

# Restoration and Sustainable Management of Irrigation and Drainage Systems and their use as a Tool for Adapting of Bulgarian Agriculture to Climate Change in the Region

Assoc. Prof. Dr. Eng. PLAMEN PETKOV\*

Eng. KRASSIMIR DANDOV\*\*

Eng. NEVYANA TENEVA\*\*\*

*Water and Rural Institute LTD – Sofia*

E-mail: pl.petkov@abv.bg\*; dandov\_u@abv.bg\*\*; tenevan@gmail.com\*\*\*

## Summary

One of the main environmental, social and economic point of view, facing agricultural production to Bulgaria now days and which will stand in front of it with even greater seriousness in the coming years are climate changes in the region. They are one of the main causes of yield variability and the risks inherent in agriculture. In the long run they will influence the technology of cultivation of several agricultural crops.

The role of irrigation and drainage is well known as indisputable and proven by many years of research and practical application in various areas of Bulgaria (irrigation crops, drainage of saturated soils, protection agricultural land from flooding) as well as for status and development of Bulgarian agriculture and economy in order to receive a stable crop production at sharply limiting adverse effects of climatic factors in different periods in years.

Taking into account the nature and objectives of irrigation and all activities involved in their development and related engineering facilities can be used as an effective tools to limit or prevent the effects of climate change, as – stress effects of drought, water shortages and scarcity plants on the one hand and on the other – to overcome the harmful effects of water on agricultural land and rural areas with other extreme weather events – floods, destroying banks of watercourses, waterlogging of agricultural soils and others.

There was not enough attention to the irrigation and drainage issues in our country over the last two decade because of which this topic was in crisis that continues now days. For this period past governments could not find real active organization and financial instruments for the sustainable management maintenance and active use of existing infrastructure. Reducing irrigation areas continues as a result of a number of objective and subjective reasons and there are the physical and moral depreciation of the entire infrastructure now. Successful implementation of irrigation possibilities requires development and use of adequate and innovative policy and real program for restoration and restructuring of all its directions and its actual conversion into main priorities of the government policy in the field of agriculture and water management.

The report comments on current issues in the state of irrigation and drainage systems in Bulgaria, makes analysis of the pros and cons of the proposed by World Bank a Common Strategy for the irrigation development and protection from harmful impact of water and performs individual issues better connected to the current state and the needs of Bulgarian agricultural solutions in order to enhance its adaptation to the adverse effects of climate changes.

**Key words:** Irrigation, drainage, climate change, strategy, innovative approaches

## Възстановяване и устойчиво управление на напоителните и дренажни системи и тяхното използване като инструмент за адаптиране на българското земеделие към климатичните промени в региона

Доц. д-р инж. ПЛАМЕН ПЕТКОВ\*

Инж. КРАСИМИР ДАНДОВ\*\*

Инж. НЕВЯНА ТЕНЕВА\*\*\*

*Институт по водите и селските райони LTD – София*

E-mail: pl.petkov@abv.bg\*; dandov\_u@abv.bg\*\*; tenevan@gmail.com\*\*\*

## **Резюме**

Климатичните промени са един от главните икономически, социални и екологични аспекти, свързани със земеделското производство на България в днешни дни. Те ще бъдат предмет на още по-сериозно обсъждане в предстоящите години. Те са една от основните причини за променливост на доходите и за присъщите рискове в селското стопанство. В по-дългосрочен план влияят на технологиите за отглеждане на някои растителни видове.

Ролята на напояването и отводняването са познати и утвърдени с многогодишни изследвания и практически приложения в различни райони на България (напояване на културите, отводняване на наводнени почви, опазване на селскостопанска почва от наводняване), както и за развитието на българското земеделие и икономика, с цел получаване на устойчива растениевъдна продукция, при строго ограничени вредни ефекти от климатичните фактори през различни периоди на годината.

Вземайки под внимание естеството и целите на напояването и всички дейности, включени в развитието му, свързаните с него инженерни съоръжения могат да се ползват като ефективни инструменти за ограничаване и предотвратяване на ефектите от климатичните промени, като: ефектите от сушата, липсата на вода и недостиг на растителни видове, от една страна, и от друга: преодоляване на вредния ефект на водата върху земеделската земя и селските райони от други екстремни метеорологични явления – наводнения, разрушаване на диги от прииждаща вода, преоводняване на земеделски земи и други.

През последните две десетилетия вниманието, насочено към напоителните и дренажните системи в страната, е недостатъчно, поради което тази област е в криза, продължаваща до днес. За този период предишните правителства не успяват да намерят активна организация и финансови инструменти за устойчиво управление, поддържане и активно използване на съществуващата инфраструктура. Намаляването на напояваните площи продължава като резултат от много обективни и субективни причини. И в момента съществува физическо и морално амортизиране на цялата инфраструктура. Успешното въвеждане на напоителни съоръжения изисква развитие и използване на адекватна и иновативна политика, с реална програма за възстановяване и реструктуриране на всички направления, като се превърне в един от приоритетите на правителствената политика в областта на управлението на селското стопанство и водния ресурс.

Докладът разисква текущите резултати и възможности в състоянието на напоителните и дренажни системи в България. Направен е анализ на положителните и отрицателни страни на предложената от Световната банка Стратегия за развитие на напояването и предпазване от вредното въздействие на водата. Предоставят се индивидуални решения, които са по-добре свързани с настоящото състояние и нуждите на българското земеделие, с цел подобряване на неговата адаптация към вредните влияния на климатичните промени.

**Ключови думи:** напояване, дренаж, климатични промени, стратегия, иновативни подходи

## **I. Climate change in Bulgaria and their impact on agriculture**

### ***1.1. The climate changes in Bulgaria are reality***

One of the main challenges faced by the agricultural production of Bulgaria at present and that it will face him with even greater seriousness in the coming years, are climate changes in the region, the need to introduce good agricul-

tural practices, environmental protection in rural land and more rational management and conservation of water in agriculture. Climate change is the greatest challenge in terms of environmental, social and economic terms.

Extreme events are already a reality and an integral part of climatic conditions in Bulgaria. Evidence of this are the great droughts in 1993–1994, 2000 and 2007, catastrophic floods in 2005

caused substantial damages to a lot of people, destruction of property and infrastructure, flooding farmland and others.

Warming trend observed since the late 70-s of last century. In recent years since 1989, 20 years are positive anomalies of mean annual air temperature to the climate norm 1961–1990. The average annual temperature in 2011 was 0.4°C above the climate norm. Longest droughts have been observed over the last two decades of the 20th century.

According to climate scenarios increase in air temperatures in Bulgaria will be from 2 to 5°C until the end of the century. Hot summers are more frequent in the second half of this century. Winter precipitation will increase, but rainfall during the warm half of the year and especially during the summer are expected to decrease.

### ***1.2. Impact of climate change on agricultural production***

Undoubtedly, agriculture will be one of the sectors most affected by climate change because of its dependence on weather conditions. The impact of climate change on the one hand will be beneficial to agriculture, such as increased air temperature will shape extend the growing season of crops and moving the upper limit of the production, which will require a new zoning of agro-climatic resources in the country.

On the other hand, increasing the temperature of the air and soil will increase evaporation, changes in rainfall and their timing, respectively, will change the mode of the water and the air consumption of the soil and water which will result in a reduction in productivity of crops.

One of the most significant negative effects of climate change is drought. This impact on crop development will be more in the future in the country in these two aspects – reducing yields and worsening of quality of production due to lack of moisture in the soil during the growing season and reduced rainfall, a sharp drop in water supplies, accumulating smaller volumes of water in irrigation dams, limiting the scope for use of water for irrigation. The negative impact on agricultural production will increase by more frequent extreme natural phenomena such as floods and droughts.

Indisputably the regional climate changes are of greatest importance for the development of agriculture. On the basis of perennial observations in representative agricultural regions of the country – Kneja, Chirpan and Sofia, the National Institute of Meteorology and Hydrology found substantial modification of the basic climatic factors. During the period 1960–2010, the amount of effective temperatures during the vegetation period has increased by about 135°C. The evaporation from discovered water surface has increased by 110 mm during the vegetation period for 50 years period. The amount of rainfall during the vegetation period was reduced by 77 mm for the same period.

This shows that for a period of 50 years rainfall in the summer national average fell by more than 75 mm, while evaporation has increased by more than 100 mm, i.e. deficit in the water balance of plants has grown by more than 175 mm, its compensation can be done by irrigation of crops. Even if we do not take into account the negative forecast for the next few decades, the significant drought in 20 years is an indisputable fact, which should be given due consideration. Even under present climatic conditions rainfall amounts in several areas of the country are insufficient for normal growth, development and productivity of agricultural crops.

### ***1.3. Adapting agriculture to climate change. European and national activities on the problem***

Obviously, a certain degree of climate change is inevitable throughout this century and beyond, even if efforts to curb over the next decades prove successful. The measures to adapt agriculture are a necessary complement to mitigation action, but not an alternative to reducing greenhouse gases. The future agricultural practices should respond to this challenge and to find ways to adapt in order to reduce the risk of harmful effects.

This is clearly expressed in the documents of all EU bodies in recent years: in 2007 the European Commission produced a Green Paper “Adapting to climate change in Europe – options for action by the Commission”, and in 2009 published a White Paper “adapting to climate change

– towards a European framework for action”. The problem with climate change directly affects Southern Europe and must be subject to special attention to agriculture in Bulgaria.

Attention was directed entirely to the efforts and implement measures to reduce greenhouse gas emissions 1–2 years ago. In subsequent years, it should be aimed at taking measures for adaptation of Bulgarian agriculture to the effects of climate change. It is obvious that particularly affected would prove small producers and farms will not be able to cope with climate change.

The country’s policy on climate change after Bulgaria joined the EU in 2007, it complies not only with the UN Framework Convention on Climate Change and the Kyoto Protocol (1997), but also with existing and newly adopted European legislation in this area. Ministry of Environment and Water prepares the National Action Plan on Climate Change for the periods of 1996–1997, 2005–2008, and 2013–2020, the number of national reports on climate change and other documents. They are steps in the implementation of European and national policy on climate change. Law to limit climate change has been prepared and adopted in 2014. It provides a common legal framework for the public relations connected to the implementation of policy in this area.

## **II. Irrigation as a means to limit the negative impact of climate change on agriculture Bulgaria**

### ***2.1. Economic benefits of irrigation in Bulgaria***

Longtime research and practical use of irrigation (irrigating crops, drainage of farmland waterlogged soil, protection from flooding/flood farmland) in different regions of the country has proven undoubtedly their role in the state and development of Bulgarian agriculture and economy in order to guarantee receipt of a stable crop production in sharply limiting the unfavorable effects of climatic factors in different climatic terms in years.

Essential for agricultural production in the country is the impact of drought and irrigation on

the yield of major crops. The science and practice have proven unambiguously ago that irrigation increases yields in corn, tobacco and other crops to 2 times, and at other cultures – more than 1.7 times. To grow vegetables, rice and other crops without irrigation in Bulgaria is impossible. The significant increase in yields is extremely important for the Bulgarian economy.

The fact is that the irrigation in different climatic years yields are 3–4 times more stable. It is estimated by the coefficient of variation, which is at 10–17% irrigation and without irrigation – 25–60%. Greater stability is important for imports and exports, prices for food and so on.

The economic effect of irrigation in average climatic year in corn and soybeans is 600 BGN/ha, in tobacco – 1000 BGN/ha, in vegetables and fruits – 1500 BGN / ha or an average of over 1000 BGN/ha. In dry years, this effect increases by more than 2–3 times. Therefore the recovery of part of the irrigation infrastructure will realize significant annual net income.

The role of irrigation and achieving the strategic goals of the government policy in the field of agriculture require reassessment of the sector as an integral element of agro-technical complex in cropping. In this regard should be taken to enhance adaptation and irrigation and irrigated agriculture of the country to the various manifestations of climate change and its implications.

### ***2.2. Status of irrigation in Bulgaria***

#### ***2.2.1. Development of irrigation***

The beginning of the national state program for development of the water sector is placed at the beginning of last century in the country with first water services for water infrastructure building. The first water syndicates\associations were established in 1920 in accordance with Water Syndicates Act (1919). The irrigation received considerable development in the post – 1960 period to 1990 in different regions of the country are built irrigation systems on an area of 1.23 mln. ha which represents 29% of total arable land (at 0.88 million from them are invested from state funds). The built irrigation systems were a total of 236 state irrigation systems and a large number of separate/small fields for irrigation. Irrigat-

ed areas were provided for over 50% of agricultural production in the country during this period (1970–1990).

The drainage of much of marshy areas and construction of protective dikes in the lowlands along the Danube river was done after 1924. In the second half of the last century they were built and operated 78 drainage systems and hundreds of kilometers of protective dikes along the Danube River and a major rivers in the country.

The irrigation in Bulgaria entered the crisis after 1989 that continues today. As a result, the amount of used irrigation systems decreased due to depreciation, destruction or looting. According to the last census of irrigated land in the country in 1999, fit irrigation systems built with public funds and operated by “Irrigation Systems” JSC are 0.54 mln. ha. Areas with suitable irrigation infrastructure have decreased to about 0.326 mln. ha in 2013. The irrigated arable lands have decreased every year and now they are about 30–35 thousand ha.

The irrigation facilities built in the past by former cooperatives are transferred as property of the local municipalities. The large number (about 2500) small dams for irrigation purpose are built by former cooperatives, which now are owned from the local municipalities.

Limited numbers of irrigation associations have been formed in the country after 2001. They take responsibility for managing irrigation infrastructure, partly owned by municipalities and “Irrigation Systems” JSC. Support given to irrigation associations from the government is too small to allow them to restore the destroyed infrastructure and the necessary operational and managerial capacity to conduct activities under irrigation.

### **2.2.2. Water management and irrigation in Bulgaria. Built irrigation infrastructure**

National state policy on water management in Bulgaria is held by the Minister of Environment and Water, which he carried through the 4 River Basin Directorates. According to Art. 10 of the Water Act, the state policy related to the operation, construction, reconstruction and modernization of water development systems and fa-

cilities shall be implemented by the Minister of Agriculture and Forestry – for irrigation systems and facilities for protection from the harmful effects of water outside the settlements. Policy relating to irrigation facilities municipal property shall be exercised by the local mayors.

In the scheme of management of irrigation in Bulgaria are so called operators. They managed facilities supply water for irrigation, discharged excess water from farmland and carry out other activities (these are companies “Irrigation Systems” JSC and “Zeminvest” JSC, MoAF, municipal enterprises, irrigation associations).

At present irrigation facilities in the country, built with state funds are managed and operated by state owned commercial companies “Irrigation Systems” JSC and “Zeminvest” JSC.

“Irrigation Systems” JSC operates about 98% of all facilities including 168 pcs. big and middle size complex reservoirs and a number of different irrigation facilities. Facilities for protection from the harmful effects of water (dams, river training, pumping stations, drainage channel and closed network) used for drainage and improvement of 0.143 mln. ha farmland waterlogged soils and prevent flooding of 0.166 mln. ha agricultural areas, settlements and other commercial sites.

“Zeminvest” JSC managed and operated small facilities mainly in Kardzhali Region, serving an area of about 1.75 hil. ha. The municipalities owned the infrastructure built in the past by former agricultural cooperatives. In 1993, their irrigation infrastructure includes more than 3,000 small dams and several other irrigation facilities.

Over 100 irrigation associations are established in recent years to use facilities in over 40 hil. ha. Some of the facilities are built from the former cooperative farms (after political changes they are handed over to municipalities). Municipalities are responsible for the rest of the facilities of the former cooperatives, including dams. There are also a small number of systems and irrigation facilities built by farmers using their own water sources (groundwater, rivers, dams, etc.). No information about the size of those built irrigation facilities and the amount of irrigated area for now.

### **2.2.3. National legislation and regulations in irrigation**

The basic principles of management, protection and use of water in the country are set out in the Water Act (1999), which carries the basic principles and requirements of Directive 2000/60 / EU on the framework for Community action in the field of water management (briefly called Water Framework Directive). The necessary regulations have been developed according to the Water Act. Another European directive, which is associated with the problems of irrigation, is Directive 2007/60 / EC on the assessment and management of flood risks (2007).

The legislation in irrigation include also Irrigation Associations Act (2001) and several regulations to itq as the Ordinance on the quality of water for irrigation of crops are adopted according to the requirements of the Water Act (2009). The irrigation are also associated with other national documents such as: Law on Ownership and Use of Agricultural Lands (1991), Law on helping farmers (1998), Law on Protection of Agricultural Lands (1996), Law for environmental protection (2002) and others.

### **2.2.4. Technical conditions of the existing irrigation infrastructure**

Overall, the most responsible state irrigation facilities (dams, water intakes, pumping stations, etc.) are under continuous monitoring and are taken a lot of care. As a result their technical conditions are relatively good. Technical conditions for rest of facilities due to lack of resources for repairs and maintenance constantly deteriorates, some systems are destroyed or removed or parts of them are missing.

The channel network of irrigation and drainage systems is in poor technical and operational condition (because it built between 1940–1980). Some of the canals are unlined and deformed profile. Abstractions for the most part are compromised. The thefts is a problem for covered distribution networks. Inter-channel network and facilities managed by former agricultural cooperatives were either looted or destroyed completely or are in very poor condition. Modern irrigation

equipment missing and available equipment is depreciated and difficult to maintain. Dams, municipal property are in extremely poor condition and have the potential danger.

The most serious problems are in correcting the inland rivers (the facilities for protection from the harmful effects of water), which are expressed in the ensuing significant change in their design parameters. A significant part of drainage facilities and protective dikes built in the period 1930-1980, also not in good condition, since they are made only partial repair and restoration of damaged areas. They are depreciated and defunct / inoperative for the most part.

The main reasons for this are lack of government intervention and mismanagement. There are a number of subjective reasons, mainly related to unrealized role and place of irrigation in agricultural production and economy of the country, unclear vision for the management and development of the sector and prospects for the use and development of constructed irrigation fund in the future, irresponsibility and lack of professionalism in the conduct of various irrigation activities and more.

The level of usability of the built and fit state irrigation systems is almost constantly below 10% over the past 15–20 years. With few exceptions, the amount of irrigated area is below 30 to 35 thousands ha. There is no information on the amount of yearly irrigated land and used the facilities (built by former cooperatives, currently at the disposal of municipalities and those of individual water users).

The rate of utilization of irrigated land is higher (15%–20% of the total managed by them territory) under irrigation associations. The main problem with them is the poor state of internal channel network and facilities, which is a serious obstacle to a more sustainable irrigation development.

The main financial sources for activities in irrigation and drainage are the funds from the budget for activities supporting infrastructure – public property (dams, drainage systems, dams, river training, retention dams, etc.); provided by operating activities of operators performing the “water supply for irrigation”; funds from munic-

ipal budgets for facilities municipal property and those of European programs and water users in recent years.

Allocated funds for the sector decreased and are insufficient each year. The low usage of public irrigation infrastructure and insufficient own revenues, and lack of necessary funds for the repair and maintenance of irrigation facilities and facilities for protection from the harmful effects of water, determine the difficulties of MoAF's companies for ensuring normal operation of existing irrigation and drainage facilities.

### **III. Strategic and program documents for the development of irrigation and irrigated agriculture in Bulgaria over the last two decades**

#### ***3.1. Documents prepared by the Bulgarian institutions***

Several documents relating to the rehabilitation and development of irrigated agriculture are developed in the country over the last 15 years in the country. Additional problems of irrigation and drainage have been developed in various strategic and program documents in the field of water management.

The most important of these documents are: Strategy development of irrigated agriculture in a market economy in Bulgaria in 2000, MoAF; Program necessary measures in terms of the trend toward drought, in 2001, MoEW; Agro-economic and technical assessment of the efficiency of irrigation systems and fields in Bulgaria, in 2001, MoAF; Concept development of irrigated agriculture and restructuring the management of irrigation in Bulgaria in 2007, MoAF; Draft Strategy Program Management and Development of Irrigation in Bulgaria in 2010, MoAF; Draft Irrigation Act 2008, MoAF; National Strategy for Management and Development of Water Sector in 2012, MoEW; National Programme for Reconstruction and Development of irrigation in the Republic of Bulgaria in the period 2009–2013, in 2009, MoAF.

A number of new and adequate to the state of agriculture in the country ideas and suggestions for the guidelines and how to reform the sector are

offered by researchers over the past two decades in these strategic documents. These proposals are not found professional understanding on government level, and are not taken into consideration by the government decision-takers in the Bulgarian agriculture.

#### ***3.2. The government policy in the irrigation during recent years***

Existing organizational and financial tools for managing irrigation and drainage were not conducted by the state over the past 20 years. Physical and moral depreciation of infrastructure for irrigation and drainage systems continues to the present. The result is a poor state of much of the irrigation infrastructure and a steady trend of annually reducing areas that are irrigated.

The sector (irrigation and drainage) is behind in its restructuring compared to all other sectors of agriculture in the country. Despite the organizational and economic changes in agriculture and economy of the country, the sector has not been changed management model, does not have a unified and adapted its laws and regulations are not solved such important issues as ownership of irrigation facilities, mechanism and manner of financing various activities in the irrigation.

The assessment of the irrigation and drainage sector clearly shows the unsatisfactory condition for which evidence a lack of vision for its reconstruction, development and professionalism in its management; outdated and obsolete irrigation systems and facilities; destroyed and plundered internal irrigation channel network and facilities and impaired functionality of facilities and equipment; lack of government investment recovery, reconstruction and maintenance of irrigation infrastructure at present.

A number of activities that do not require significant financial resources (as updated by the operators of information about the size and the technical and functional fitness of all systems and facilities in the country for the necessary funds to carry out repair and restoration work on them) were not carried out. The changes in the sector are expressed only in the reduction of structures and to reduce the funds allocated by the state for maintenance and operation of irrigation facilities

and for the protection from the harmful effects of water.

### ***3.3. The World Bank project for common strategy for management and development of irrigation and protection from the harmful effects of water***

The state of irrigation in Bulgaria in recent decades and the recognized need for their recovery and use as a key element for the development of agriculture in the country and in order to fulfill the imposed obligation of the National Strategy for Management and Development of the Water Sector (2012) to develop sub-branch management strategy and development force in 2014. The Government of Bulgaria to conclude an agreement for consultancy services and the International Bank for Reconstruction and development.

The agreement (ratified by the National Assembly) provides the Ministry of Agriculture and Food to receive expert technical assistance in four areas: drafting a common strategy for irrigation of the country to outline future policies and principles of development of the sector objectives and strategic guidelines for resolving priority issues proposed changes in the institutional and regulatory framework; a framework for programming and prioritizing financed by the European Agricultural Fund for Rural Development measures and presentation of a report on integrated irrigation investment plans and flagship projects.

The consulting team of the World Bank presented a draft Common Strategy for management and development of irrigation and protection from the harmful effects of water. The project was discussed and approved at the ministry and Council of Ministers (August 17, 2016).

The project envisages the Irrigation sector to manage infrastructure for irrigation and drainage services and infrastructure to oversee flood protection and river training that protects agricultural land from harmful effects of water. Strategic and operational objectives were formulated as a vision for future development.

The draft Common Strategy provides timespan than fifteen years (2016–2030), which should be filled two-step process of legal and institutional

reform, allowing a gradual coordinated and targeted recovery of irrigated areas by modernizing and efficient management of irrigation infrastructure in Bulgaria. It outlined a framework for these reforms, which will have a significant impact on the current organizational structure of the sector. It provides a shared responsibility between service providers, irrigation associations and government systems management.

The key elements of this common strategy are conducting legal and institutional reforms, a new pricing policy of irrigation water, restoration and modernization of the infrastructure for irrigation and drainage, separation of greater attention to higher education and vocational training in the field of irrigation engineering planning and building.

In institutional terms, the changes are expressed mainly in restructuring “Irrigation Systems” JSC. The company provides is first time to restructure several regional autonomous enterprises “Irrigation” its own structure and budget, to be responsible for the operation, maintenance and management of irrigation infrastructure. In addition certain amount of budget financing, the proceeds of these enterprises will be generated from the sale of water in bulk to associations and other water users.

Subsequently, these companies will be transformed into self-financed, independent, decentralized organizations such as the long period they will be incorporated municipalities and their infrastructure. They will be responsible for the management, operation and maintenance of irrigation infrastructure within a defined geographical area without being holders of property such as irrigation infrastructure remains state or municipal property.

Legal reform aims to provide the necessary basis for institutional change and new organization of government in the sector, to facilitate the establishment of associations for irrigation and other planned change in the sector. It is envisaged that the drafting of new legislation for the sector in the form of suit for Irrigation Act through which should be regulated by changes in the sector, as well as amendments to the Irrigation Associations Act and the relevant regulations.



It is proposed new pricing policy of irrigation water based on the principle of cost recovery and incentive-based pricing the water services. To be enter the two-component tariff, under which farmers will pay two different rates. One will be formed based on area under cultivation by each member of the irrigation associations and the other will be based on actual use of water for irrigation. Separately, there will be a price for the drainage of agricultural land, which will be calculated based on the area.

The strategy envisages investments for reconstruction and modernization of existing irrigation infrastructure to reduce the cost of providing services and gradually increase the actual irrigated area. Also the Irrigation associations are key players in the industry and have an important role, including being beneficiaries of investment financing by the EU. Discussed are issues of voluntary or compulsory membership in associations of owners of agricultural land in their territory, to ensure the long-term support in setting up their training and in creating the necessary capacity. The infrastructure investments could be regarded as the real way to promote the creation of sustainable irrigation associations. To encourage their creation, all investments in the European programs is intended to be carried out by or in connection with the associations.

It provides a framework for programming and setting priorities for investment support, which is fully integrated into Rural Development Programme (RDP). Besides attracting investment support for irrigation on the farm and beyond, the main objective is to develop a competitive agriculture in compliance with the aquatic environment. RDP 2014–2020, shows that support for investments in irrigation facilities and infrastructure will be provided by sub 4.1 (strengthening the competitiveness of farms) and sub 4.3 (support for investments in irrigation infrastructure to increase efficiency in the use of water in agriculture economy).

The establishment of a Management Committee for irrigation / drainage; Implementation and coordination Unit; and optimization of the “Irrigation, investment policy and concessions” in MoAF are part of the proposals in the Strategy

for development of the sector. In support of the reforms and the management structures in the sector will be separate National Centre for Research and Training in Irrigation and Drainage, which is a joint product of existing public bodies now. They will cover the need for the development and implementation of strong and viable national education and vocational training, as well as guidelines for their implementation.

The whole process of implementation of reforms in the sector is structured in stages with particular spelled out basic tasks and deadlines.

Most of the proposals in this common strategy of the World Bank as the institutional, legal, financial and economic reforms for the sector irrigation and drainage in Bulgaria have been dealt with and offering government sector over the past two decades in one form or another from the Bulgarian scientific community and irrigation professional's.

This applies also to the restructuring of “Irrigation Systems” JSC into independent regional companies, facilitating the establishment of associations, providing them with technical assistance and advice, how to determine the price of water for irrigation, etc.

Some of these proposals were partly implemented (separate fees for irrigation and drainage of farmland, training and technical support to the members of irrigation associations, etc.) in our irrigation practice and concrete results were reported after their introduction in the recent past. For such activities carried out in the proposed World Bank Strategy does not mention or comment as familiar to science and practice in the country.

### ***3.4. Author's views on some issues in the Common WB Strategy***

Obviously, the Common Strategy for management and development of irrigation, drainage and protection from the harmful effects of waters in Bulgaria, proposed by the World Bank team, will be accepted as a basic foundation of the state policy in the field of irrigation and drainage in the next 15 years.

The authors of this article, after reviewing the Common strategy of the World Bank, have different views on some proposals in the document.

It was also identified certain gaps and ambiguities that would constitute an obstacle to implementing the strategy and will not lead to the necessary results from reconstruction and development of the sector irrigation and drainage in the country.

***The most important of them are mentioned below:***

1. Studies and analyzes to assess the baseline sector Irrigation in Bulgaria are not based on detailed and specific data from site visits for covered farmland of irrigation systems and facilities and the territorial location in the country but are used general data provided MoAF and “Irrigation systems” JSC, which refer to past years and have not been updated thereafter. Data on drainage systems and facilities for protection from the harmful effects of water (dikes, river training) are very common and are not updated. Evaluation of areas such as assessment of the actual size and status of all established and functioning irrigation and drainage facilities after 2000 is not made in the country. Actually without establish the real picture of the sector as a basis for developing strategic directions and activities all other efforts will not lead to the expected results. This is important and necessary, especially for irrigation and drainage systems when it comes to taking serious efforts and use of significant human and financial resources.

2. Strategies, concepts, programs and other strategic documents related to the problems of irrigation and the possibilities of recovery and development made in the country in recent years are not included in the Common strategy. It is not necessary to review the existing materials in the sector, but the review and analysis of current practice in the country can help to avoid some repetitions and errors.

3. The proposed institutional reform (as part of the overall strategy) provides new participants managing the sector “Irrigation and Drainage”. Our view is that in the formation of an Advisory Board to the Minister of Agriculture and Food should be involved not only ministers and their representatives (who are usually not familiar with the problems in the sector) but professionals

with long experience and expertise in irrigation and drainage and / or agronomists by state institutions, commercial companies, private companies, associations for irrigation, which still exist in Bulgaria.

4. The new Unit for implementation and coordination of the Strategy provides for its implementation together with the “Irrigation, investment policy and concessions” Directorate in MAF. This unit will operate for a decade as part of the composition of MoAF. More appropriate and effective would instead unit to recover the Executive Agency on Irrigation and Drainage (which worked a few years ago very well off) with headquarters and regional offices in several important irrigation area of the country. This Executive Agency will provide support and control of all activities conducted in the sector, including operation and maintenance of irrigation systems in the country and new required activities for execution from new Implementation Unit.

5. The authors consider a poorly reasoned proposal for the transformation restructuring “Irrigation Systems” JSC, first in the regional state-owned enterprises, relying almost entirely on the state budget, and later the same be restructured into regional self-financed, self-distributed organizations. The question of ownership of irrigation and drainage facilities is not clarified well. Analysis and evaluation of irrigation and drainage now and expected results after these changes for 2020 and 2030 are not presented in the Common strategy. The change should be made in stages, but separation into independent self-financed units. First of those units “Irrigation Systems” JSC, is found to have good management results. These branches of the company are well-known (in Plovdiv, Pazardzhik, Stara Zagora, Varna, Sliven and others.).

6. The review of proposed materials in the strategy found that the analyzes and conclusions are based on the common presumption for irrigation structure in the whole country. In practice there is a substantial and not a small difference in irrigation activities in different regions of the country. In the past 20–25 years especially brightly outlined trends and interest in irrigation activities in different regions. Areas around

Pazardzhik, Plovdiv and Stara Zagora revived interest in rice production and sharply increased water consumption for this culture. There are positive trends in the cultivation of vegetables, fruits and grapes. Interest in irrigation is found in the regions of Sliven, Yambol, Sandanski. There is moderate interest in the irrigation districts of Blagoevgrad, Targovishte, Pleven. There is little interest in irrigation in the regions of Vidin, Vratsa and Montana somewhat. In the regions around the Danube, develop activities related to the prevention of harmful effects of water – drainage, river training, dikes. This indicates that the analyzes and recommendations for rehabilitation and development of irrigation cannot be mixed for different regions. In order to create conditions for a real implementation of the main strategic objectives of the changes in the sector should be more clearly delineated and priorities of the regional policy of the state, which would be properly followed in assessing investment projects of infrastructure beneficiaries recovery them.

7. The strategy does not consider the issues of irrigation in areas where existing irrigation infrastructure is managed by the state company “Zeminvest” JSC. Completely private investment in irrigation infrastructure is one of the major future trends in the development of irrigation in Bulgaria.

8. The section from the strategy examines the implementation of activities related to the restoration of infrastructure for irrigation and drainage is very unclear. This is provided after completed two projects, possibly after 2020 or after 2025. This calls into question the final results of the implementation of the reforms set out in the Strategy. We believe that the construction and study of leading projects in two regions of the country will not receive significant and important results that are subsequently used in the restoration of irrigation systems throughout the country, given the different and specific organizational, economic and technical-technological features on reclaimed farmland in different areas. Reliable results could be obtained only after several years of operation and monitoring of processes in irrigation and drainage of agricultural land and all elements of engineering infrastructure. Construc-

tion of drainage facilities in agricultural areas not provided for in content of the Strategy.

9. There are no proposed priorities for restoration of irrigation infrastructure in terms of the main trends in the sector – irrigation of crops, land drainage in waterlogged soils and flood protection as well as for irrigation of crops in terms of their type, spatial distribution in developed strategy. There is none proposed priorities for restoration of drainage facilities and those associated with flood protection and protection from the harmful effects of water.

10. In the proposed policies to promote the application of new technologies for farm irrigation in order to increase the productivity of water and efficient use of water resources in irrigated agriculture lacks specifics, do not comment on or recommend appropriate water and energy saving technologies and techniques for irrigation of crops and drainage of farmland. It is well known that their type, basic parameters and price, significantly affected on proposed capital investments for the rehabilitation of systems and equipment, respectively the effect of the realized activities.

Besides this is necessary to identify and propose to use “Good agricultural practices for irrigation and drainage” based on the type of crops and natural conditions for different areas of the country. This includes optimized parameters of technologies and techniques and as well as optimal from biological and economic point of view irrigation / drainage regimes of agricultural crops and adequate organization of irrigation / drainage.

11. One of the most significant issues related to the prospect of execution of the strategy is to finance all planned activities on restoration and development of irrigation in Bulgaria, including of the engineering infrastructure. This question is not developed and explained as well as the various stages of implementing the strategy for the period until 2030. There is mention only source of funding for irrigation activities in two main sub-measures (4.1 and 4.3) from Measure 4 on Rural Development Program (RDP) for the period 2014–2020 (plus national co-financing amounting to 20%). In sub-measure 4.1 will finance projects to restore infrastructure holding

and sub-measure 4.3 – to restore the infrastructure outside the farm.

Too long is the time frame which are proposed the activities connected with rehabilitation of irrigation systems outside the farm only just build and monitoring of the two leading project, this mean after 2020q or may by after 2025. From other site the fact that the above mentioned two sub-measures from RDP will opened in different time will create a lot of difficulties during rehabilitation and future functioning of the infrastructure in the framework of one irrigation system. No estimate was made in the strategy of the necessary investments for reconstruction and modernization of irrigation facilities in stages and a total of 2030. There are none assessments of the amount of needed investments in the sector for different stages throughout the period to 2030.

12. Our opinion is that the available potential of these sub-measures, the volume of implemented activities in the sector will not be large. Undoubtedly financing only with funds from the Rural Development Programme 2014–2020 will not be enough. This applies both to restore the irrigation infrastructure and particularly for the reconstruction of drainage fields and other facilities for protection from the harmful effects of water. It should have in mind that while irrigation activities can achieve a balance between revenue and expenditure, it is very difficult to achieve balance in activities related to the prevention of harmful effects of water. Therefore, self-financing, proposed as a major source of funds for carrying out activities in the sector is almost impossible.

During assessment there is no taken into consideration that the actual technical condition of the irrigation and drainage facilities are not good. Drainage fields are almost fully depreciated, drainage channels for the most part are far from design parameters, pumping stations are outdated and highly energy-intensive, dikes also need restoration, river beds are filled with sediments. All this details forms a tough and hard task to solve, and which is not widely place in the proposed strategy.

As a part from the future financing of the strategy, the team does not pay attention to the enormous material resources, which was part of

the state irrigation systems and equipment that can be used for another activity (construction of small hydropower plants, fish breeding, afforestation activities, etc., which developed in the past in almost all branches of “Irrigation systems” JSC.

Inconsistency of the proposal decision to restore irrigation in Bulgaria with the amount of potential things placed funds for this purpose raises serious doubts about the ability to achieve the expected results on stages till the end of 2030 for implementation of this Strategy.

13. Taking into account the proposed unclear financing of the strategy, we consider the proposed size of irrigated land during different stage of implementation of the strategy by 2030 as unrealistic. Moreover, no assessment is made of the areas and periods where it will be cost effective to invest in the restoration of irrigation infrastructure.

14. The strategy does not include analysis of the expected benefits (economic and others. effects) from the implementation of the proposed reforms in the sector “Irrigation and Drainage| and match them with the funds spent on reconstruction and development of this sector, which is essential because the public should be convinced of the expediency of the investments for the recovery of the sector.

15. The problems of training specialists, conducting research and providing advice on irrigation and drainage require more attention in the proposed strategy. This applies to education and training of specialists who should govern and manage irrigation facilities and specialists and members of irrigation associations. The problems in this area for a long time and there is no real solution for now. Higher education institutions have almost zero years (without admission of students), “Irrigation Systems” JSC without the necessary qualified staff in many branches does not have the technical resources. One solution is to promote the need for specialists by providing them with scholarships during training. Into the strategy was listed only institutions operating at the moment (in fact, some of these do not deal real problems of the sector), no proposals for change in the structure of total system and individual organizations, financing and exploita-

tion of results in practice. The implementation of such reforms in the sector (as development of research, advisory and educational activities) is essential and useful in order to actually recover and operation of irrigated agriculture in the country.

16. The main aim set in the Strategy is the creation and development of irrigation associations. Provided incentives to increase the interest of farmers to unite their efforts in irrigation and drainage by creating associations are not enough. It should be emphasized that the territory of these organizations has depreciated old irrigation network. On the one hand it is very difficult potential users of these facilities to be convinced that they should take it as such. All is clear that the maintenance of these systems is very expensive and difficult because the facilities were built 50–60 years ago.

The Irrigation associations are unable to provide the necessary funds for this purpose. Measure 4 of the RDP 2014–2020 (sub Measures 4.1. and 4.3.) on which association may rely, does not clarify what the disposable financial resources will be able to use. Newly formed association will have difficulties and would not actually start its activities until the start of sub 4.3. RDP 2014–2020, Self-financing of associations (referred to as the main source of funds for restoration of depreciated equipment) is unlikely to be realized.

On the other hand to finance activities in irrigation and drainage with funds from the Rural Development Programme 2014–2020, is limited to associations which cannot be regarded as appropriate. There are no prerequisites for the formation of associations in all regions of the country.

17. Nevertheless that RDP 2014–2020 allow investment for rehabilitation of existing irrigation systems for water saving, in accordance with European requirements, the proposed values and potential savings in water consumption with new projects. Can only formally be proved and compared with limiting their size into account the available data on these indicators. There is no proposals how this indicators will measure and control in practice during process of irrigation, as they intervene from many side factors.

18. A very important issue is the maintenance and operation of dams for irrigation. Of course the new established General Directorate “Supervision of dams and related facilities” will take over the registration and control of these facilities. But the problems are many and most of them are related to the lack of funds for the overhaul of trained service personnel and others. The strategy does not provide solutions for them. One output is a concession, but there are other solutions which could provide future owners.

19. Taking into account that assessment of irrigated land has not been conducted in the country for more than 20 years (including drainage areas and areas to prevent flooding) one urgent assessment is mandatory. After such assessment it is necessary to build GIS of existing irrigated and drained areas and areas protected by flood embankments along major rivers. On the one hand this will give a realistic assessment of the activities to be implemented, on the other hand – will be able to directly monitor the use of services and their implementation.

#### **IV. Conclusion**

The presented opinion (on the main issues developed by the Common Strategy of the World Bank for the management and development of irrigation and protection from the harmful effects of water) aims to support structures of MoAF in preparation on the planned acts and related regulations and other documents for the implementation of Strategy in field of the irrigation and drainage.

We emphasize that the successful and timely implementation of all actions and measures for rehabilitation and further development of irrigation in Bulgaria can be done only in a reassessment of their role and importance to agricultural production and the country’s economy and turning them into one of the main priorities of the state policy on agriculture. Only using this way the irrigation and drainage systems could be used as a tool for adapting Bulgarian agriculture to climate change in the region and the successful development of agriculture.

REFERENCES

**Petkov, Pl.**, 2010. State of Irrigation and Drainage in Bulgaria, Agricultural Academy

**Petkov, Pl.**, 2009. Irrigation - effective means of adapting the Bulgarian agriculture and mitigation of climate change, Plenary report of International Conference, November 5 to 7, Institute of Land Reclamation and Agricultural Mechanization, Sofia.

**Petkov, Pl. et al.**, 2002. Necessary measures to improve adaptation of irrigation and irrigated agriculture in Bulgaria to drought. National Scientific and Practical Conference MAF.

**Petkov, Pl., Ivanov, St., et al.**, 2000. Strategy for the Development of the Irrigation in the Free Market Economy in Bulgaria. Vodno delo, 1-2, pp. 29-33

**Petrova, R., Petkov, Pl., Dandov, Kr.**, 2009. Management of Irrigation and Drainage Infrastructure in

Bulgaria – Problems and Challenges. Annual of The University of Architecture, Civil Engineering and Geodesy (UDCEG), Sofia, Fascule IX, Vol. XLIV, pp. 237-247

**Slavov, N., Moteva, M., Georgieva, V.**, 2004. Changes of the Climate and Drought in the Last Century in Bulgaria. Vodno delo, 1-2, pp. 33-37

**Varlev, I., Petkov, Pl., Diankov, Z.**, 2004. Irrigation – Main Factor for Decreasing of Drought Damages in Agriculture. Vodno delo, 1-2, pp. 22-28

Common Strategy for Management and Development of Hydro-melioration and Protection against Harmful Effects of Water, Draft report, 2016. The European Agricultural Fund for Rural Development, MoAF.

Irrigation and drainage Act, 2008. Draft, MoAF.

National Programme for Reconstruction and Development of irrigation in Bulgaria 2009–2013, 2009. MoAF.

Strategy with program for development and management of irrigation in Bulgaria in 2010, Draft, MAF.