

INFLUENCE OF IRRIGATION AND DRAINAGE TO AGRICULTURE PRODUCTION IN VOJVODINA PROVINCE

Andelka Belic¹, Radovan Savic¹

(1) University of Novi sad, Agricultural Faculty, Department for Water Management, 21000 Novi Sad, Trg Dositeja Obradovica 8, Serbia

Telephone: ++381 21 4853259, Fax: ++381 21 455713, e-mail: anbel@polj.ns.ac.yu

Abstract The plain part of Vojvodina province is characterized by a relatively favourable soil, climatic and hydrological situation. However, in the course of the last two centuries extensive measures have been undertaken to protect the land from the action of unfavourable external waters and from excessive waters, along with the development of the system for irrigation. All these measures have created the conditions enabling fine regulation of the soil water-air regime as the basis for agricultural production and the development of the region as a whole. This paper is review of natural characteristics of area and the size of water engineering projects grew (flood protection, drainage, irrigation), followed by numerous practical problems. In recent years it has become more and more evident that within the present water management system still not enough account is taken and use made of the interrelationships within the water systems.

INTRODUCTION

The Vojvodina's unique relationship with water is a direct consequence of its geographical location on the central part of the Danube basin with the largest concentration of rivers and canals. This has meant that control and management of the water has been a major condition of survival for people living in this area. At first man's aim was to protect himself against the water but gradually control of the water came to play a greater role. This emerged in the management of the water for diverse interests: agriculture, industry, and shipping. For all these activities and purposes water in Vojvodina is of vital importance and of inestimable economic significance.

CLIMATE, SOIL AND HYDROLOGICAL CHARACTERISTICS

The plain region of Vojvodina is distinguished by relatively favourable climate, soil and hydrological characteristics. However, in the course of the last two centuries extensive measures have been undertaken on the protection of the region against unfavourable action of external waters, land protection against excess water, as well as on the development of irrigation systems. All these measures have created the conditions that made possible fine regulation of the water-air regime as the basis for highly profitable and stable agricultural production and the development of the region as a whole.

In the recent decade, climate extremes have been registered, either in the air temperature, amount of precipitation, or extreme hydrological occurrences manifested as the level and duration of high/low water stages. However, Marjanov (1973) cited data reported by Rethly about a series of catastrophic wet and dry years occurring in the past. Apparently, e.g.

in the 15th century, the drought was such that one could wade across the Danube. This indicates that climatic changes, or better to say, the sequences of favourable and unfavourable distribution and amounts of precipitation, external and internal waters, are of a certain cyclic nature. Some recent investigations (Savic and Salvai, 1997) have also pointed to the existence of these natural cycles that are characterized by the periods of 8, 11, and 28 years. Owing to circumstances, the last decade has been characterized by an irregular distribution of precipitation in the course of a year, necessitating thus the intensification of some reclamation measures. The mentioned dry periods have imposed the need for undertaking some complex measures with the aim of improving farming conditions, exceeding the scope of conventional reclamation. With the aim of reducing the disproportion between the water requirements and its available quantities, about 20 accumulations have been built in the region of Vojvodina in the course of the last 30 years. Before that, the Hydrological System Danube-Tisa-Danube (HS DTD) has been constructed with the objective of making for the potential water shortage and collecting the excess or used waters.

FLOOD PROTECTION

Protection of land against adverse influence of external waters had in the beginning a local character. The aim of these activities was the protection of the coastal regions of the Danube and Tisa against high waters. The constructed embankments, made by human and animal power, have created the conditions for cultivation of significant parts of the soil of the alluvial plane. These embankments were constructed first as some sort of bridges between two legs of the higher terrain. Only in the beginning of the 19th century these works have attained a more organized character, based on the appropriate project documentation. At the same time, such regulation works have also been undertaken on some smaller water courses (the Begej, the Tamis, the Jegricka). Besides, at the end of the 19th century the Tisa riverbed was regulated by cutting through the meanders, which resulted in additional areas of land suitable for agricultural production. It is interesting to mention that the oldest works on regulation of water courses date back to the 3rd century, when during the reign of the emperor Probus some of Fruska Gora streams were regulated. The embankments along the Danube and the Tisa constructed in the 19th century serve even today as the basis for the lines of protection against external waters. Of course, with the appropriate constructive solutions and modern technology of building and maintenance, matching the contemporary requirements. The most extensive works on modernization, i.e. reconstruction of protection embankments, were undertaken after the high waters of the Danube in 1965 and of the Tisa in 1971. As basic material in constructing the protection lines served the material from the riverbeds. Peak elevation of the embankment crown was set for the 1% water. Apart from the reconstruction of the old embankments, some new ones have been built, accompanied by reconstruction of some auxiliary objects (watchman boots, telephone lines, roads, long-distance power lines, etc.), without which the protection against high waters would not be efficient. The maintenance of the objects for flood protection and their present state, despite of the existence of numerous problems, can be considered satisfactory.

DRAINAGE

After undertaking the measures of protection against external waters the need has appeared for more intensive collecting and conducting of excess waters of internal origin. Digging of canals, which can be related to the time of regulation of the rivers, has enabled transformation

of more than 1/3 of the Vojvodina region into arable land. Before these undertakings that land was seasonal or perennial bogs and marshes. Nowadays, the Vojvodina region has a network of almost 20,000 km of these canals. They are used mostly for collecting and conducting excess waters from the region, although they have recently been used as supplies of water for irrigation. About 60% of the drainage systems gravitate to natural water courses and the rest serves to evacuate the collected excess waters to the Basic Canal Network of the Hydrological System Danube-Tisa-Danube (BCN HS DTD). The digging of about 900 km of the BCN HS DTD, officially completed in 1975, represents undoubtedly an impressive activity that ensured the realization of reclamation measures on a substantial portion of the Vojvodina territory. Besides, the HS DTD is a multipurpose system, which apart from the drainage and irrigation function, represents the basis for the development of water traffic, fishery, industry, recreation activities, tourism, etc. In the course of the 20th century, with the aim of more efficient evacuation of the collected excess water, more than 100 pumping stations were constructed with the individual capacity up to 30 m³/s and a total capacity of about 400 m³/s. First such station was built in the far 1896. Besides, a number of other smaller objects for regulation of water level and flow have been built on the drainage systems. Among them, most numerous are culverts and bridges, about 20,000 in number. Because of the problems in financing water resources management activities in the last fifteen years the money allocated for the maintenance of the drainage systems was only about 1/3 of the amount needed. As a consequence, sporadic difficulties can be observed in the functioning of the canal network, caused by intensified weed infestation and over muddying. However, such state of affairs has been subject of manipulations on all levels of expertise, practise, and politics, so that it is difficult to draw reliable conclusions about the current state of the objects. Some field measurements (Belic et al., 2002) have indicated the existence of muddiness of the canals, primarily of the main canals of the drainage system, but without significant decrease of their functional capacities. Despite of the fact that Vojvodina is covered with the canal network and the necessary constructions on the drainage systems, floods caused by internal waters have occasionally occurred. In 1942. year flood endangered about 420,000 ha and in 2000 about 700,000 ha, mostly of agricultural land. From the aspect of reclamation, the year 2000 was especially interesting as the winter-spring period with large excess of water was followed by a dry summer with extremely large amount of rain in July.

Pipe drainage systems, which frequently appear as a necessary way of collecting excess water, especially from heavier soils, cover in Vojvodina only about 40,000 ha. As a rule, they are horizontal pipe systems based on modern materials, i.e. perforated ribbed plastic pipes. Materials of mineral origin are used as filtering materials, though successful experiments have been carried out using harvest wastes in the form of continual and discontinued filters.

Irrespective of the measures that have been undertaken, occasionally, especially in early springs, excessive moisture in the soils of micro and medial depressions can be observed. Investigations showed that the most frequent cause of the appearance of occasional stagnant water pools is a consequence of the existence of a dense subsurface layer below the usual depth of soil cultivation. Land users, i.e. the agricultural producers, solve the problems caused by stagnant waters. At that, basic farming mechanization is used for digging seasonal open ditches. From the aspect of reclamation, this measure is very efficient but the open seasonal ditches represent a serious obstacle for the motion of agricultural machines on the plot in the course of all operations that follow until the harvest. Vertical drainage of stagnant waters has a limited possibility of application on higher geomorphologic units, where the groundwater level is at a greater depth and the water is not under pressure. The possibilities of using covered horizontal pipe drainage for regulating occasional stagnant waters using materials at hand are still in the stage of investigation. In the reclamation of stagnant waters,

including also improvement of the quality of the environment, high importance should be assigned to biological drainage. This type of regulating water-air regime of the soil under stagnant water is known and widely used under somewhat different climatic conditions (Piperska, 2003). However, this measure has not been used in Vojvodina, although it is considered as being very convenient, especially on lower geomorphologic units. Besides, the emphasis is laid on the improvement of the biodiversity and on the possible profit that can be higher than that gained in the present low and unstable crop farming.

Some land reclamation characteristics of Vojvodina Province are given in Table 1.

Table 1. Some land reclamation characteristics of Vojvodina Province

Land reclamation area	Drainage area (ha)	Thick of canals (m/ha)	Culverts (piece/km ²)	Pumping stations (m ³ /s)
Zapadna Bačka	169,054	10.68	0.67	16.25
Severna Bačka	101,575	2.10	0.41	0.80
Senta	93,717	3.97	0.50	7.36
Krivaja	76,783	2.07	0.13	0
Srednja Bačka	52,048	7.95	0.68	8.50
Bačka	103,426	7.63	0.98	4.00
Dunav	128,275	10.05	1.15	24.37
Šajkaška	191,835	7.45	0.59	37.16
Gornji Banat	189,959	11.35	0.82	54.77
Srednji Banat	255,799	9.25	0.68	50.69
Tamiš-Dunav	138,064	5.90	0.43	24.86
Podunavlje	72,564	9.02	0.57	24.76
Južni Banat	212,495	9.58	0.44	32.70
Galovica	194,341	13.38	0.53	47.05
Bosut	162,866	13.05	0.45	44.97
Vojvodina	2,143,401	8.81	0.61	378.24

IRRIGATION

Irrigation has become an indispensable and not an auxiliary measure in Vojvodina. It can be said that the region is rich in water and has a relatively dense hydrological network but a main characteristic is the large quantity of transit waters. At the present, about 40,000 ha are irrigated. Those areas that have available sources of water, primarily surface watercourses and accumulations, serve for growing mercantile crops, seeds and vegetables. With the exception of the northern Backa region, irrigation of perennial plantations is not still widely practised. Irrigation is mostly carried out with the aid of large-span equipment. The available quantities of water are sufficient for irrigating much larger areas of agricultural land, but the problem of suitability of these waters for irrigation has recently arisen. The influence of soil and watercourses as recipients of industrial and municipal wastewaters has resulted in the degradation of the surface water quality. Besides, from the aspect of irrigation, water mineralization has an adverse effect, especially in the spring months, which significantly limits the possibility of using this water for irrigation. It can be assumed that in the existing circumstances of irrigation in Vojvodina there are no problems in supplying the necessary amounts of water. This statement is supported by the richness of the natural watercourses –

the Danube, the Tisa, the Sava, along with the BCN HS DTD. However, the problem of suitability of the water for irrigation is becoming more and more acute. Chemical and biological analyses of water samples taken at different dynamics by the service of the Hydro meteorological Institute of Serbia, give a relatively reliable picture of the water applicability not only for the purpose of irrigation. This is also supported by numerous investigations, e.g. Belic i Savic (1994). Using the known classification of suitability of water for irrigation, surface waters can be characterized as good on more than one half of locations, i.e. profiles. Somewhat different picture is obtained when considering suitability of water for irrigation on the basis of the analysis of samples taken at the water capture of the irrigation system itself (Fig. 1). Besides, it appears that the intensity of water requirement is in an inverse proportion to the quality of available water. Namely, in the regions of Northern Backa, Northern and Middle Banat, which are characterized by somewhat smaller annual sums of precipitation and its unfavourable distribution, and where the requirements for irrigation are most pronounced, the water quality is significantly worse compared with that in other parts of Vojvodina. This fact is especially alarming in the region of Northern Backa, whose high-quality soil could be endangered by irrigation because of secondary salinization. Mineral contents in the surface waters in Vojvodina are characterized by seasonal variations with the highest contents of soluble salts in spring months, i.e. in the beginning of the irrigation season. Besides, an especially harmful approach has been pursued recently – to keep the winter excess water in the network of drainage canals to use it for irrigation in early spring months. This, as a rule, highly mineralised water can have an adverse effect on both the soil and crops treated.

When groundwater is considered as a source for irrigating smaller areas of agricultural land, their suitability is significantly less favourable.

The canal network of the drainage system and land use in the plain region of Vojvodina has been organized according to the principles dictated by a technical approach to the reclamation measures. As a consequence, the land has attained characteristics close to a cultural steppe with a reduced biodiversity. In the agricultural production involving irrigation, first of all on larger land complexes, the need of applying the approach of “site-specific farming” is becoming more and more pronounced. (Benka et al, 2002)

A great effect on the quality of surface waters and groundwaters in Vojvodina has the livestock farms. In this respect, of special significance are pig farms with liquid waste discharge. In Vojvodina, there are 67 such farms with the capacity of 1,128,000 pigs. The amount of wastewater is estimated to about 6.8 milion m³/year. These wastewaters, representing a mixture of liquid manure, feed remnants, water and washing agents, disinfection agents, etc., are usually discharged into lagoons around the farm. In the majority of cases, the liquid wastes from these lagoons are discharged in an uncontrolled manner into the canal network, causing thus pollution of the surface and ground waters, as well as of the adjacent soil.

The characteristics of the wastewaters from stock farms are such that there exists the possibility of their usage for irrigation. These waters can also be used as partial substitute for the nutrients used in crop production. The experiments carried out under controlled conditions at the lysimetric station Rimski Sancevi, and under field conditions confirmed this thesis (Belic and Savic, 1994). At the lysimetric station of drainage type (volumetric) in the period of 1990-1994, experiments were carried out with the aim of investigating the effect of irrigation with concentrate and diluted pig-farm wastewater on crop yield and of the effect of such water on the changes of the quality of groundwaters. It has been concluded that the yields of maize in the lysimeters where farm wastewater was used as a source of nutrients was the same as those obtained using optimal doses of mineral fertilizers. At that, the effect on the groundwater was not observed except for a mild increase in the content of ammonium ion.

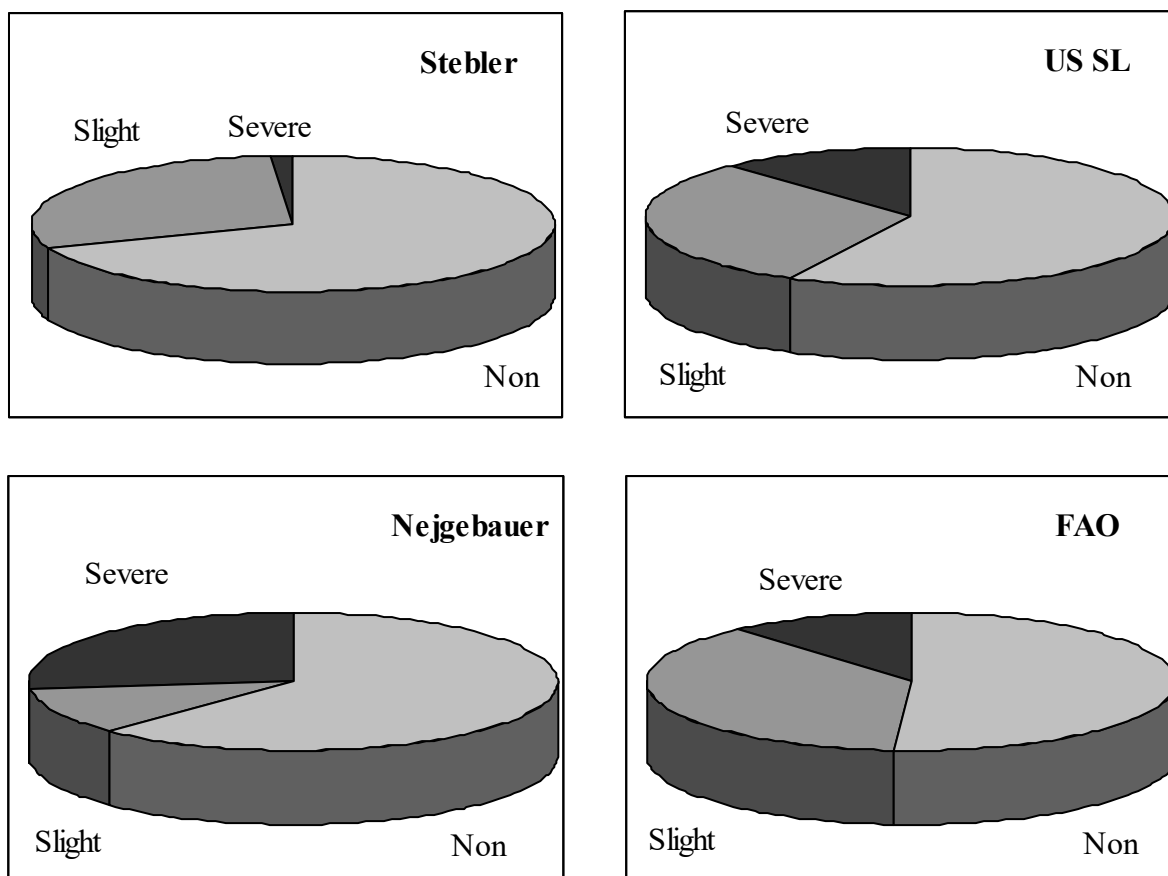


Fig. 1 Degree of restriction on use water for irrigation

CONCLUSION

The paper presents a creative way of living with water in Vojvodina. Such a way enables the potential of water system to be used more than has been done in the past. Moreover, a management system offers the prospect of solving major problems of the moment such as water quality. The social use and the functioning of these water systems as an ecosystem will thus be improved, with all the accompanying social and economic benefits.

References

- Belic A. (2002) Produkcija otpadnih voda na farmama i njihova upotrebljivost, *Melioracije i poljoprivreda*, 178-186, Novi Sad
- Belic S., Savic R. (1994) Mogucnosti primene nekih savremenijih klasifikacija vode za navodnjavanje, *Voda i sanitarna tehnika 1-2*, 45-53, Beograd.
- Benka P., Tabakov J., Gostovic M. (2002) Upravljanje zalivnim sistemom prema principima precizne poljoprivrede, *Melioracije i poljoprivreda*. 158-161, Novi Sad.
- Marjanov M. (1973) *100 godina rada na uredjenju voda područja Backopalanacke vodne organizacije*, Backa Palanka.
- Piperska J. (2003) *Mogućnosti primene ekoloških principa u održivoj poljoprivredi na melioracionom području*, magistarski rad, Poljoprivredni fakultet, Novi Sad.
- Savić R., Salvai A. (1997) Precipitation Periodicity as a Factor in Drought Analysis, *International Symposium Drought and Plan Production*, 61-67, Belgrade.