity. The main recommendations to promote social entrepreneurship include:

*Conceptual base and value system:* a unified understanding is needed on the essence of social entrepreneurship, social enterprises, social economy, etc. Many often different concepts are confused due to ignorance of the theoretical and legal basis, ie there is a need of information and training activities, also motivational and encouragement;

- *Regulatory framework and institutions:* government policies supporting initiatives for social entrepreneurship needed; they must include the state (municipal) and private structures;

- *Support:* state and local government can only facilitate the process, but the initiative must come from the private sector;

- *Models:* the better option is each company to develop social activities, albeit in a smaller scope, rather than relying on fewer but larger social enterprises.

- *Training:* establishment of a value system should start from an early age. Thus the desire for development of social entrepreneurship will be manifested as a necessity, as a mandatory element of the business organization. To provide training in specific programs, events, etc., in which participants can join - receive information, experiences and a result in their development.

- *Cooperation:* state, local governments and private producers to unite and create links among themselves on supporting the development of social entrepreneurship; social entrepreneurs to unite in associations by exchanging experiences and ideas.

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## Social programming as an alternative in front of small business or small business a challenge to social programming

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### SUMMARY

The exhibition is related to the review and analysis for the last years of the development of two vital ideas for the Bulgarian society – small business and social programming. The increasing capacity of social programming and the proven viability of small businesses create conditions, even in crisis situations, for successful ideas to generate many tangible and intangible goods that society needs for its existence and perfection. The symbiosis of these two socio-economic phenomena forms the conditions in which a number of initiatives find way for realization. Indeed, in the established economic situation, a number of sectors continue to exist precisely through the presence of small business entities who successfully and actively participate in the implementation of social programs and declare their expectations

for the structuring of program frameworks.

**Key words:** small business; social program; social adaptation

It has been written enough for the small business, and at the same time insufficient. The reason for this claim is rooted in its ability to appear wherever there is a certain shortage in production and goods and services provoked by the closing of certain old factories and enterprises. It is in such conditions that the creative beginnings and entrepreneurial spirit are manifested.

The analysis of the „small business” phenomenon is a process in which the vast amount of literature studied and the exhaustive retrospection cannot accurately account for the occurrence and emergence at a particular point in the evolution of conscious human activity. It is certain that the review of all directions and areas in which this socio-economic phenomenon emerges and develops proves that its path is sufficiently long and the beginning lies in antiquity (Maymeskulov, 2014). It is not so important whether the need to preserve any specific professional skills and habits in the family or the possibility of ensuring the existence of certain small personality formation is the root cause or the occasion. What is important is that, although limited and small, both as a definition and capacity, this type of conscious and purposeful human expression has left very profound marks of the process of development and improvement affecting the past and present of the human race.

Summarized data from the recent years prove that worldwide the small business accounts for more than 70% both for work organization and for presence. Although there are rather contradictory opinions on these facts, it is considered that in Bulgaria the share of small business accounts for about 90-93%. In the structure of this impressive

(Maymeskulov, 2014).

70%

90 – 93%.

“ ”  
 (Stoyanov, 2014).  
 70-  
 90-  
 and Evans, 1989).  
 (Bygrave and Hofer, 1991).

share, the only variable is the exact ratio of micro-enterprises - small enterprises under the meaning of the Bulgarian legislation. This written so far has formed the impression that the „small business” generic category has an increasingly tangible presence in modern economic life (Stoyanov, 2014). Various manifestations create some difficulty for a full and comprehensive definition. In this context, it may be more appropriate to analyse the key features that define this phenomenon and specify it.

The analysis of small business gives reason to believe that its essence relies on the entrepreneurial spirit and the development of project thinking. This conceptual-ideological symbiosis provides evidence that it is too difficult and risky to indicate what and under what conditions is differentiated as a cause and what as a consequence.

Still, in chronology, entrepreneurship as a phenomenon has attracted the attention of a number of scholar economists long time ago, i.e. long before the appearance of the concept of the projects and the changed thinking related them. In addition, the theoretical developments looking at entrepreneurship a little earlier create the conditions to consider that in the economic stagnation of the 1970<sup>s</sup> the so-called "entrepreneurial revolution" is a chance or an alternative for the economic development. This idea finds followers in the transformations that took place in the economies of the post-socialist economies in the early 1990s.

Generally, it can be said that in the fundamental classical studies of economic theory (Smith, Say, Mill, etc.) and in the contemporary ones there is no unambiguous definition of the socio-economic phenomenon of entrepreneurship.

Explanation of this may be sought in several ways:

First. Economists focus their attention on the big business (Brock and Evans, 1989).

(Andronov and Aleksandrova, 2003) [5]

Riskat, 1985).

(Draft, 2005).

1993),

(Davidkov,

Second. The development of models and theories built on exact science (Bygrave and Hofer, 1991).

Third. Multi-directional searches in optimizing government regulation.

Indeed, if qualifiers and definitions of entrepreneurship have to be registered, perhaps the list will be very long, because the phenomenon has existed since the 17<sup>th</sup> century (Andronov and Aleksandrova, 2003). Opinion on this issue was provided, in addition to the quoted classical economists, also by Marshall, Knight, Schumpeter, Thünen, Mises, Hayek, Kirzner, Axe, Kahn, Sokoloff, and others.

The analysis of the various definitions proves that in each of them the focus of the point of view affects different essential characteristics of the phenomenon. The range is far too wide from the existence of unpredictable risk, according to Cantillon, to the formation of entrepreneurial income, focused by Say on the one hand, and on the other, the implementation of a particular type of personal behaviour commented by Schumpeter to the systematic investment in innovation, reflected by Kahn and Sokoloff (Andronov and Riskat, 1985).

However, by summarizing a dozen definitions, it can be argued that entrepreneurial activity is a process of establishing an organization with a commercial purpose, which uses in its activity specific operations and certain resources at high risk to achieve fixed results (Draft, 2005).

The other conviction that emerges from the critical review of entrepreneurial perceptions is that it can predominantly be almost identical to the attempts to discover features that acquire definitions of the small business. In other words, in most cases, a small business engine is the entrepreneurial spirit of the entrepreneur who implements his ideas in a high-risk market environment (Davidkov, 1993), taking into account a number of legal and moral constraints and



hierarchical dependencies.

The other concept, which is consolidated with the entrepreneurial concept and influences the development of the idea of a small business, is the entrance of the projects into the contemporary economic reality. Although being a much more recent one, the concept of projects and the development of project thinking generate a very serious economic effect, due to which the last years of the twentieth century can boldly be recognized as a „project revolution”.

Attempts to define the term "project" register two approaches to determining its nature. One treats it as a cumulative process associated with a specific result, and the other as a set of logically arranged activities planned for a specific duration and purpose.

Looking at small businesses as a specific form of socio-economic existence and development, it may be more appropriate to attach to it the first approach. In this sense, despite the many definitions, it is more appropriate to assume that „the project is a separate enterprise with defined objectives, often including requirements related to duration, value and quality of the desired results” (APM, 1992).

The minimal incompatibility between the nature of the project and that of small business is the uncertainty in the definition related to the use of time resource. But here too, the interpretation can be seen in two ways, because each project is based on a limited time and budget, while the small business may not work in unlimited time, but in most cases with resource constraints. In this context, it is appropriate to define that the project is an "entrepreneurial effort organizing human, financial and material resources in a certain way within a unique set of tasks with a specified specification, with limited costs and time, and by implementing the lifecycle of the project successful changes are made defined by quantitative and qualitative goals and

1992).

“ (APM,

(ICB-IPMA)".

(Davidkov, 1998).

(Davidov and Andronov, 1983).

( . .).

tasks" (ICB-IPMA).

The short but critical analysis of the essence of the „small business" phenomenon does not claim to be comprehensive but reveals the mechanism that makes it sustainable and highly adaptable in today's economic conditions and at the same time enables it sell the goods and services produced, to mediate and consult, i.e. to be where the bigger ones have no interest or opportunity. (Davidkov, 1998). In the operation of small business it is quite natural to take into account the influence of the intense changes in the economic environment provoking demand for change in different directions and at the most diverse levels of human knowledge. The variety of approaches, methods and overall methodologies are more generally focused on key processes such as management, and in detail on such as decision-making, organization building, and a number of others. The analysis of the environment in which small businesses exist provides evidencethat there are several significant trends such as: narrowing of markets despite globalization, the growth of the service sector due to the growing needs, escalating competition, the difficulty in finding high tech solutions to increase productivity and more. Their presence and importance form the question whether the challenge of risk or creativity is leading in modern management (Davidov and Andronov, 1983).

The commented economic conditions, and especially the tendentionously developing basic characteristics, create prerequisites for a kind of renaissance of interest in a specific functional field of socio-economic management, as is the operational management. The focus on this area of human knowledge is adequate and appropriate as some features of small businesses (scale, specifics of activity, capacity, etc.). As in other areas of

“ , , (Colins, 1986)”.  
 “ ” (Galloway, 1994).  
 “ ” (Andronov, 1983)  
 “ ” (Galloway, 1994).

science and research a number of researchers present their views by concentrating them on definitions and structuring them in scientific studies. The starting point is the understanding of an operation that is interpreted as a „process, method or set of actions of predominantly practical nature” (Colins, 1986). In this context, „operations are an integral attribute of every conscious human activity, which inherently needs to be organized and productive” (Galloway, 1994).

Based on the perceptions of the essence of the economic notion of „operation”, many authors create definitions for operational management. However, the scope of the interpretation is not broad, but on the other hand the emphasis is placed on the fact that the operational management encompasses the decision-making process (Andronov, 1983) for an appropriately directed „transformation of the materials into a finished product and its delivery to the user“ (Galloway, 1994).

The structure of the process that is the object of the operational management contains several key components - the decision-making act and the resulting responsibility, the process of transformation of materials, energy, labour, capital and information and the act of product sale. Analysis of the component content of the process confirms that it is the operations that convert the materials into products and services but they also generate „another result” measured by heterogeneous types of responsibility in terms of change of result, effective capacity, convenient availability, sufficient human capital and optimal quality.

It has been shown that the interaction of economic reality and organization predetermines processes of mutual influence in both directions. It is normal to think over the changes that have occurred, as well as to clarify that an internal organizational and external

“ / ” (Deming, 1950).

(Deming, 2006).

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environment for the organization are defined. Practice convinces that it is precisely a deviation that reveals something different, suggests innovation or points to a model of a true solution. It is not accidental that new models often appear as good attempts at improvement in the different stages of socio-economic development.

As such, specifically for functional improvement, the model known as the „Shewhart/Deming Cycle” (Deming, 1950) is perceived. This model is itself a process related to product, service or process analysis and optimization (Deming, 2006). Its structure distinguishes four stages: planning, experimental actions, analysis and introduction of change. Objectively, each stage has a fixed, but also a creative nature. The reason for its inclusion in the essence and specificity of small business is that on the one hand, specific operations can be taken into account in the content of each stage, i.e. there is a possibility of upgrading and in the testing of the next result a solution can be identified for the initiation of a new operation and, on the other hand, the object of optimization are mostly the results of the normal activity of small business materialized mainly in the form of goods and services.

In conceptual terms, the structure in the mid-1980<sup>s</sup> is considered and perceived as a material expression of the organization only if it meets two key conditions - to divide the core activity of specific operations while coordinating the actions of their implementation. In this line of thought, a specific structural configuration is interpreted as a fixed response in coordinating certain operations, or in other words, architectural design is an active form of coordination, and most importantly, a specific control format, set on the system of operations.

The above written lines on the small business phenomenon provide an opportunity to conclude that this is a phenomenon that has acquired the

characteristics of an economic phenomenon due to its characteristics - high resilience and incredible adaptability. Together with the opportunity to engage in diverse and almost impossible business combinations, it proves that it can be likened to a compensatory mechanism of the existing economic systems, covering a deficiency in almost all economic areas and areas. The consolidation of the entrepreneurial spirit and the markedly practical thinking make it a significant socially-based institution, which, together with its sustainable present, accumulates a potential for a guaranteed future.

Still, given that change is the only constant in social processes for the realization of a better future, it is appropriate to envisage certain trends that society initiates, imposes and adopts in order to make its well-founded expectations into reality. In this sense, since the late 1980s, the focus of attention has been shifted from optimizing the quality of the operations to the implementation of various scale strategies. As an essential proof of this process is the perception and development of the idea of a strategically oriented organization. At organizational level, these are usually successful organizations, and at the above-organizational level these are the economically more stable countries materializing the concept through the transformation of structured programs and doctrines into concrete actions and policies.

At the heart of the analysed tendency in state and social development are principles of strategic management. In a modern economic sense, the strategy is characterized as a set of theories that form a certain management doctrine, with the development of tactical descriptive plans (Trifonova, 2005). The variety of adequate definitions of the concept under consideration does not obstruct the process of improving its content, but at the same time it tracks the evolutionary

(Trifonova, 2005).



planning addresses the plan by focusing on its long-term and targeted nature (including the financial plan but excluding its detailed short-term alternative in the form of accounting budgeting). Strategic management focuses on the overall structural reorganization of organizational activity with the intention of adapting it optimally to changes in the environment.

In the development of strategic management in the late 1970<sup>s</sup>, Ansoff's theoretical developments were particularly influential. Following the logic of the thesis that strategic decisions relate mainly to external rather than internal problems of the organization and especially to the choice of production nomenclature and the markets for its realization, he continues and develops it further (Ansoff, 1965). Considering each solution as a resultant variable concretized under the influence of incoming information from the outside environment, in the form of signals of varying intensity and significance, Ansoff and his school develop a „Method for the Use of Weak Signals” (Ansoff, 1984).

In the analysis of the proposed methodology, the factor value of the input information is raised. The accent is emphasized on weak signals from the external environment as the most important source to indicate emerging trends that predetermine the planning of responses by the organization in question. Response dynamics and a wide choice of decision options diagnose readiness and provoke successful strategic development in the conditions of weak signals.

In the process of exhibiting the theoretical development of Ansoff, along with the proven innovations that give drive to the ones seeking motives for improvement in the development of the strategic topic, some weaknesses can be noted. First of all, the implementation of control in strategy modelling is ignored. It is formed as a result of the impact of weak

signals from the external environment.

The role of the control is diminished, it is formalized and applies only to incoming information. The deformation found of the control function is deficient both in the implementation of the strategic process and in the mechanism of its updating.

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In the 1980<sup>s</sup>, the strategic management concept based on the strategic analysis thesis gradually emerged. Management theory specialists at this stage broaden the scope of strategic analysis to include all aspects of organizational environmental relations. This determines a far greater variety of management objects that can be categorized and qualified as the subject of strategic research.

The characteristics of the economic strategy are objectified by fixing its target content, focusing on the role of the production-financial factors, emphasizing the necessity to acquire competitive advantages of the organization. The strategy at this stage is considered as a basic framework for cost-effective, resource-efficient utilization by specifying the procedures for realization of organizational, business goals (Hofer, 1978). The opinion is formulated that the strategy ensures the possibility of achieving a competitive advantage (Porter, 1985). The formulated strategic decisions are differentiated from the perspective of the specificity of the organization under consideration and its sectoral situation - factors that influence the applied methods used in the process of making the specific decisions.

1978).

(Porter, 1985).

(Hofer,

(Mintzberg et al., 1997)

The strategy has, above all, the characteristics of a specific expression of the particular organization, clearly defining it as a selective, forward-looking activity, sustainable over time, focusing on certain priorities (Mintzberg et al., 1997) and organizational characteristics. In its



meaning, it is a long-term plan for permanent performance tracking of the use of the aggregate of internal and external resource potential in the hierarchical management structure to implement organizational goals.

Formal and content requirements are formulated to differentiate the strategy so that it is clearly defined to qualify as a logical unity of management interpretations and solutions for specific objectives and specific policies for their implementation, established range of regulated activity and expected effects of its implementation (Andrews, 1980).

(Andrews, 1980).

An important role in the development of management thinking about strategic management has the Mintzberg School. This school, in the full and specific sense, can be defined as alternative in terms of evolution in the development of strategy topic. In the course of time, the definitions of strategy in the economic sphere are specified in the preservation of its target character, but the focus of the material, resource factors shifts on the intangible ones, reinforcing their priority (Mintzberg, 1973). This qualitative jump registers a tendency for a change in the strategic process, with the corresponding conceptual weight of planning shifting to system analysis. In terms of content, the 'behavioural model' addition is also included to the definition of the strategy.

(Mintzberg, 1973).

The combination in the process of making and implementing a strategy of several characteristics, such as an action plan, a pattern of behaviour, a means of achieving and retaining a competitive position, proves in addition not only content but formal improvement either (Mintzberg, 1973). Emphasizing the process of modelling and implementing a specific behavioural model and introducing adjustments to it in order to fully coordinate between the potential of

1973).

(Mintzberg,

- the behavioural model and the desired strategic outcome proves the irreversibility of the process of introducing the Feedback Mechanism into the strategic process. Strengthening the role of feedback in the strategic process traces the possibilities for development and improvement both in content and in functional terms.

- By analysing the turbulent processes of dynamic economic reality, by comparing the significance of theoretical developments for the development of management thought, proving the increasing impact of their practical applicability, it can be assumed that Ansoff's main contribution is to focus attention on the issues of implementing a strategy, although this importance in some areas is over-exposed (Ansoff, 1984). As the most significant contribution of the Mutzberg school, one can note the motivated shortening of the implementation cycle of strategies and the introduction and demonstration of the growing role of strategic control with feedback (Mintzberg, 1979).

- As a method of organizational management, the strategy was initially implemented in the field of organizational activity planning (Stoyanov, 2013). In the period 1970-1990, strategic planning has become a leading avenue in theoretical and managerial thinking in the most advanced economies. Currently, strategic management is sufficiently detailed in the methodological management theory. It is seen as a unity of formulated, managerial decisions and actions taken in connection with the definition and implementation of strategies to achieve certain organizational goals, organized as a process through which long-term, sustainable development is implemented (Mihnev, 1999). A certain group of Bulgarian authors engage the content of organizational, strategic management also with the inevitable inclusion of operational (situational) management based on the attachment of the

(Ansoff, 1984).

(Mintzberg, 1979).

2013). 1970-1990 (Stoyanov,

(Mihnev, 1999).

( )

(Pamukchiev, 2002).

2015).

(Terziev et al.,

(Terziev, 2013).

organization to a specific strategy. Naturally, prioritizing the strategic management with the process of developing strategic and respectively long-term solutions (Pamukchiev, 2002).

In recent years it was on this basis that the concept of social programming has developed (Terziev et al., 2015). In general, established and socially committed strategies turn into policies, and the set of policies structure the stated socio-political doctrines also known as „program frameworks“.

The short analyses made proved that the specifics of the phenomena under consideration and their essential characteristic define them as factors of a system which in their interaction reveal trends of development and presence of problems (Terziev, 2013) The interaction process acquires a dynamic and continuous nature that brings variable success for many reasons, two of which are based on the state of small business and social programming:

The first is related to the active role of small business, interpreted as a subject that constantly experiments and seeks for success and change.

The second, in which social programming is perceived as a specific expression of the interests of society and the will of the state to create conditions in which economically active entities, including small businesses, can achieve stable and fruitful behaviour.

The above written lines of the expose predetermine the generalizing conclusion that small business is a mandatory requisite in the social system that materializes innovative ideas in many areas and shows high sustainability, including in a crisis. In this context, it is expressed as a test of new and unconventional ideas and a challenge to social programming. Finding a direct and adequate link between social programs and initiatives suggested by small

businesses would create a more sustainable business environment and would in particular prove that the state not only thinks about the future of all the subjects who build its authority but creates doctrines and programs in which to consolidate their intentions, interests and efforts.

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## „Drought Intensity-Crop Evapotranspiration” relationships under maize relative to climate regions and soil groups in North Bulgaria

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### SUMMARY

dry  
" / " - "  
**SPI2**  
**ETa-dry**  
( ) - ( )  
(180 mm m<sup>-1</sup>), (157 mm m<sup>-1</sup>)  
(116 mm m<sup>-1</sup>)  
(mm day<sup>-1</sup>)  
(mm)  
**ETa-dry**  
WinISAREG.

Drought is a natural disaster that results in significant hazards for agriculture and environment. Rainfed maize development, water requirements for evapotranspiration **ET-dry** and water balance in "soil-crop-atmosphere" system depends mainly upon the amount and distribution of precipitation during the periods of intensive maize development "July-Aug" and "June-Aug". The objective of present study was to search for reliable relationships between the Standardized Precipitation Index of seasonal dryness **SPI2**, on one hand, and Rainfed Maize Evapotranspiration totals **ET-dry** during „July-Aug”, „June-Aug” and „May-Sept” periods, on the other, under Moderately Continental (Pleven) and North-Black Sea (Varna) climate. Soil groups of large (180 mm m<sup>-1</sup>), average (157 mm m<sup>-1</sup>) and small (116 mm m<sup>-1</sup>) total available soil water were considered. Daily (mm day<sup>-1</sup>) and Seasonal **ETa-dry** (mm) were computed by applying previously validated water

*SPI2<sup>July-Aug</sup>*

$0.86 < R^2 < 0.96$

$(0.78 < R^2 < 0.89)$

*ETa-dry*

*SPI2*

*SPI2<sup>June-Aug</sup>*

SPI,

(Popova et al., 2014b).

SPI,

McKee

1993

(Alexandrov, 2011; Popova (ed.) 2012)

SPI2

*ETa-dry*

$R^2$   
*SPI2*

*SPI2*

*ETa-dry*

*SPI2<sup>July-Aug</sup>*

balance and irrigation scheduling simulation WINISAREG model. When drought intensity was characterized by the index ***SPI2<sup>June-Aug</sup>***, the linear relationships relating it to ***ETa-dry*** were highly reliable having coefficients of determination within the range  $0.86 < R^2 < 0.96$ . If ***SPI2<sup>July-Aug</sup>*** was averaged for July and August, the coefficients were still generally high ( $0.78 < R^2 < 0.89$ ). Results indicate that a large fraction of the ***ETa-dry*** interseasonal variation was explained by the ***SPI2<sup>July-Aug</sup>*** and ***SPI2<sup>June-Aug</sup>*** or by the dryness conditions during the maize peak demand periods. Thus, it was concluded that both ***SPI2<sup>July-Aug</sup>*** and ***SPI2<sup>June-Aug</sup>*** indexes could be used as an indicator of drought intensity impact on rainfed maize water demands for evapotranspiration.

**Keywords:** drought intensity, standardized precipitation index SPI, crop evapotranspiration, rainfed maize, North Bulgaria

## INTRODUCTION

Drought is a natural threat that causes great losses of crop yield worldwide. Rainfed maize development depends mainly on the rainfall quantity and distribution during “July-August” and “June-August” periods. It has been found that due to the ongoing climate change, precipitation during the most intensive periods of maize development decreases (Popova et al., 2014b).

The standardized precipitation index SPI, proposed by McKee in 1993, is a commonly used indicator of the degree of drought intensity, since it is calculated by using rainfall data only. Moreover, it facilitates the comparison between regions in terms of precipitation deficit in multiple time and space scales. Considerable number of Bulgarian (Alexandrov, 2011; Popova (ed.), 2012) and foreign (Li Yan-jun et al., 2012;

(Li Yan-jun et al., 2012; Jayanthi et al., 2013; Paulo et al., 2016)

RYD (%)  
NIRs (mm)  
1951-2004 (Popova et al., 2012; Popova et al., 2012; Popova et al., 2014; 2015).

(Popova et al., 2014; 2015; Popova and Ivanova, 2015).

Popova and Ivanova (2015)

dry<sub>May-Sept</sub>

<sup>1</sup>).  $ETa-dry_{May-Sept}$

( $157 < TAW < 180 \text{ mm m}^{-1}$ )

(1951-2004)

330 540 mm

( $TAW = 180 \text{ mm m}^{-1}$ ).

$ETa-dry$  (mm),

SPI (Pereira et al., 2010)

$ETa-dry$ .

Jayanthi et al., 2013; Paulo et al., 2016) scientists have applied the SPI index to analyze quantitatively the intensity of drought.

Aiming at vulnerability assessment of agriculture to drought in Bulgarian plains over a 54-year (1951-2004) period, reliable relationships between SPI and relative yield decrease under rainfed maize RYD (%) and respective net irrigation requirements to overcome these losses NIRs (mm) have been derived for representative climate regions in our previous studies (Popova et al., 2012; Popova et al., 2014; 2015). Trends to yield decrease and crop water requirements increase for evapotranspiration and irrigation have been identified, not only for South but also for North Bulgaria as well (Popova and Ivanova, 2015).

Referring to North Bulgaria, Popova and Ivanova (2015) have defined that the probability curve of seasonal evapotranspiration relative to rainfed maize  $ETa-dry_{May-Sept}$  over 1951-2004, which is substantially influenced by climate conditions and soil characteristics, is the lowest in the region of Varna for soils of small water holding capacity TAW ( $116 \text{ mm m}^{-1}$ ).  $ETa-dry_{May-Sept}$  reaches its highest values for Haplic and Luvisc (Leached and Degraded) Chernozem soils ( $157 < TAW < 180 \text{ mm m}^{-1}$ ) in the region of Pleven, where over the studied 54-year period it ranges between 330 and 540 mm on soils of large TAW ( $180 \text{ mm m}^{-1}$ ).

In order to establish easily  $ETa-dry$ , mm, for the needs of agriculture and irrigation management, as well as, for assessment of water stress impacts on yield, a version of the so called Seasonal Standardized Precipitation Index SPI (Pereira et al., 2010) is used in this study to characterize the categories of drought intensity and to define relationships with rainfed maize evapotranspiration  $ETa-dry$ , mm. This new approach has significant advantages in the context of increasing probability of occurrence of extreme natural events, such as drought, and established trends to precipitation and



(Popova (ed.) 2012; Popova et al., 2014; Popova and Ivanova, 2015).

*ETa-dry*,

(Statistical Yearbooks, 1951-2004).

$T_{max}$  (mm day<sup>-1</sup>)

*-dry* (mm day<sup>-1</sup>)

" TAW (Popova and Ivanova, 2015).

WINISAREG (Pereira et al., 2003)

(Popova et al., 2006; Popova, 2008; Popova and Pereira, 2011; Ivanova and Popova, 2011).

SPI2,

" - "

( )

" " " " " TAW (Total Available Water) (mm m<sup>-1</sup>),

" - " " - " " - " - T - dry<sub>May-Sept</sub>, T<sub>-dry</sub> June-Aug T<sub>-dry</sub> July-Aug, mm.

WINISAREG

SPI2

1951-2004 .

evapotranspiration change at the agricultural regions of Pleven and Varna (Popova (ed.) 2012; Popova et al., 2014; Popova and Ivanova, 2015).

The research deals with rainfed maize evapotranspiration *ETa-dry* since irrigation is presently practiced only over limited territories in North Bulgaria (Statistical year books, 1951-2004). Maize is selected as a representative summer crop, since the maximum value of evapotranspiration daily rate *ETmax* (mm day<sup>-1</sup>) is practically identical for these crops, while the period of *ETmax* duration could be different. Under rainfed maize, however, the period of water stress impact on *-dry* (mm day<sup>-1</sup>) depends mainly on climate variability&change and soil characteristics, mostly the "Total Available soil Water" TAW (Popova and Ivanova, 2015). In our previous studies the water balance and irrigation scheduling WinISAREG (Pereira et al., 2003) simulation model of was validated by using independent datasets from long-term field experiments with maize (Popova et al., 2006; Popova, 2008; Popova and Pereira, 2011; Ivanova and Popova, 2011).

The aim of the present study is to search for reliable relationships between the index of seasonal drought SPI2 averaged for the months "July-August" and "June-Aug", on one hand, and the seasonal evapotranspiration of rainfed maize relative to the periods given in subscript – *ETa-dry*<sub>May-Sept</sub>, *ETa-dry*<sub>June-Aug</sub> and *ETa-dry*<sub>July-Aug</sub>, on the other hand, under a moderately continental (Pleven) and a North-Black Sea (Varna) climate. Soil groups of large (180 mm m<sup>-1</sup>), average (157 mm m<sup>-1</sup>) and small (116 mm m<sup>-1</sup>) TAW, mm, are considered. For that purpose, the seasonal SPI2 index specified above and the validated WinISAREG simulation model are applied over the 1951-2004 period.

# MATERIAL AND METHODS

## 1. Climate characteristics and trends

It has been already found that the agricultural regions of Pleven and Varna are representative in terms of climate for North Bulgaria (Alexandrov, 2011; Popova et al., 2012; 2014 ; 2014b).

The precipitations totals for June, July and August vary considerably over the studied period in Pleven, showing a standard deviation 1.28 from the average between 46 and 54 mm, while in Varna the monthly totals and their variability are significantly lower having 1.28 within the range 30-38 mm (Popova et al., 2014).

It has been also found that the difference between precipitation fallen at Pleven and Varna in "July-August" is about 20 mm during the very dry seasons ( $P_{pre} > 90\%$ ), while this difference ranges from 30 to 80 mm in the average and moderately wet years having probability  $20 \leq P_{pre} \leq 75\%$  and reaches 135 mm in the very wet year (Figure 1a).

1.  
(Alexandrov, (ed.) 2011; Popova et al., 2012; 2014 ; 2014b)  
e  
-  
-  
-  
-  
1.28  
-  
46-54 mm.  
-  
-  
1.28  
(Popova et al., 2014).  
30 38 mm  
-  
 $P_{pre} > 90\%$   
20 mm,  
( $5 \leq P_{pre} \leq 70\%$ )  
45 60 mm  
135 mm  
( 1a).

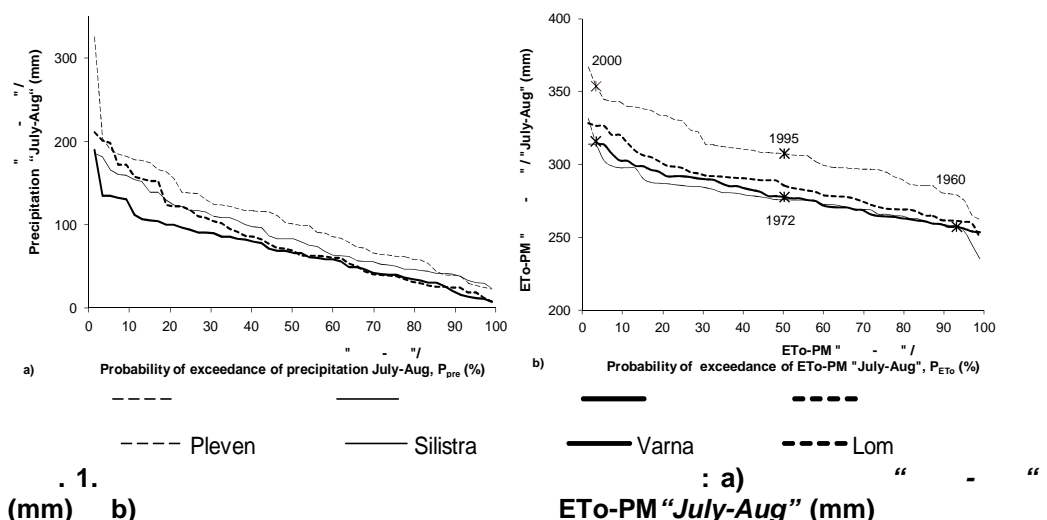


Fig. 1. Probability curves of occurrence of: a) a precipitation "July-Aug" (mm) and b) a reference evapotranspiration ETo-PM "July-Aug" (mm) for 1951-2004 comparing four climate regions

( $ET_o-PM$ )

ETo-PM

330 mm 260 250 370 mm

30 40mm -

( $ET_o$ )

$\leq 70\%$ ) (1b) (Popova and Ivanova, 2015).

1951-2004

(2000;  $P_{ET_o} < 5\%$ ), (1995/1972;  $P_{ET_o} = 50\%$ )

(1960;  $P_{ET_o} > 87\%$ )

a-dry (mm day<sup>-1</sup>),

(2).

2

TAW

(157 < TAW < 180 mm m<sup>-1</sup>).

( )

( )

( )

(Boneva, 2012).

/

TAW  $\leq 116$  mm m<sup>-1</sup>.

When comparing the probability curves of a seasonal reference evapotranspiration ( $ET_o-PM$ ) occurrence relative to the main agricultural regions in North Bulgaria, it is observed that during the water stress sensitive "July-August" period of maize development,  $ET_o-PM$  totals vary from 250 to 330 mm in Varna and from 260 to 370 mm in Pleven respectively, i.e. the evaporation capacity of the atmosphere in Pleven is up to 40-50 mm higher than that in Varna in high and average climatic demand years ( $P_{ET_o} \leq 50\%$ ) (Figure 1b) (Popova and Ivanova, 2015). The probability curves of a seasonal reference evapotranspiration  $ET_o-PM$  occurrence relative to the 1951-2004 period have been previously used as well to select years, representing a high (2000;  $P_{ET_o} < 5\%$ ), an average (1995/1972;  $P_{ET_o} = 50\%$ ) and a low (2000;  $P_{ET_o} > 87\%$ ) irrigation demand conditions, under which the evolution of daily evapotranspiration rate a-dry mm day<sup>-1</sup> has been studied for maize grown in soils of different total available water TAW (Figure 2).

## 2. Soil characteristics

The research is carried out for the most widespread soils in North Bulgaria - the Chernozems of average to large total available soil water (157 < TAW < 180 mm m<sup>-1</sup>). The Vertisols predominate in the North-West part of the Danube Plain (Northwestern Danube province), while the Carbonate and Typical Chernozems are located between The Danube River to the North and The Stara Planina Mountain to the South (Central near Balkan province) (Boneva, 2012). In North-Eastern part of Danube plain (Ludogorsko-Dobrudjanskata province) the Degradated/Leached Chernozems of vigorous humus horizon are found. The Alluvial&Deluvial meadow soils (Arenic Fluvisols and Sceletic Fluvisols) and light-textured Leached/Haplic Cambisol and Luvisol of small TAW  $\leq 116$  mm m<sup>-1</sup> predominate along the river terraces. The multi-layer character of deposit materials

3.  
**WINISAREG  
SPI**

WINISAREG (Pereira et al., 2003).

( To).

( ), ( )

TAW

o- -FAO56,  $T_{crop}$   
ID (Allen et al.,

1998). WINISAREG

(Popova et al., 2006; Popova, 2008; Popova and Pereira, 2011; Ivanova and Popova, 2011).

( )

Ta-dry 1951-2004. Ta-dry  
without irrigation“ “soil water balance“  
“ - - “,

ETa-max,

irrigation scheduling”.

4

“non-stress

in Alluvial and Diluvia soils allows keeping the capillary hanged water that leads to soil water holding capacity increase.

**3. Simulation model WINISAREG and standardized precipitation index SPI**

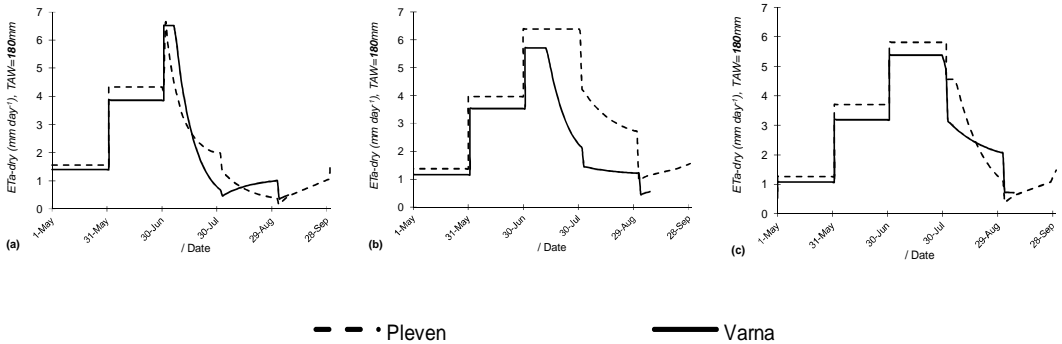
The irrigation scheduling and water balance WINISAREG simulation model (Pereira et al., 2003) is used for the calculation of crop evapotranspiration ETa-dry relative to rainfed maize. Input climate data are precipitation and reference evapotranspiration ETo. The soil data are referred to a multilayer profile, as for every layer are included the values of Field Capacity (FC) and Wilting Point (WP), from which the total available soil water (TAW) is calculated over one-meter soil depth from the surface. The model assumes renewed methodology for reference evapotranspiration ETo-PM-FAO56, crop evapotranspiration ETcrop and irrigation demands ID calculation (Allen et al., 1998). The model was previously validated using detailed data from independent long-term field experiments that include also seasonal and daily rate of ETa observed at different levels of water deficit (Popova et al., 2006; Popova, 2008; Popova and Pereira, 2011; Ivanova and Popova, 2011). The validated crop and soil parameters allow applying the model with a high degree of credibility for the crop evapotranspiration calculation under irrigated Ta and rainfed Ta-dry maize over a long-term period. Ta-dry is computed by the option “crop without irrigation“ and “soil water balance“ for the “soil-crop-atmosphere“ system, while the potential crop evapotranspiration ETa-max is computed with the same climate, soil and crop data but using “non-stress irrigation scheduling“ option.

**4. Impact of climate change and soil characteristics on rainfed maize crop evapotranspiration**

The seasonal evolution of daily

ETa-dry, mm day<sup>-1</sup>  
TAW (Popova and Ivanova, 2015).

evapotranspiration rate relative to “maize without irrigation” a-dry (mm day<sup>-1</sup>) was studied under the climate conditions of Pleven and Varna depending on the total available soil water TAW (Popova and Ivanova, 2015).



. 2.

**ETa-dry (mm day<sup>-1</sup>)**

**180 mm m<sup>-1</sup>) : a) (2000 P<sub>ETo</sub><5%); b) (1995 P<sub>ETo</sub>=50%); c) (1960 P<sub>ETo</sub>>87%) (TAW 180 mm m<sup>-1</sup>)**

**Fig. 2. Seasonal evolution of rainfed crop water uptake ETa-dry (mm day<sup>-1</sup>), as influenced by climate region for weather conditions relative to: a) a high demand (2000 P<sub>ETo</sub><5%); b) an average demand (1995 for Pleven/1972 for Varna P<sub>ETo</sub>=50%) and c) a low demand (1960 P<sub>ETo</sub>>87%) year; soil of large TAW (180 mm m<sup>-1</sup>)**

(2000 P<sub>ETo</sub><5%),  
(1995/1972, P<sub>ETo</sub>=50%)  
(1960 P<sub>ETo</sub>>87%)  
TAW (180 mm m<sup>-1</sup>)  
2, 2b 2c  
- 2000 .  
P<sub>ETo</sub><5%  
( 2 ).  
P<sub>ETo</sub>=50%)  
ETa-dry  
( )  
( )  
( 2b).  
ETa-dry  
6.4 mm day<sup>-1</sup>

The results in figures 2a, 2b and 2c that are relative to the very dry 2000 (P<sub>ETo</sub> <5%), the average 1995/1972 (P<sub>ETo</sub> = 50%) and the wet 1960 (P<sub>ETo</sub> > 87%) and soils of large TAW (180 mm m<sup>-1</sup>) show that:

The impact of climate conditions in July and August of the very dry 2000, having probability of occurrence of an *ET<sub>O</sub>July-Aug* less than 5%, is devastating at the both locations (Figure 2a).

In the average demand 1995/1972 of P<sub>ETo</sub> = 50% the impact of climate on ETa-dry differs in the locations, representing Central-West (Pleven) and East coastal (Varna) part of North Bulgaria (Figure 2b). The evapotranspiration ETa-dry keeps its maximum value of 6.4 mm day<sup>-1</sup> over the whole July in Pleven. Contrarily, ETa-dry

5.5 mm day<sup>-1</sup>  
 2.2 mm day<sup>-1</sup>

1960 ( $P_{ET_0} > 87\%$ )

*ETa-dry* reaches the potential evapotranspiration rate of 5.4 and 5.8 mm day<sup>-1</sup> for July in both locations that decreases to 3.2 and 4.6 mm day<sup>-1</sup> in the beginning of August.

TAW=157 mm m<sup>-1</sup>

10 -  
 20 , 1 -

TAW=180 mm m<sup>-1</sup>.  
 TAW=116 mm m<sup>-1</sup> *ETa-dry*

( 16 )

4.3 mm day<sup>-1</sup>

(Popova and Ivanova, 2015).

### 5. SPI

*Seasonal SPI (2) (Standardized Precipitation Index SPI)*,

“ - “,

Guttman (1998)

relative to Varna starts declining from 5.5 mm day<sup>-1</sup> in mid-July reaching 2.2 mm day<sup>-1</sup> at the end of the month.

In the wet 1960 ( $P_{ET_0} > 87\%$ ) *ETa-dry* reaches the potential evapotranspiration rate of 5.4 and 5.8 mm day<sup>-1</sup> for July in both locations that decreases to 3.2 and 4.6 mm day<sup>-1</sup> in the beginning of August.

When maize is grown on soils of medium water holding capacity (TAW=157 mm m<sup>-1</sup>) the impact of seasonal drought on *ETa-dry* begins 10 days earlier in Pleven, on the 20<sup>th</sup> of June, and 1 day earlier in Varna than that of maize, grown in soils of a large TAW=180 mm m<sup>-1</sup>. Relative to the soils of small TAW=116 mm m<sup>-1</sup>, the decrease of *ETa-dry* logically starts on the earliest possible date for Pleven - the 16<sup>th</sup> of June, while for Varna the maximum rate of 4.3 mm day<sup>-1</sup> is kept over the whole June (Popova and Ivanova, 2015).

### 5. Standardized Precipitation Index SPI

The version of so called Seasonal Standardized Precipitation Index SPI2, calculated as an average value of the index for the period of the highest maize sensitivity to water deficit “July-Aug”, is used to define categories of agricultural drought for maize in the both studied regions.

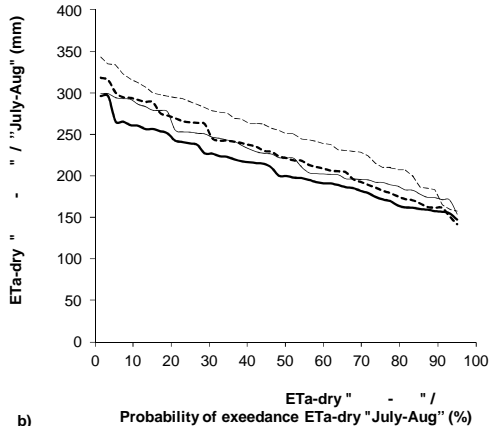
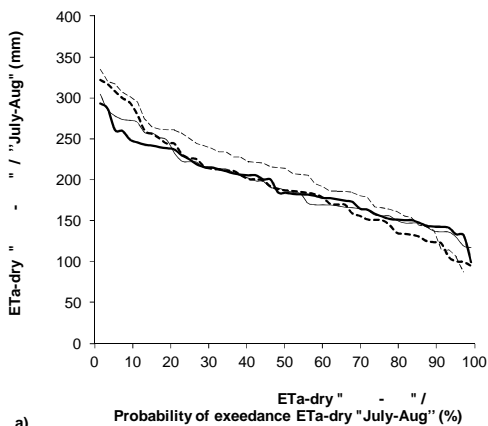
The positive values of the index shows a higher and the negative values show a lower than the average precipitation values. Guttman (1998) recommended the index, as standardized and having a probability interpretation, thus could be compared between years and regions and also used for risk assessment and taking decisions.

## RESULTS AND DISCUSSION

In Figure 3 the probability curves of occurrence of a rainfed maize evapo-

dry  
 TAW=157 mm m<sup>-1</sup> ( 3 )  
 TAW=180 mm m<sup>-1</sup> ( 3b).

ETa-  
 transpiration a-dry "July-Aug" (mm)  
 relative to the locations, representing the  
 main climate regions in North Bulgaria, are  
 compared when the impact of the soils of  
 medium TAW = 157 mm m<sup>-1</sup> (Figure 3a) and  
 large TAW = 180 mm m<sup>-1</sup> (Figure 3b) is  
 taken into account.



a)

b)

----- Pleven      ——— Silistra  
 ——— Varna      - - - - Lom

3.  
 a-dry " (mm) : ) TAW= 157  
 mm m<sup>-1</sup> b) TAW=180 mm m<sup>-1</sup>  
 1951-2004 .

Fig. 3. Probability curves of occurrence of a crop evapotranspiration of rainfed maize a-dry (mm) for "July-Aug" comparing four climate regions for soil groups of ) medium TAW= 157 mm m<sup>-1</sup> and b) large TAW=180 mm m<sup>-1</sup>, 1951-2004

P<sub>ET-dry</sub> ≤ 80%,

ETa-dry

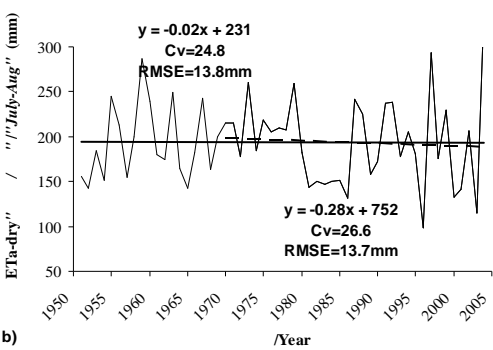
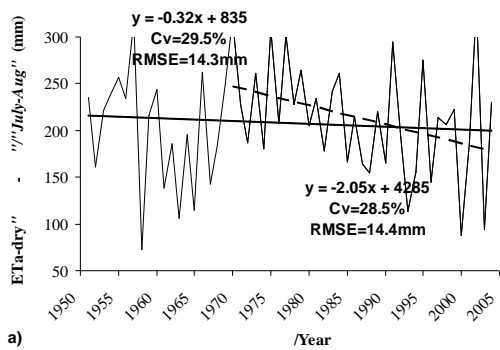
TAW=180 mm m<sup>-1</sup> ( 3b).  
 TAW=157 mm m<sup>-1</sup> ( 3 )

P<sub>ET-dry</sub> > 90%

Regarding a-dry "July-Aug", results indicate that the difference between the studied regions is practically essential (between 50 and 70 mm) only when the rainfed maize is grown in soils of large TAW and during years of average to low irrigation demand conditions having probability P<sub>ETa-dry</sub> ≤ 80% (Figure 3b). Up to the soils of medium TAW=157 mm m<sup>-1</sup>, the difference between the regions in terms of a-dry "July-Aug" is much less significant (Figure 3a). The results also indicate that the difference in evapotranspiration of rainfed maize grown in Plevna and Varna is negligible and does not depend on the soil water holding capacity during high climatic demand (very dry) years, having probability of occurrence P<sub>ETa-dry</sub> > 90%.

e  
 a-dry „ - ” (mm)  
 1970-2004,  
 (-2.05 mm  
 -1),  
 , -  
 ,  
 0.28 mm  
 -1 ( 4).

A trend analysis of rainfed maize evapotranspiration *a-dry* “July-Aug” (mm) is performed for both studied locations under the current weather conditions (1970-2004). It results into a considerable magnitude of a negative slope coefficient  $b = -2.05 \text{ mm year}^{-1}$  showing *a-dry* decrease in Pleven (Figure 4a). In Varna however, due to the influence of higher air humidity along the coastal zone, rainfed maize evapotranspiration *a-dry* “July-Aug” has decreased only by  $-0.28 \text{ mm year}^{-1}$  (Figure 4).



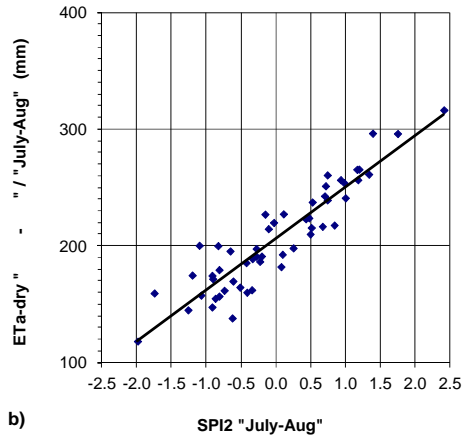
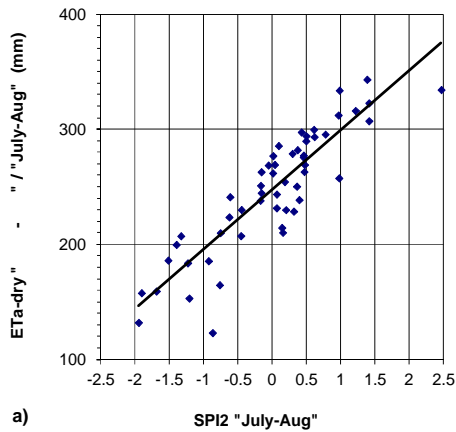
4. (mm) : ) b) ; a-dry „ - ” 1970-2004 1951-2004, (TAW=157 mm m<sup>-1</sup>)

Fig. 4. Variability and respective trend lines of crop evapotranspiration relative to rainfed maize *a-dry* „July-Aug” (mm) at: a) Pleven and b) Varna, soils of medium water holding capacity (TAW=157 mm m<sup>-1</sup>), 1951-2004 vs. 1970-2004

*ETa-dry*  
 „ - ” „ - ” „  
 „ - ” „ - ”  
 SPI2 „ - ”  
 - ( )  
 - ( )  
 5.  
 y=a+bx 1951-2004  
 1.

Correlation relationships between total rainfed maize evapotranspiration *ETa-dry* over the “July-August”, “June-August” and “May-September” periods and standardized precipitation index of seasonal drought *SPI2* “July-Aug” and *SPI2* “June-Aug” have been derived under the conditions of a moderate continental (Pleven) and a North Black Sea (Varna) climate and studied soil groups, as shown in Figure 5. The obtained parameters of the linear relationship of a type  $y = a + bx$  relative to the 1951-2004 period have been summarized in Table 1.





5.  $SPI2$  " " ( )  $ETa-dry$  " " (mm) ( Y )  $TAW=180mm m^{-1}$ : a) , b)

Fig. 5. Relationships between seasonal  $SPI2$  "July-Aug" (X-axis) and crop evapotranspiration  $ETa-dry$  „July-Aug" (mm) (Y-axis) for soils of large  $TAW=180 mm m^{-1}$ : a) Pleven, b) Varna

$SPI2$ ,  
/  
 $ETa-dry$ , mm  
( $TAW=180mm m^{-1}$ )  
 $R^2 > 91\%$ ,  
 $SPI2$  " "  $R^2 > 78\%$ ,  
 $SPI2$  " " .  
 $R^2 > 86\%$   $R^2 > 85\%$  ( 1).  
,  
 $R^2$  ,  
(mm) 1951-2004  
" "  $SPI2$  " "  $SPI2$   
" " .  
 $R^2$   
( 1).

The derived relationships between seasonal  $SPI2$  index, averaged for July and August, and the rainfed maize evapotranspiration  $ETa-dry$ , mm, cumulated over the months as specified above, are characterized by a high degree of association. In the case of soils of large  $TAW = 180mm m^{-1}$ , Pleven region, the coefficient of determination is  $R^2 > 91\%$  when the index  $SPI2$  "June to Aug" has been used versus  $R^2 > 78\%$  if using  $SPI2$  "July-Aug". Respective values for the region of Varna are derived  $R^2 > 86\%$  and  $R^2 > 85\%$  with the same soil (Table 1).

Observing the defined relationships of the type  $y = a + bx$ , it is clear that the determination coefficient  $R^2$  is high, which means that most of the variations in the  $ETa-dry$ , mm over the years 1951-2004 are described by  $SPI2$  "June-Aug" and  $SPI2$  "July-Aug" i.e. from the intensity of drought in the most sensitive to water stress periods of maize development. The coefficients of determination  $R^2$  are close in value at different soils groups (Table 1).

1.

$$y = a + bx$$

$$ETa\text{-dry} \text{ " " - " " - " " (mm) } - SPI2$$

“ “ - “ “ - “ (mm)  
 “ - ” “ - ”, 1951-2004 ,

**Table 1. Parameters of derived specific relationships  $y=a+bx$  between crop evapotranspiration totals of rainfed maize  $a\text{-dry} (mm)$  relative to „July-Aug”, „June-Aug”, „May-Sept” and High Peak Season  $SPI2$  relative to “July-Aug” and “June-Aug”, 1951-2004, Pleven and Varna**

| region / Climate           | TAW / Soil groups according to TAW                   |                                    |                                   | TAW / Soil groups according to                       |                                    |                                   |
|----------------------------|------------------------------------------------------|------------------------------------|-----------------------------------|------------------------------------------------------|------------------------------------|-----------------------------------|
|                            | / Small<br>116 mm m <sup>-1</sup>                    | / Medium<br>157 mm m <sup>-1</sup> | / Large<br>180 mm m <sup>-1</sup> | / Small<br>116 mm m <sup>-1</sup>                    | / Medium<br>157 mm m <sup>-1</sup> | / Large<br>180 mm m <sup>-1</sup> |
|                            | <i>ETa-dry "July-Aug" = a+b.SPI2 "July-Aug" (mm)</i> |                                    |                                   | <i>ETa-dry "July-Aug" = a+b.SPI2 "June-Aug" (mm)</i> |                                    |                                   |
| <b>/Pleven</b>             |                                                      |                                    |                                   |                                                      |                                    |                                   |
| / Intercept <b>a</b>       | 186.35                                               | 207.71                             | 247.57                            | 186.32                                               | 207.69                             | 247.55                            |
| Slope coefficient <b>b</b> | 63.84                                                | 60.67                              | 51.78                             | 78.24                                                | 74.95                              | 63.88                             |
| <b>R<sup>2</sup> (%)</b>   | 0.82                                                 | 0.80                               | 0.78                              | 0.96                                                 | 0.95                               | 0.93                              |
| <b>RMSE, mm</b>            | 27.00                                                | 27.09                              | 24.28                             | 13.34                                                | 13.46                              | 14.13                             |
| <b>/Varna</b>              |                                                      |                                    |                                   |                                                      |                                    |                                   |
| / Intercept <b>a</b>       | 142.95                                               | 193.51                             | 206.25                            | 142.97                                               | 193.53                             | 206.27                            |
| Slope coefficient <b>b</b> | 54.20                                                | 48.39                              | 43.99                             | 67.50                                                | 59.12                              | 54.10                             |
| <b>R<sup>2</sup> (%)</b>   | 0.82                                                 | 0.86                               | 0.85                              | 0.93                                                 | 0.93                               | 0.93                              |
| <b>RMSE, mm</b>            | 22.96                                                | 17.93                              | 17.11                             | 14.52                                                | 12.28                              | 11.34                             |
|                            | <i>ETa-dry "June-Aug" = a+b.SPI2 "July-Aug" (mm)</i> |                                    |                                   | <i>ETa-dry "June-Aug" = a+b.SPI2 "June-Aug" (mm)</i> |                                    |                                   |
| <b>/Pleven</b>             |                                                      |                                    |                                   |                                                      |                                    |                                   |
| / Intercept <b>a</b>       | 308.33                                               | 330.17                             | 369.72                            | 308.31                                               | 330.15                             | 369.70                            |
| Slope coefficient <b>b</b> | 62.27                                                | 58.91                              | 50.35                             | 75.04                                                | 70.92                              | 60.19                             |
| <b>R<sup>2</sup> (%)</b>   | 0.85                                                 | 0.85                               | 0.84                              | 0.96                                                 | 0.96                               | 0.94                              |
| <b>RMSE, mm</b>            | 23.52                                                | 22.14                              | 19.53                             | 12.24                                                | 11.60                              | 12.42                             |
| <b>/Varna</b>              |                                                      |                                    |                                   |                                                      |                                    |                                   |
| / Intercept <b>a</b>       | 251.87                                               | 296.59                             | 314.93                            | 251.89                                               | 296.61                             | 314.95                            |
| Slope coefficient <b>b</b> | 52.88                                                | 47.35                              | 43.00                             | 64.39                                                | 56.56                              | 51.78                             |
| <b>R<sup>2</sup> (%)</b>   | 0.86                                                 | 0.89                               | 0.88                              | 0.93                                                 | 0.93                               | 0.93                              |
| <b>RMSE, mm</b>            | 19.44                                                | 15.02                              | 14.58                             | 13.84                                                | 12.32                              | 11.22                             |
|                            | <i>ETa-dry "May-Sept" = a+b.SPI2 "July-Aug" (mm)</i> |                                    |                                   | <i>ETa-dry "May-Sept" = a+b.SPI2 "June-Aug" (mm)</i> |                                    |                                   |
| <b>/Pleven</b>             |                                                      |                                    |                                   |                                                      |                                    |                                   |
| / Intercept <b>a</b>       | 360.49                                               | 381.52                             | 421.14                            | 360.46                                               | 381.50                             | 421.12                            |
| Slope coefficient <b>b</b> | 67.57                                                | 65.67                              | 59.8                              | 77.76                                                | 75.84                              | 69.27                             |
| <b>R<sup>2</sup> (%)</b>   | 0.87                                                 | 0.88                               | 0.87                              | 0.90                                                 | 0.91                               | 0.91                              |
| <b>RMSE, mm</b>            | 22.91                                                | 22.15                              | 20.69                             | 20.34                                                | 18.99                              | 17.38                             |
| <b>/Varna</b>              |                                                      |                                    |                                   |                                                      |                                    |                                   |
| / Intercept <b>a</b>       | 293.55                                               | 314.96                             | 356.31                            | 293.58                                               | 314.98                             | 356.33                            |
| Slope coefficient <b>b</b> | 58.83                                                | 52.20                              | 48.56                             | 62.52                                                | 60.55                              | 56.11                             |
| <b>R<sup>2</sup> (%)</b>   | 0.86                                                 | 0.87                               | 0.89                              | 0.85                                                 | 0.86                               | 0.86                              |
| <b>RMSE, mm</b>            | 20.24                                                | 18.13                              | 15.75                             | 20.72                                                | 19.30                              | 17.35                             |

RMSE, mm  
 mm, -

11-27

The calculated root mean square error *RMSE*, mm ranges between 11-27 mm, as the lower values refer to the cases when the seasonal *SPI2* is averaged for the months from June to August. These results demonstrate the ability to use *SPI2 "July-Aug"* and *SPI2 "June-Aug"* as indicators for the impact of drought intensity on rainfed maize

*SPI2*

*SPI2* “ - ” *SPI2*

“ - ”

-dry (mm),

TAW.  $b$

SPI2 “ - ”/“ - ”

(

)

,

.

$b$

TAW,

.

(

SPI2 “ - ”

0)

TAW,

TAW.

- evapotranspiration totals  $ETa-dry$ , mm,

- during „July-Aug”, „June-Aug” and „May-Sept” periods, which do not depend on TAW. The slope coefficient  $b$  can be assumed as an indicator of the linear increase of  $ETa-dry$ , mm, when the  $SPI2$  „July-Aug”/“June-Aug” indices increase from negative values (characterizing the category of the intensity of drought) to positive, that characterizes wet conditions.

The results show that the values of slope coefficient  $b$  decrease from soils with small to those with large total available water TAW, and they are higher in Pleven region. The intercept (the value of respective  $ETa-dry$ , mm when  $SPI2$  „June-Aug”/“July-Aug”= 0) also depends on the soil groups according to total available water TAW, as it increases from soils with small to those with large total available water TAW.

**CONCLUSIONS**

The study on the correlation relationships between  $SPI2$  „June-Aug”/“July-Aug” indices and rainfed maize evapotranspiration totals  $ET-dry$ , „July-Aug”,  $ET-dry$ , „June-Aug” and  $ET-dry$  „May-Sept” relative to representative climate regions and soil groups in North Bulgaria indicates that:

When drought intensity is characterized by the averaged  $SPI2$  index for the months „June-August”, the relationships with all the three  $ETa-dry$  totals are reliable, as proved by the high coefficient of determination ( $86 < R^2 < 96\%$ ) obtained for studied regions. When  $SPI2$  is averaged for „July-August”, the determination coefficient is slightly lower but still acceptable ( $78 < R^2 < 89\%$ ). The relative mean square error  $RMSE$  values are acceptably low (11-27 mm).

The high determination coefficient of the established correlations between  $ETa-dry$  totals and  $SPI2$  indices shows that the major part of  $ETa-dry$  variations

“

-

-dry<sub>July-Aug</sub>

,

:

-

SPI2

-dry” (mm)

( $86 < R^2 < 96\%$ ).

SPI2

”

( $78 < R^2 < 89\%$ ).

RMSE, mm

(11-27 mm).

-dry, mm SPI2

”

-dry (mm)

SPI2 ” - ”

”

|                                                                                                                                                            |                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p style="text-align: center;"><i>SPI2</i></p> <p style="text-align: center;"><i>-dry (mm).</i></p> <p style="text-align: center;"><i>a-dry - SPI2</i></p> | <p style="text-align: center;"><i>a-dry - SPI2</i></p> | <p>- are characterized by <i>SPI2</i> during the most sensitive to water deficit period of maize development. Consequently, the standardized precipitation indices <i>SPI2</i> can be used as an indicator for the impact of drought intensity on rainfed maize evapotranspiration <i>ETa-dry</i>, mm.</p> <p>- The derived "<i>ETa-dry - SPI2 "Jun-Aug"</i>" and "<i>ETa-dry - SPI2 "Jul-Aug"</i>" relationships are an easy and accessible tool for computing the maize evapotranspiration from the drought intensity. They could also be used in calculating net irrigation requirements by physically-based simulation tools, as well as in hydrology and hydrogeology for simulating the water balance at catchment scale and water resources management.</p> |
|------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

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## Assessment of residual inorganic nitrogen content in soils from Northern Bulgaria for potential dangers of nitrate pollution

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### SUMMARY

990

mg/kg

2035

41.5 mg/kg  
- 20.9  
- 9047  
6254

- Residual inorganic nitrogen was  
- evaluated on real farms in Northern  
- Bulgaria. The results of the analysis of  
- 990 soil samples were used. The  
- statistical analysis shows a trend for  
- increased nitrogen content in the soil and  
- the presence of separate farms and fields  
- with significant amounts of residual  
- inorganic nitrogen. The average load on  
- agricultural land with residual inorganic  
- nitrogen is highest in the region of Vidin  
- 41.5 mg/kg of soil, lowest in the Montana  
- region – 20.9 mg/kg of soil. In the Pleven  
- region there are the most cases of  
- extremely high residual inorganic  
- nitrogen.

- By total quantities of nitrogen potentially  
- leached in the environment from the  
- studied areas the largest quantities are in  
- the Pleven region - 9047 tons for spring  
- crops and 6254 tons for winter crops, and  
- the smallest in the Lovech region 2035  
- tons for spring crops and 1320 tons for

1320

52 kg

winter crops. On average, about 52 kg of nitrogen per hectare may be lost for the surveyed areas.

**Key words:** nitrogen fertilization, residual inorganic nitrogen in soil, nitrate pollution

## INTRODUCTION

The soils in Northern Bulgaria are among the most fertile in the country with the highest yield. With the development of agriculture, ways are sought for their enrichment and fertility improvement and the yields increasing of the agricultural production and, at the same time, the protection of the environment.

One of the most powerful agro-technical factors for increasing yields to date is fertilization.

Fertilizers are used both to increase yields from crops and to restore and enrich soil resources. Given the fact that, together with harvesting, nutrients such as nitrogen, phosphorus, potassium, sulfur, calcium, magnesium and other trace elements are irreparably exported from the soil, different ways to recover them are needed.

The way to achieve this is the application in the arable land of phosphates, nitrates, potassium salts, etc., as an equivalent to the nutrients exported by the crops.

Nitrogen fertilizers such as ammonium nitrate, urea and ammonium sulfate are the most commonly used.

Application of chemical fertilization undoubtedly increases yields of crops, but with high doses, it contributes to crop pollution, soils, groundwater and groundwater and increases the chemical load in agroecosystems.

It is also largely economically unjustified.

20

18%

For 20 years in Canada, 18% of arable

(De Jong, et al., 2007; Drury et al., 2007).

20 kg

Katsarova, Koutev, 2014

2001-2015

2

, 2015).

5

2,5

(

land has been moved from a non-polluting category to a high risk of pollution (De Jong, et al., 2007; Drury et al., 2007).

Nitrogen losses have fluctuated from 5 to 20 kilograms per hectare. Katsarova, Koutev, 2014 have make recent study of residual inorganic nitrogen in some regions of Bulgaria. A number of surveys of annual monitoring of the state and quality of water in the country show increased levels of nitrates from agricultural sources in the waters. The amount of fertilizers used has increased 2.5 times for the period 2001-2015. Nitrogen fertilizers application increase twice in the same period (National Report on the Status and Protection of the Environment in the Republic of Bulgaria, 2015).

As a result of agrochemical surveys conducted in recent decades, the law on optimal fertilization and optimal yields is formulated in many countries. In general, it states: mineral fertilization increases yields up to certain limits of application.

There is no increase in yields above the marginal levels when the quantities above the optimal levels are introduced, moreover the unnecessary nutrients appear to be residual harmful substances in agricultural production.

Mankind faces the real environmental risk of contamination of soil resources and hence of agricultural production with toxic elements, which will subsequently worsen the health status of the population.

*AIM: To quantify the content of available forms of nitrogen in soils from real intensive farms to establish whether soil fertility or contamination is present and to show areas threatened by nitrate pollution.*



## MATERIAL AND METHODS

14  
5000  
990  
Bremner, Keeney (1965)  
Statgraphics  
centuruion XV

In the present study 14 farms from Vidin, Montana, Pleven, Lovech and Veliko Tarnovo with a total area of over 5000 hectares are included. For the evaluation, the results of the analyzes of almost 990 soil samples from the laboratory data of N. Poushkarov Institute of Soil Science "N. Poushkarov, Sofia. Agrochemical analysis of soil samples for the determination of inorganic nitrogen in the soil was carried out by the Bremner, Keeney (1965) distillation method.

The statistical software Statgraphics centuruion XV was used in the study

## RESULTS AND DISCUSSION

5  
1964  
2014).  
2 13.09.2007

One of the major environmental problems arising from the agricultural activity of humans is the excessive use of nitrogen-containing fertilizers as well as those produced by livestock breeding and used in various soil treatment natural fertilizers. Indirectly, as a result of percolation and infiltration processes, hazardous point or diffuse sources of soil and groundwater contamination may occur.

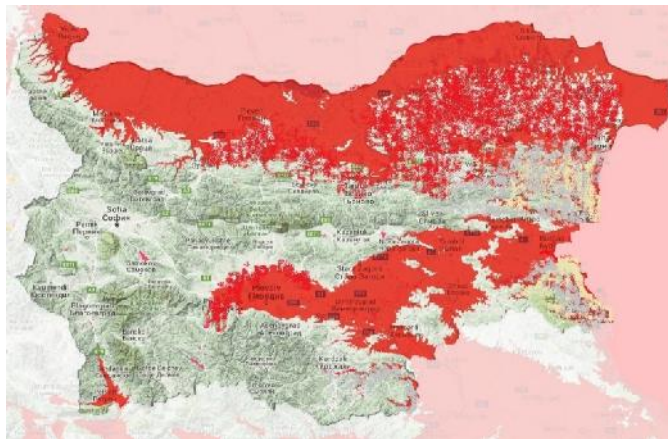
The US has been monitoring the results of soil analyzes for years. More than 5 million soil analyzes have been made in Wisconsin since 1964. Providing recommendations for fertilization based on soil analysis has led to a reduction in the content of mobile forms of nitrogen, phosphorus and potassium in recent years, but still in sufficient quantity. (Peters John, 2014). That should be the strategy of agriculture in our country for all nutrients.

In Bulgaria, the legislative framework regulating the use of nitrogen fertilizers is given by Ordinance No. 2 of 13.09.2007 for the protection of waters from pollution with nitrates from agricultural sources. The Nitrate Directive

91/676/

- has been developed on the basis of 91/676/EEC. Its creation was due to the increased nitrate content in the water that is used for the population's drinking needs. It aims to protect water pollution from excessive use of fertilizers in agriculture, water protection from nitrate pollution and subsequent eutrophication in the "vulnerable zones" on the territory of the country (Figure 1).

“ ( ” 1).



. 1. ( ) ,  
-795/10.08.2004 .

**Fig. 1. Nitrate vulnerable zones (in red) in the Republic of Bulgaria, according to Order No. RD-795 / 10.08.2004 of the Minister of Environment and Waters**

” ”

, ,  
2015

- All five areas surveyed fall into nitrate vulnerable zones. In order to limit the pollution from "diffuse" sources, it is necessary to determine the fertilizer norms based on the well-selected limit values of each method used for the analysis of available substances. Koutev, Markov, Stoyanova and Koutev, Stoyanova in 2015 publish results for the frequency distribution of large samples of soil, nitrogen, phosphorus and potassium data.

- These studies allowed the determination of the value to be excluded from the calculation of the fertilizer rate - 30 kg of nitrogen per hectare.

- 30 kg

990

- In the present study, 990 samples were tested. The minimum and maximum

1.

values are given in Table 1.

1.

**Table 1. Multiple-Sample Comparison**

|            |                                  |                     |
|------------|----------------------------------|---------------------|
| Vidin      | - 76<br>76 values ranging from   | 20.2 to 100.0 mg/kg |
| Montana    | - 96<br>96 values ranging from   | 10.4 to 92.7 mg/kg  |
| V. Tarnovo | - 155<br>155 values ranging from | 11.5 to 107.7 g/kg  |
| Pleven     | - 443<br>443 values ranging from | 5.0 to 118.1 mg/kg  |
| Lovech     | - 220<br>220 values ranging from | 13.9 to 118.1 mg/kg |

2 3.

- For soils included in the present  
 - study the average mineral nitrogen  
 - content after harvest is presented in  
 Tables 2 and 3. The results obtained from  
 the statistical tests contribute to the  
 correct evaluation of the results.

2.

**Table 2. Inorganic nitrogen content in soil from different regions after harvest - minimum, maximum, average mg/kg**

|         | <i>Vidin</i> | <i>Montana</i> | <i>Veliko Tarnovo</i> | <i>Pleven</i> | <i>Lovech</i> |
|---------|--------------|----------------|-----------------------|---------------|---------------|
| minimal | 20.2         | 17.8           | 11.5                  | 15.6          | 13.9          |
| maximal | 100          | 26.1           | 77.8                  | 40.3          | 68.7          |
| average | 41.5         | 20.9           | 34.5                  | 28.7          | 33.9          |

3.

(kg/ha)

**Table 3. Inorganic nitrogen content in soil from different regions after harvest - minimum, maximum, average kg/ha**

|         | <i>Vidin</i> | <i>Montana</i> | <i>Veliko Tarnovo</i> | <i>Pleven</i> | <i>Lovech</i> |
|---------|--------------|----------------|-----------------------|---------------|---------------|
| minimal | 61.0         | 31.0           | 35.0                  | 15.0          | 42.0          |
| maximal | 300.0        | 278.0          | 323.0                 | 354.0         | 354.0         |
| average | 125.0        | 81.0           | 102.0                 | 99.0          | 94.0          |

The average results provide information on the overall picture in different areas. The highest is the average mineral nitrogen content in the soils of Vidin region and the lowest in the soils of Montana region. The remaining three areas, Veliko Tarnovo, Pleven and Lovech, have a similar average nitrogen content in the soils – Table 2.

The coefficients of variation vary from 35,9% to 55,7%. The biggest changes in the values are in the regions of Pleven and Lovech whose coefficients are 55,7% and 46, 8%. All coefficients of variation are over 30% and this indicates a strong heterogeneity of the data obtained.

The range represents the difference between the maximum and minimum values. Used when the sign of heterogeneity is large and measures the width of the range in which the attribute varies. The highest values for this statistic are the data for Pleven 113,1 mg/kg, followed by Lovech 104,2 mg/kg, Veliko Tarnovo 96,2 mg/kg, Montana 82,3 mg/kg and Vidin 79, 8 mg/kg (Table 4).

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4.

**Table 4. Summary Statistics**

| Regions    | Count | Average | Standard deviation | Coeff. Of variation | Minimum | Maximum | Range |
|------------|-------|---------|--------------------|---------------------|---------|---------|-------|
| Vidin      | 76    | 41.8    | 15.0               | 35.9%               | 20.2    | 100.0   | 79.8  |
| Montana    | 96    | 26.9    | 12.3               | 45.7%               | 10.4    | 92.7    | 82.3  |
| V. Tarnovo | 155   | 33.9    | 14.6               | 43.1%               | 11.5    | 107.7   | 96.2  |
| Pleven     | 443   | 32.9    | 18.3               | 55.7%               | 5.0     | 118.1   | 113.1 |
| Lovech     | 220   | 31.2    | 14.6               | 46.8%               | 13.9    | 118.1   | 104.2 |
| Total      | 990   | 32.8    | 16.5               | 50.4%               | 5.0     | 118.1   | 113.1 |

5  
95%  
(  
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-  
32,8 g/kg.  
2.

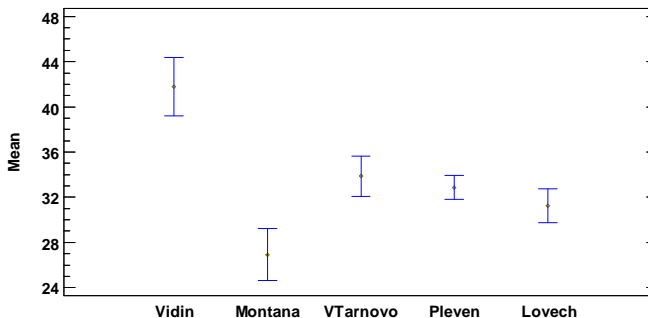
Table 5 shows the mean values and intervals of 95% of the remaining results for a given sample (two standard deviations). The standard error is an indicator for the deviation of the statistical mean of a given sample from the general average of 32.8 g/kg. Graphically, the results are presented in Figure 2.

5. 95.0%

**Table 5. Table of Means with 95.0 percent LSD intervals**

| Regions    | Count | Average | Stnd. error | Lower limit | Lower limit |
|------------|-------|---------|-------------|-------------|-------------|
| Vidin      | 76    | 41.8    | 1.86        | 39.2        | 44.4        |
| Montana    | 96    | 26.9    | 1.65        | 24.6        | 29.2        |
| V. Tarnovo | 155   | 33.9    | 1.30        | 32.1        | 35.7        |
| Pleven     | 443   | 32.9    | 0.77        | 31.8        | 33.9        |
| Lovech     | 220   | 31.2    | 1.09        | 29.7        | 32.7        |
| Total      | 990   | 32.8    |             |             |             |

Means and 95.0 Percent LSD Intervals



. 2.

**Fig. 2. Mean values for the mineral nitrogen content in the towns of Vidin, Montana, V. Tarnovo, Pleven, Lovech**

(Skewness) (Std. Kurtosis) - The results for asymmetry (Standard Skewness) and Excess (Kurtosis) are characteristics of the form of the average dissipation. A strong deviation from the normal distribution is observed when their values exceed  $\pm 2$  - Table 6.

6.

**Table 6. Standard skewness and standard kurtosis**

| Regions    | / Std. skewness | / Std. kurtosis |
|------------|-----------------|-----------------|
| Vidin      | 4.30            | 4.26            |
| Montana    | 8.71            | 16.60           |
| V. Tarnovo | 9.07            | 11.28           |
| Pleven     | 16.98           | 20.11           |
| Lovech     | 17.13           | 38.17           |
|            | 25.94           | 36.35           |

(Skewness) - Skewness measures the distribution asymmetry. When this coefficient is positive, the right distribution arm is drawn, and when the left is left.

17.13. - 4.3,

(Kurtosis)

4.3 38.2,

7

F-ratio, 9.70329,

P-value F- 0.05,

In our case, all values are positive. The lowest asymmetry is the data for the Vidin area – 4.3 and the highest for Lovech 17.13 This means that for the five areas in most of the results the nitrogen residues are higher than the average.

Kurtosis is a measure of the peak distribution of the distribution. In our case the excess has a value of 4.3 to 38.2, which means it is sharp - it is above the top of the normal distribution.

In Table 7, variance analysis shows results for the variance decomposed by two components – in group and between group variance. The F-ratio, which is 9.70329, is the ratio between group: in group variation. Since the P-value of the F-test is less than 0.05, we have a statistically significant difference between the mean values of the five data groups surveyed.

7.

**Table 7. Multiple Range Tests - ANOVA Table**

| Source         | Sum of Squares | Df  | Mean Square | F-Ratio | P-Value |
|----------------|----------------|-----|-------------|---------|---------|
| Between groups | 10199.4        | 4   | 2549.85     | 9.70    | 0.0000  |
| Within groups  | 258841.        | 985 | 262.782     |         |         |
| Total (Corr.)  | 269040.        | 989 |             |         |         |

8

(14, 9)

Table 8 characterizes the data groups that differ statistically. The results from Lovech, Pleven and Veliko Tarnovo form a group of data that do not differ statistically. The highest value (14, 9) has a statistically proven difference between the towns of Vidin and Montana. Logically, the data for Montana have the lowest average and the data for Vidin is the highest average. Thus, we find the places with the highest degree of pollution and with the lowest degree of environmental pollution with nitrates, respectively Vidin and Montana.

8. : 95.0 %

**Table 8. Method: 95.0 percent LSD**

| Regions    | Count | Mean | Homogenous Groups |
|------------|-------|------|-------------------|
| Montana    | 96    | 26.9 | X                 |
| Lovech     | 220   | 31.2 | X                 |
| Pleven     | 443   | 32.9 | X                 |
| V. Tarnovo | 155   | 33.9 | X                 |
| - Vidin    | 76    | 41.8 | X                 |

P-Value = 0.000 > 0.05

| Contrast        | Sig. | Difference | +/- Limits |
|-----------------|------|------------|------------|
| - Vidin-Montana | *    | 14.9       | 4.9        |
| - V. Tarnovo    | *    | 8.0        | 4.4        |
| - Pleven        | *    | 8.9        | 3.9        |
| - Lovech        | *    | 10.6       | 4.2        |
| - V. Tarnovo    | *    | -6.9       | 4.1        |
| - Pleven        | *    | -6.0       | 3.6        |
| - Lovech        | *    | -4.3       | 3.9        |
| - Pleven        |      | 1.0        | 3.0        |
| - Lovech        |      | 2.6        | 3.3        |
| - Lovech        |      | 1.6        | 2.6        |

\*

\* denotes a statistically significant difference.

plot

box and whisker

Another way to estimate the normal distribution of a data sample is by using a box and whisker plot. With this graphical approach, the variation of



multiple datasets can be presented.

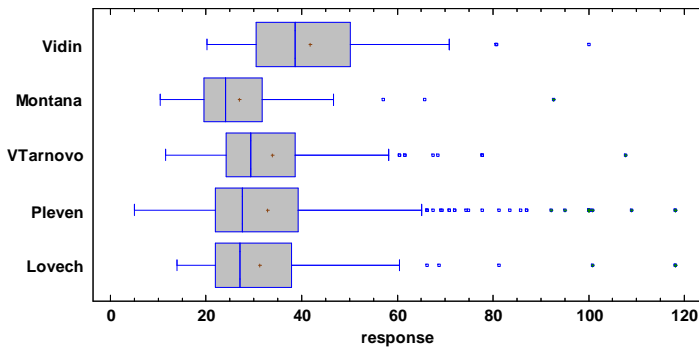
Such a result can also be achieved with histograms, but the box and whisker plot gives us more opportunities. It can also clearly see the points lying outside the normal distribution of the results. In addition, several data sets on one scale can be compared in one graph - Figure 3.

The most values outside of the normal distribution are data from Pleven region.

The reasons are unbalanced use of nitrogen fertilizers by certain farmers. Further research is needed to solve the causes and to locate the terrain where the very high values are reported. These farms and the water basins around have the highest local dangers of nitrate contamination.

3.

Box-and-Whisker Plot



3.

Fig. 3. Graph "Box and whiskers" of the mineral nitrogen content in the towns of Vidin, Montana, V. Tarnovo, Pleven and Lovech

Presenting the data as histograms besides the capabilities of the previous analysis also allows us to see the frequency distribution of the results. Grouping close data allows us to immediately see if the results are close to

( 3-8).

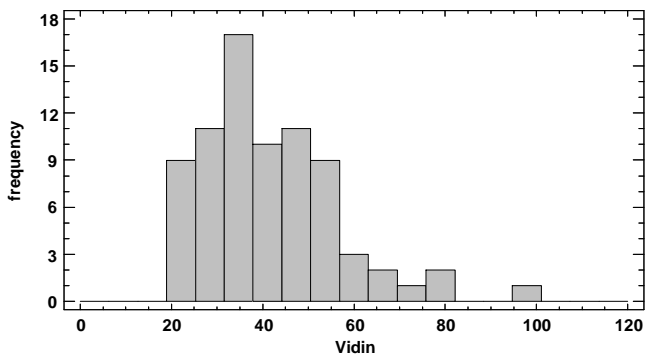
kg

10 mg

(2015).

normal (Figures 3-8). The results have a lower positive limit of close to 10 mg of nitrogen per kg of soil. This coincides with the researches of Koutev, Stoyanova (2015). There are also points that are significantly out of the normal distribution. These points could be excluded from the research. However, these points are potentially the hottest sites - the sources of the highest nitrate pollution.

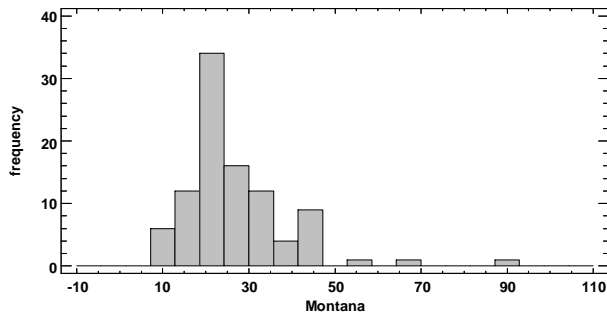
Histogram



. 4.

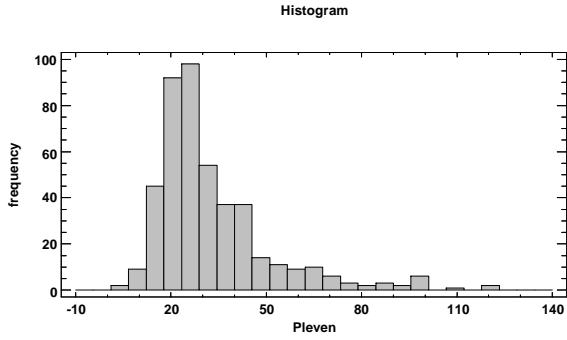
Fig. 4. Histogram of Inorganic Nitrogen Content in Vidin Region

Histogram

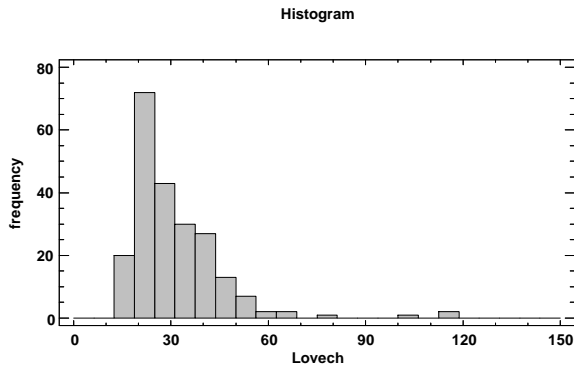


. 5.

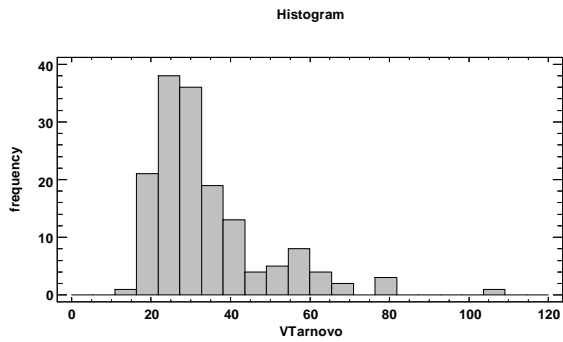
Fig. 5. Histogram of Inorganic Nitrogen Content in Mo



. 6.  
**Fig. 6. Histogram of Inorganic Nitrogen Content in Pleven**



. 7.  
**Fig. 7. Histogram of Inorganic Nitrogen Content in Lovech**



. 8.  
**Fig. 8. Histogram of Inorganic Nitrogen Content in V. Tarnovo**

(Koutev et al., 2015).  
 5 2 kg  
 61 kg  
 300 kg  
 81 kg  
 9.  
 9.

The assessment of the potential nitrogen leaching from the soils in different areas can be made on the basis of the mean values for the areas, first of the mineral nitrogen content in kilograms of soil - Table 2. Then, based on the recalculation of the mineral nitrogen content in one hectare - Table 3.

Recent studies for soils from Northeastern Bulgaria show similar results, albeit lower (Koutev et al., 2015). Nitrogen losses fluctuated from 50 to 20 kg per hectare. In our conditions, these potentials for nitrogen wash from the soil range from 61 kg in the results for a minimum of 300 kg of nitrogen per hectare in peak results in the Vidin region. The average results fluctuate from 81 kg for Montana region to 125 kg for Vidin region - Table 9.

**Table 9. Inorganic nitrogen content in soil from different regions after harvest - minimum, maximum, average kg/ha**

| Region                | Vidin | Montana | V. Tarnovo | Pleven | Lovech |
|-----------------------|-------|---------|------------|--------|--------|
| <i>- Winter crops</i> |       |         |            |        |        |
| minimal               | 1.0   | -       | -          | -      | -      |
| maximal               | 24.0  | 218     | 263        | 294    | 294    |
| average               | 65    | 21      | 42         | 39     | 34     |
| <i>- Spring crops</i> |       |         |            |        |        |
| minimal               | 31    | 1.0     | 5.0        | -      | 12     |
| maximal               | 270   | 248     | 293        | 324    | 324    |
| average               | 95    | 51      | 72         | 69     | 64     |

(2015)  
 10 mg  
 30 kg

In the studies of Koutev and Stoyanova (2015) it is shown that there is constantly in the soil about 10 mg of nitrogen per kilogram of soil or 30 kg of nitrogen per hectare. It is necessary for the microorganisms to maintain the

60 kg  
(Nikolova et al., 2014).  
60  
30 kg  
0 1 kg  
218 kg  
294 kg  
240 kg  
21 kg  
65  
kg  
0 31 kg  
248 kg  
324 kg  
270 kg  
51 kg  
95 kg  
10.  
(9).  
52 kg

nitrogen cycle in the soil. The remaining amount may be lost under adverse soil-climatic conditions. On the other hand, it is assumed that about 60 kilograms of nitrogen in the soil is necessary for winter crops to grow and hibernate (Nikolova et al., 2014). Therefore, the potential losses in winter crops are calculated at a nitrogen content in the soil of over 60 kg per hectare and in the spring at 30 kg per hectare.

Minimal losses for winter crops can be from 0 to 1 kg per hectare. The maximum losses can be really significant – from 218 kg for Montana region to 294 kg for Pleven and Lovech districts and 240 kg of nitrogen per hectare for Vidin region. These values are valid for individual fields of course. For the studied areas the average results, which fluctuate from 21 kg of nitrogen per hectare for the Montana region to 65 kg for the Vidin region, are valid. The trend for potential winter crop losses in spring crops is the same, but the amount is significantly higher.

Minimal losses fluctuate from 0 to 31 kg per hectare. The maximum losses can be really significant – from 248 kg for the Montana region to 324 kg for the Pleven and Lovech districts and 270 kg of nitrogen per hectare for the Vidin region. These values are valid for individual fields of course. For the studied areas the average results, which fluctuate from 51 kg of nitrogen per hectare for Montana region up to 95 kg for the Vidin region, are valid.

The area losses can be assessed after the sowing areas with winter and spring crops - Table 10. We see that the biggest polluters are the areas with the largest areas of arable land - Pleven and Veliko Tarnovo. The smallest pollutant is the Lovech region (Figure 9). On average, for the surveyed areas it can be said that about 52 kg of nitrogen per hectare may be lost. This significantly exceeds the norms achieved in countries with a high culture of agriculture.

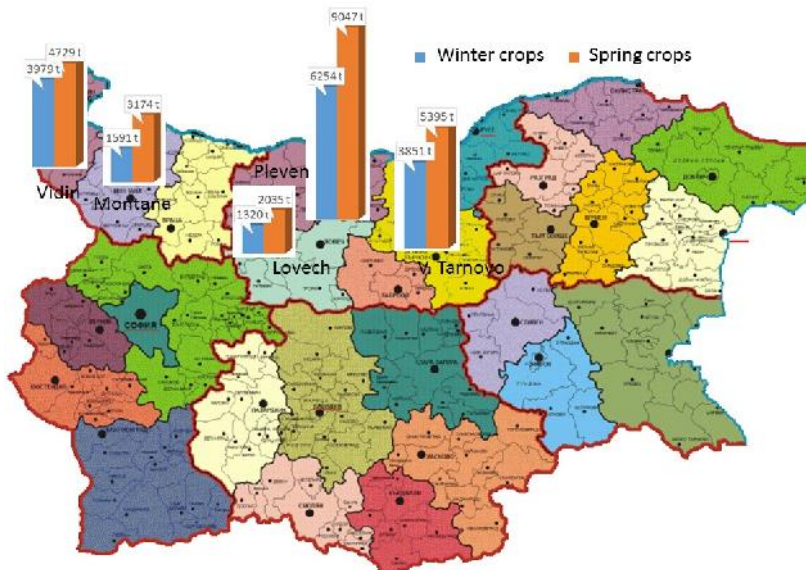
. 10.

( )

**Table 10. Potential nitrate loss by washing in water basins at different land use (tonnes) of arable land in the surveyed areas**

| Region                    | Vidin    | Montana  | V. Tarnovo | Pleven   | Lovech | Total, ha and tons |
|---------------------------|----------|----------|------------|----------|--------|--------------------|
| *<br>Arable land, ha      | 1 126 66 | 1 422 97 | 1 710 04   | 2 992 78 | 727 28 | 797973 ha          |
| * - Winter crops          |          |          |            |          |        |                    |
| , da                      | 60840    | 76840    | 92342      | 161610   | 39273  | 430905 h           |
| minimal                   | 37       |          |            |          |        |                    |
| maximal                   | 14602    | 16759    | 24295      | 47562    | 11558  |                    |
| /average                  | 3979     | 1591     | 3851       | 6254     | 1320   | 16994 t            |
| * - Spring crops          |          |          |            |          |        |                    |
| , da                      | 49573    | 62611    | 75242      | 131682   | 32000  | 351108 h           |
| minimal                   | 1517     | 75       | 339        | -        | 374    |                    |
| maximal                   | 13385    | 15534    | 22053      | 42705    | 10378  |                    |
| /average                  | 4729     | 3174     | 5395       | 9047     | 2035   | 24380 t            |
| Total,fort average values |          |          |            |          |        | 41374 t            |

\* Source: MAF, Agrostistics Department, Monitoring crop yields - harvest 2013



. 9.

**Fig. 9. Potential nitrate loss by washing in water basins at different land use of arable land in the studied areas - tons**

## CONCLUSIONS

1. In our country the practice with unbalanced nitrogen fertilizers continues.
2. From the studied areas the average load of the agricultural lands with residual mineral nitrogen is highest in the region of Vidin 41.5 mg/kg of soil, lowest in the Montana region – 20.9 mg/kg of soil.
3. In the Pleven region there are the most cases of extremely high mineral nitrogen residues.
4. By total quantities of nitrogen potentially washed in the environment from the studied areas the largest quantities are in the Pleven region – 9047 t for spring crops and 6254 t for winter crops, and the smallest in the Lovech region 2035 t for spring crops and 1320 t for winter cultures.
5. On average, about 52 kg nitrogen per hectare may be lost on the surveyed areas.

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