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SITUATION AND DEVELOPMENT POSSIBILITIES OF IRRIGATION IN HUNGARY

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Summary

Irrigation is one of the most important factors of surface water resources management, therefore water saving irrigation farming is desired which could promote better utilisation of the agricultural potential of Hungary. In our article we deal with the situation, problems and development possibilities of water resources management, especially with the development possibilities of irrigation farming.

Key words: water resource management, water balance, irrigation

INTRODUCTION

The role of water – as a strategic significance resource – has remarkably increased socially, environmentally and economically and protection and utilisation of water reserves have become the key factors of sustainable development. The complex role of water appears – among others – in the living quality of the population and in the fulfilment of its water demand, agricultural use, in the field of forestry and fishery, as environmental and economic requirement of numerous industrial, transportation and service activities and as an environmental security factor.

Water shortage and drought mean an increasing challenge for water management experts worldwide, as well in Europe and in Hungary. As a result of climate change, the frequency of extreme situations (drought, flood, internal water) is increasing which deepens the severity of the problems.

It is more and more clear that the effects of drought not only affect agriculture and plant production, but at the same time every living organism, including the domesticated and wild species of plants and animals and humans themselves. This means that the damages occur not only on cultivated areas but also on non-cultivated and naturally protected ones, not mention human society. Consequently, there is a demand for the elaboration of tools and measures which can be deployed against the harmful effects of drought and which could influence the preparedness of the whole society, politics, economy, ecological environment, jurisdiction and ethics as well as individual and social behaviour for the sake of sustainable development. One of the most effective programmes against drought is the development of irrigation farming. In Hungary the degree of warming has not threatened plant production yet. However, more problematic for the agriculture are the increase temperature and water management extremities. Temperature rise and the intense decline of precipitation have adverse effects. The annual average amount of precipitation in Hungary – mainly in the central and southern areas – has decreased by 50 mm during the last 100 years, which is quite a large change considering the water demand of plants [Nagy et al. 2012]. Periods without precipitation become longer and droughty season become more and more frequent. Drought as a serious water shortage also means an economic catastrophe both in plan production and in horticulture. Analysing the last 10 years it can be stated that the yield fluctuation is caused by the erratic rainfall on average in 25-30%. The question remains: how could we defend ourselves against the unfavourable climate change?

MATERIAL AND METHODS

For the creation of present article, we used data originating from field trials. The irrigated field maize trial was setup in East Hungary at the Látókép trial site of the University of Debrecen, Centre for Agricultural and Applied Economic Sciences (47° 33' É, 21° 26' K, 111 m), in a moderately warm and dry climate, on a loess-based, deep humic layered, lime-coated chernozem soil (Mollisol-Calciustoll or Vermustoll; USDA).

Weather was evaluated based on the data (air and soil temperature (^{o}C), relative air humidity (%), wind speed ($m\ s^{-1}$), incoming radiation ($W\ m^{-2}$), and amount of precipitation (mm)) which was measured and recorded by the automatic weather station installed on the trial field. Irrigation was carried out by a Valmont type linear irrigation system.

RESULTS AND DISCUSSION

Hungary is situated in the deepest area of one of the most closed basins of the world (Figure 1). The proportion of areas without an outlet or exposed to flooding is high. The average discharge of our surface waters is 118 $km^3 \cdot year^{-1}$, but 95% of this originates from abroad. Our water stock per capita is one of the largest in Europe, but most of it is linked to the Danube. However, inland discharge in terms of its proportion is the smallest on the continent (6 km^3·year^{-1}, 5 %). 52 km^3 of the fallen 58 km^3 evaporates and percolates (Figure 2). As a result of the climatic characteristics, the domestic discharge is small because of evaporation.

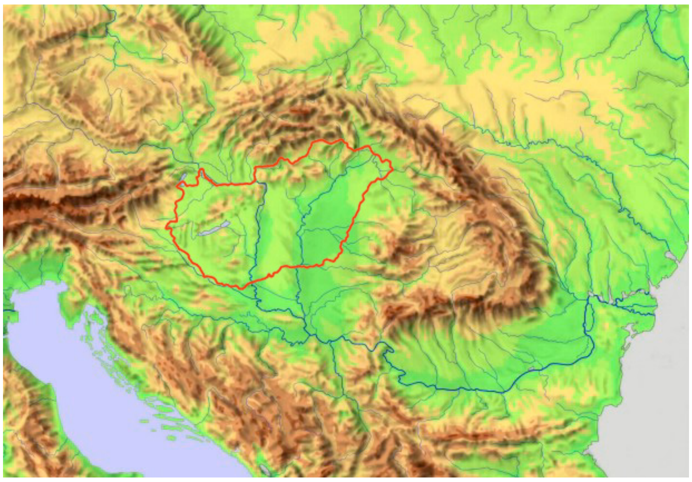
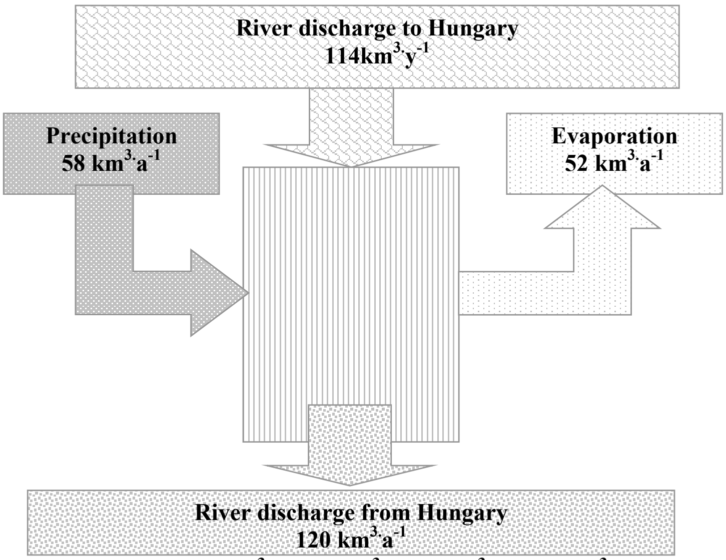


Figure 1. Geographical situation of Hungary



$$58\ km^3 + 114\ km^3 = 52\ km^3 + 120\ km^3$$

Figure 2. River discharge to/from Hungary

Three-quarter of the water is situated within the riverbeds of Danube, Tisza and Drava (Figure 3). It is clear that by means of a reasonable water keeping and rainwater management, agriculture and water management have some reserves.

The main reason of the decline of irrigation is the fact that the extra costs of irrigation are difficult to integrate into the price of the produced crops, and that the domestic producers irrigate mostly to avoid drought damage and according to the principles of intensive irrigation farming. The majority of irrigation costs (70-90%) emerges within the plot, since the transportation of water to plant is only possible through a significant input of energy. The most important plants in terms of irrigation (field vegetables, sugar-beet) got out of the irrigation culture because of the termination of the processing capacity, consequently decreasing the total irrigated area. Development of irrigation, introduction of modern irrigation culture and processing has close connection and they explicitly demand the simultaneous modernisation of landscape utilisation.

The era of organised irrigation in Hungary is the starting period of the institutionalised irrigation of the Great Plain. One of the most important events of the era was the establishment of the National Irrigation Office in 1937, as a result of which the issue irrigation development became centrally controlled. The significance of horticultural irrigation further increased during this period. The application of orchard irrigations also took place at that time. Irrigation farming reached its most significance period during 1960-80s.

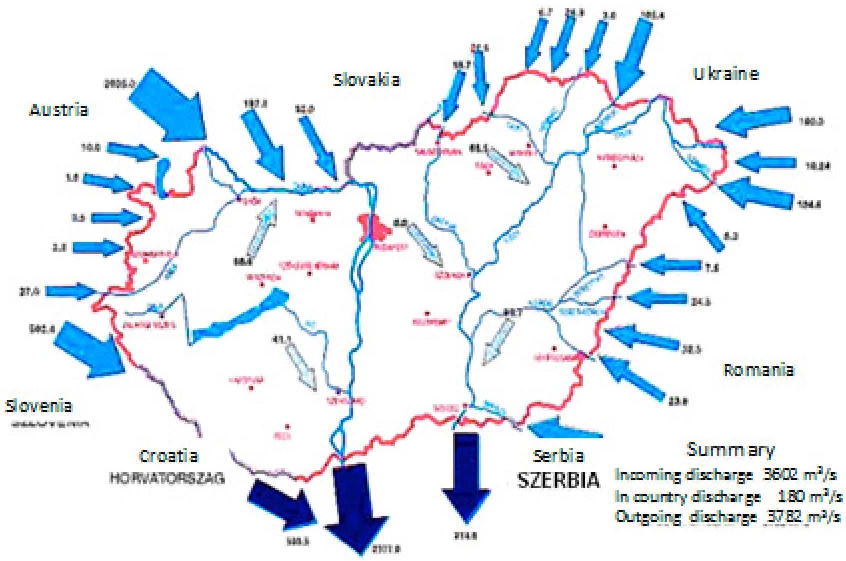


Figure 3. Yearly average discharges of transboundary rivers in Hungary, (m^3/s)

The structure of agricultural water usage underwent a fundamental change due to the change of political transformation in 1989. Because of the new land ownership and land use structure the previously used irrigation devices could not be operated economically, especially in the case of smaller farms. Some larger farms which remained intact further used the irrigation devices, but irrigation almost totally disappeared from smaller, individual farms. From 1990 irrigation water provided through the main works became a product with a market governed price, its direct, state subsidisation stopped. After 1990, a slow decrease of irrigated areas started (Figure 4). In 2000, out of 203,115 ha of legally permitted area only 115,733 ha was actually irrigated and this tendency continued; by the end of the decade the amount of irrigated area was below 100,000 ha.

Agricultural water supply is characteristically demand-based, water users utilise the service depending in their needs, but for the proper temporal and spatial fulfilment of demands (for the assurance of the required water amount) the water provider has to be available, namely it has to operate its technical infrastructure to be able to provide the actually demanded water amount. The ration of availability (fixed costs) and the actual water utilisation (variable costs) is generally 80-20 %.

Irrigation is a determining factor of surface water stock management. The possibilities of irrigation development are primarily good in high-quality areas and in the frame of solid capital enterprises. Nevertheless, water management tasks cannot be handled separately in the case of irrigation either [Tamás 2009].

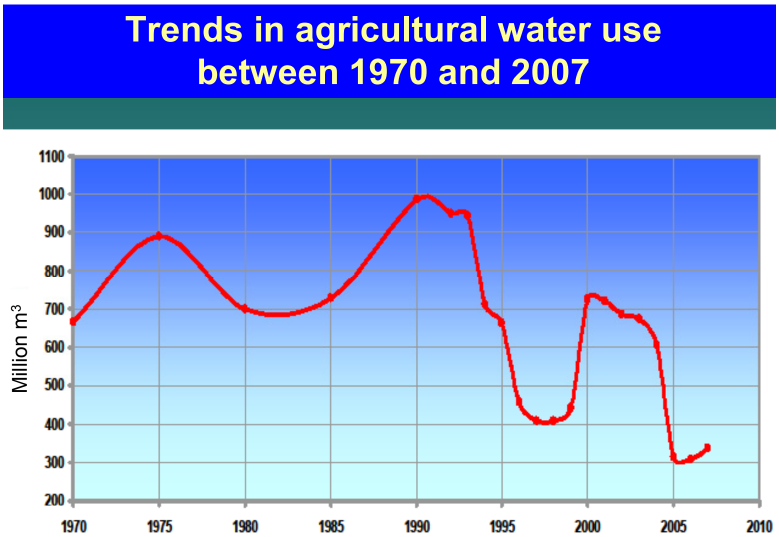


Figure 4. Trends in agricultural water use during 1970–2007

In the non-mountain areas of Transdanubia, Hungary has a free water stock of 1,100 million m^3. Since total exploitation is impossible, one-third of the free water stock is enough for the irrigation of 180-210,000 ha. With the increase of the water stock management aimed at utilisation of reservoirs, the irrigable area can be further increased. Considering foreign origin water supply, water storage and water connections, the free surface water stock is 93 $m^3 \cdot s^{-1}$. After the deduction of the reserved stock for uncertainly known ecological purposes (for example the water demand of Hortobágy-Berettyó and Körös rivers), the remaining amount is enough for the irrigation of 120-120,000 ha. In the Danube valley, the amount of water led out of the Ráckeve-Soroksár-Danube (RSD) is currently fixed at a ratio of less than 10%, therefore the free stock is available for an additional 50-60,000 ha. The free water stock within the Little-Rába system has potential of irrigation approximately 20-25,000 ha.

It is clear that from the free water stocks – without further reservoirs, but with the reservation of the foreign origin water output of the Tisza catchment – a total of 400,000 ha field irrigation can be realised. If we assume that out of this, 80,000 ha is represented by intensive irrigation (with double water demand), then approximately 240,000 ha remains for regular field areas. These areas, together with the currently irrigated fields (approximately 30,000 ha intensive and 70,000 ha normally irrigated), can amount to two-third of the long-term demands (150,000 and 500,000 ha).

The free underground water stock on the Great Plain is inessential, only through the reduction of other water usage would it be possible to provide significant amounts of water for irrigation.

The reasonably planned water stock management enables a more effective area use, especially in terms of agricultural water utilisation and rural development. The water amount used for irrigation is far behind the potentials in terms of surface waters, however the demand for the irrigation purpose use of underground waters is increasing; this mainly situated in the areas of the Great Plain short in water. The harmonisation of stocks and demands – especially for the sake of sustainability – is an explicitly important task.

In Hungary, only 2.1% of the agricultural area is irrigated (Figure 5). The majority of floral biomass is produced by precipitation management and irrigation has both statistically and economically a supplemental water resource nature in Hungary.

In the case of the most cultivated plant species it is possible to carry out a profitable production even without irrigation, but the fluctuation of yields and the assurance of yield security and quality production require irrigation even in these areas.

Basic principles of modern and established irrigation:

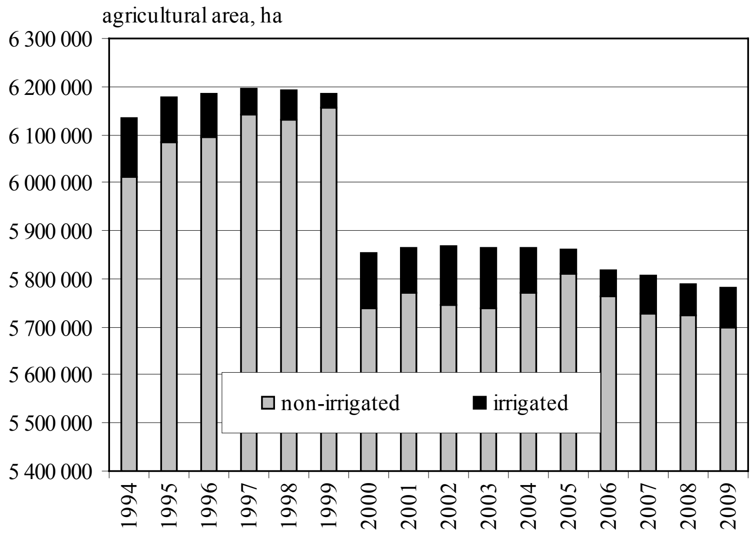
– Irrigation is the most effective to be developed in areas where the best natural and economic conditions are present.

– It is most reasonable to introduce irrigation when the performance of production has reached the level which is economically achievable under non-irrigated conditions.

– Irrigation is one of the methods of intervening in the water management of a given area, which is primarily aimed at fulfilling water demand of soil.

– Soils suitable for irrigation: good productivity, there is no secondary salinification.

– Conditionally irrigable: the depth and quality of ground water are influencing factors.



Not suggested for irrigation: the danger of secondary salinification and swamping.

Figure 5. The range of irrigated agricultural areas of Hungary, 1994–2009

Irrigation is one of the determining factors of surface water management; therefore it is an objective to carry out a water-saving irrigation farming, which facilitates the better utilisation of our agricultural potential. Spreading of water-saving irrigation technologies is essential, as well as the consideration of the aspect in the course of the elaboration of permission procedures and subsidisation systems. However, the more effective legal regulation of irrigation carried out from wells established without permission is also worth mentioning, since these activities might result in overuse in many cases.

The domestic situation of surface water management is influenced by the fact that there is a warming tendency in all four seasons in Hungary. The most significant, of course, it is during summer, which increases the frequency of heat waves and potential evapotranspiration. The amount of precipitation is decreasing except for summers; there is no significant tendency during summers. This does not mean that summer water balance is unchanged, since as a result of the increasing precipitation intensity and temperature the situation is getting worse and the sensitivity to droughts is also growing. Consequently, the frequency of droughts is increasing in Hungary, which however does not mean a monotone change. There are shorter periods of drying and moistening effects, which result in a long-term decreasing annual amount of precipitation (Figure 6). The 100-year average of precipitation is 568 mm. The 30-yearsaverages represent the reduction of precipitation well. In the first third of the 20th century, average precipitation was 590 mm, whereas it was 565 mm in the other two thirds. The amount of precipitation was only 520 mm between 1990 and 2007. The weather data base shows significantly precipitation decrease in the last century (Figure 7).

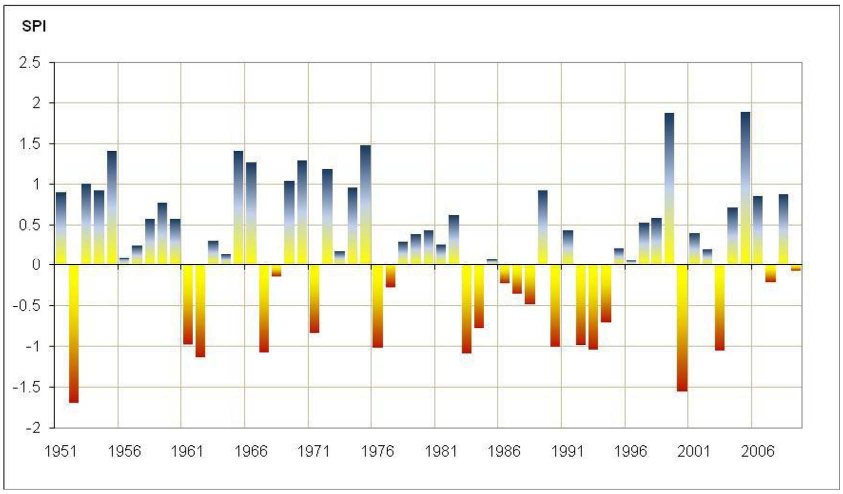


Figure 6. The time series of the three-month SPI (Standard Precipitation Index) of summer in Hungary [Bozó et al. 2009]

Our irrigation field trials prove that in a dry year (2007) with natural precipitation supply, the nitrogen uptake of the maize leaf improves in time owing to irrigation. In a year with good precipitation supply (2008) the dynamics of N-uptake is positive until the R1 development phase, the positive increase remained as a result of irrigation as well, however, its absolute value is lower. The obtained results show that the increase of N doses is not always accompanied by yield increase, if the amount of water needed for crop growth is limited.

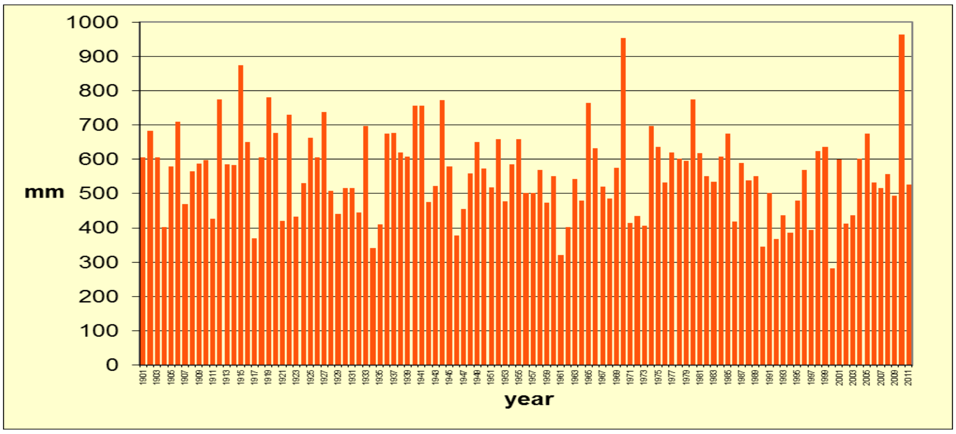


Figure 7. The amount of precipitation in the Hungarian Great Plain during 1901–2011

Excessive amount of water (precipitation, over-irrigation) and water shortage (the lack of precipitation and irrigation) both result in stress in the case of maize and they significantly reduced the amount of yield [Ványiné et al. 2012].

Based on the evaluation of the water utilisation indexes of maize, N-fertilisation without irrigation improves water utilisation under droughty conditions, but water utilisation becomes acceptable only after the fulfilment of the increased water demand. The strongly negative irrigation efficiency indexes (additional yield/1 mm irrigation water) clearly indicate that during the explicitly moist year of 2008 the application of more N would have been necessary in order to exploit the yield improving effect of irrigation.

CONCLUSIONS

After the change of regime in 1989 and as a result of the changes of land us, irrigation farming started to significantly decline in Hungary. Hungary belongs to the zone of conditional irrigation, where most of the plant species can be produced without irrigation. However, planned irrigation farming decreases the fluctuation of yield even in these areas, it increases yield and improves product quality and makes cultivation security more computable by terminating its dependency from extreme meteorological effects. In Hungary supplemental, ecological irrigation is the most optimal solution, which is aimed at the fulfilment of the ecological soil moisture demand. Spreading of water-saving irrigation technologies is essential, as well as the consideration of the aspect in the course of the elaboration of permission procedures and subsidisation systems. Fulfilment of irrigation-aimed water demands have to be provided primarily from surface water stocks, since only the renewal of these is ensured.

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