STATUS OF IRRIGATION IN LIGHT OF RECENT HISTORY OF THREE CENTRAL EUROPEAN COUNTRIES: CZECH REPUBLIC, AUSTRIA AND SLOVENIA

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ABSTRACT

The three central European countries, Czech Republic, Austria and Slovenia not only have common culture and share much of the history, they also share experiences with growing more or less the same kind of crops. This paper gives overview for each country individually in pre and post Second World War. It is evident that events of the 20th century, especially second half, greatly influenced the state of irrigation as well as challenges and issues each of the countries are facing. The Czech Republic is facing the need for rehabilitation and modernization of irrigation systems and for that new, economic tools are needed. The process of the building of new, modern irrigation systems is already happening on a small scale and suggests that the future irrigations systems will be small and flexible. For Austria it is expected that the irrigation amount will remain on the same level. Only in the Eastern part of Austria, especially in the Marchfeld Hochterasse and the Wachau region, an increase is expected. The need for irrigation in Slovenia is growing, irrigation becoming a necessary measure to meet the demands of intensifying agricultural production and to ensure quality and yield. In spite of short tradition, the use of water efficient technologies is strongly presented on the market and applied in practice, as well as favored by governmental financial support programs.

INTRODUCTION

As agriculture is the biggest consumer of fresh water, and with impending climate change bringing severe weather conditions, such as prolong droughts, flexible and reliable policy for irrigation regulation will be prerequisite to maintain sustainable water use as well as to provide water consumption control. Improving the recent irrigation technologies and consequently water use efficiency as well as fertilizer input levels on

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farm level are the major contributors to increase crop production, reverse the degradation of the environment or avoid irreversible environmental damage and allow a sustainable irrigated agriculture. The three central European countries, Czech Republic, Austria and Slovenia (Figure 1) not only have common culture and share much of the history, they also share experiences with growing more or less the same kind of crops. All that, as well as their geographical position, provides good conditions for technology exchange. Before the scientific development of the new sustainable and environmentally friendly technology can be initiated, it is necessary to establish the current status of existing irrigation systems and practices. In addition to that the needs of the end users, technicians and farmers, the benefits and shortcomings of existing systems should be defined and described, to ensure successful improvement (Št'astna et al., 2005).

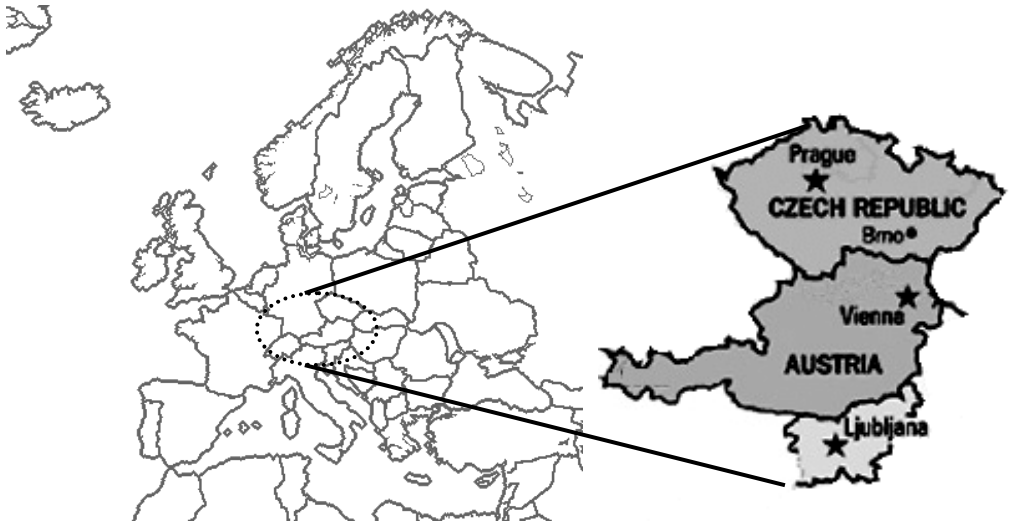

Figure 1: The three central European countries, Czech Republic, Austria and Slovenia

Historically both Czech republic and Austria have had early experience with irrigation systems. The oldest irrigation canal of Lower Austria is first mentioned in a mid- 12th century document, whereas in Czech Republic the first reports of irrigation systems are from the early 16th century in north Bohemia (Dvořak et al., 2002). Irrigation engineering came to full expansion under the Empress Maria Theresa at the end of 18th century (Cate et al., 2002). Slovenia is relatively young in implementation of irrigation systems, first designed irrigation system being in first half of 20th century (Jamnik, 1938).

The paper gives overview for each country individually in pre and post Second World War. After the Second World War the political situation in the three countries was greatly different. Austria has democracy, Slovenia was part of Socialist Federal Republic of Yugoslavia and Czech Republic was part of Czechoslovakia. For Czech Republic and Slovenia the most obvious mark was the downfall of the communist

regime in the year of 1991. The political situation influenced the legislation, administrative mechanisms and as well as socio-economic perception of irrigation.

CZECH REPUBLIC

Historical sources indicate that first more extensive irrigation structures on Czech Republic territory were built by the end of 19th century. For example, a cross-contour-furrow irrigation system was built in 1875 for the irrigation of meadows and pastures in the Upa river valley. A similar project was operational in the Metuje river valley between 1905 and 1912. Before 1940, when the total irrigated area amounted to almost 18 000 ha, further irrigation systems had been built in the Labe lowland, in the Cidlina valley, in the northern part of the so-called Little Hana (along the Trebuvka and the Jevicka rivers) and, in particular, in the Morava lowland between Otrokovice and Hodonin. Further expansion of irrigation systems took place after the Second World War. The statistics tell that, in 1950, the total irrigated area on the territory of the Czechoslovak Republic was 28 400 ha. This area grew up to 39 000 ha ten years later. It also included fertiliser application systems supplying crops with both inorganic and organic fertilisers and special-purpose irrigation systems. The latter made their way into the practice of fruit, wine and hop growing and were also used for protection against frost and other harmful factors.

The year 1970 brought further dynamic expansion of irrigation systems. In that year, the Federal Assembly adopted the Act on the State Land Improvement Fund. The Ministry of Agriculture, its guarantor, founded within its competence a new organisation, the State Administration of Land Reclamation and Improvement, today's Agricultural Water Management Administration. This institution, supported by the State Land Improvement Fund, took over administration of both the existing and the newly built land reclamation structures, small water courses (called "agricultural streams") and the reservoirs built on them (Jancak and Goetz, 1997). The construction of main irrigation structures, starting from the intake structures up to water supply hydrants, was fully financed by the state. The State Administration of Land Reclamation and Improvement took care of maintenance, repairs and operation of these structures. The exploiters of these irrigation systems used to receive, up to 1991, subventions from the State Land Improvement Fund. The subventions enabled them to procure the so-called irrigation detail (i.e., the equipment for distribution of water over individual field). The subventions amounted between 30 and 80 % of the total investment costs. The electricity and water for irrigation were available to the users under very favourable conditions (details are given below); water, in particular, was provided free of charge until 1997.

All the above-quoted factors caused immense expansion of irrigation systems over our territory. The systems were built in order to assist in intensification and stabilisation of agricultural production. The development was planned on three conceptual levels: the long-term (20 years), the middle-term (5 years) and the short-term (1 year) ones. In this way, the state succeeded in building and subsequently administering the property worth about 3.5 billion CZK. The total irrigable area in 1969 was 30 100 ha. It grew up to 82 600 ha in 1979, up to 137 100 ha in 1989 and up to 154 900 ha right before the privatisation in 1997 (Št'astna et al., 2005).

The irrigation is rarely appreciated as an indispensable part of agricultural production and its economic, socio-demographic and environmental sustainability in the Czech Republic. Economical analyses show that the operation cost of irrigations is high and the irrigation is not always profitable. An overall decrease in agricultural production took place after 1989 and the intensity and efficiency of the production is not yet as high as in most old EU countries. The crop yields represent on average 60 to 80 % of those in old EU, the use of fertilisers is lower and also the productivity of labour is lower. There are, of course, large differences between particular enterprises.

The circumstances described above lead to establishment of the Czech Irrigation Association (CIRA) in December 1997, which brought together owners and operators of irrigation systems, farmers, researchers, and designers, manufacturers and distributors of irrigation equipment. CIRA's main role was up to now to negotiate subsidies for the water abstracted for irrigation, adjustments of prices of electric power, procedures how to specify quotas of water freely provided for irrigation, etc.

A limiting factor of the development of irrigation in the Czech Republic may be seen in the implementation of the Act on Agriculture (252/1997 Coll.), which resulted in classifying the regions with high precipitation deficits as less favourable areas (LFA), in compliance with EC regulations. The operation of irrigation may be also affected by implementation of the EC nitrate directive.

In future, the fundamental driving force of the expected renaissance of irrigation can be the demand of market for stable and high quality production. The target is not the maximisation of food production but the stabilisation of yields and quality by irrigation. This is the way, how to ensure a long-term profitability of husbandry and, at the same time, to protect the environment. The stability of yields will increase commercial credibility of Czech farmers, strengthen their competitiveness at local markets and on the common European market. It will also render them a better position for negotiations with business chains and other partners.

Another important instigation for future expansion of irrigation may be the oncoming climate change. The droughts in 2000 and 2003 clearly demonstrated what impact a shortage of water can have on the growth of crops. In 2000, the Ministry of Agriculture estimated the loss due to drought at app. 10 billion CZK. Apart from that, the need to irrigate „energy" crops, newly planted windbreaks or shelterbelts etc. is also expected (Št'astna et al., 2005).

Unfortunately, the operators of irrigation systems suffer from the lack of financial resources for modernization and reconstruction. Thus the state endowment is important. Governmental subsidies in agriculture for 2005 are provided in accordance with the Act on Agriculture (252/1997 Coll.), the Horizontal Plan of Rural Development, the system of direct payments related to the land area, the Operational Plan of the Ministry of Agriculture and other subsidy programmes. Only few subsidies are focused on the support of irrigation. It is recommended that new economic tools will sought, which would motivate the owners and users of irrigation systems to finance the maintenance and modernisation of the systems. A separate question is the building of new, modern irrigation systems. It is already going on a small scale and suggests that the future irrigations systems will be small and flexible. Strategy for decision support system

would be new and practical solution for all users dealing with irrigation and it may bring them even higher profit by saving water and energy.

AUSTRIA

The oldest irrigation system was mentioned in the 12th century, where a channel between two rivers in Lower Austria should supply the area along the channel with additional water. During the 17th century an irrigation system, which distributes the water by side channels, was built by military engineers (Cate et al., 2002). Tyroleans had a great familiarity with irrigation technique therefore they were consulted. It was an early example of domestic colonisation. At the beginning of last century, wastewater from Vienna was used for irrigation of the near Marchfeld area. Between the two world wars, sprinkler irrigation systems were introduced in the Marchfeld plain, which was a great progress for plant production.

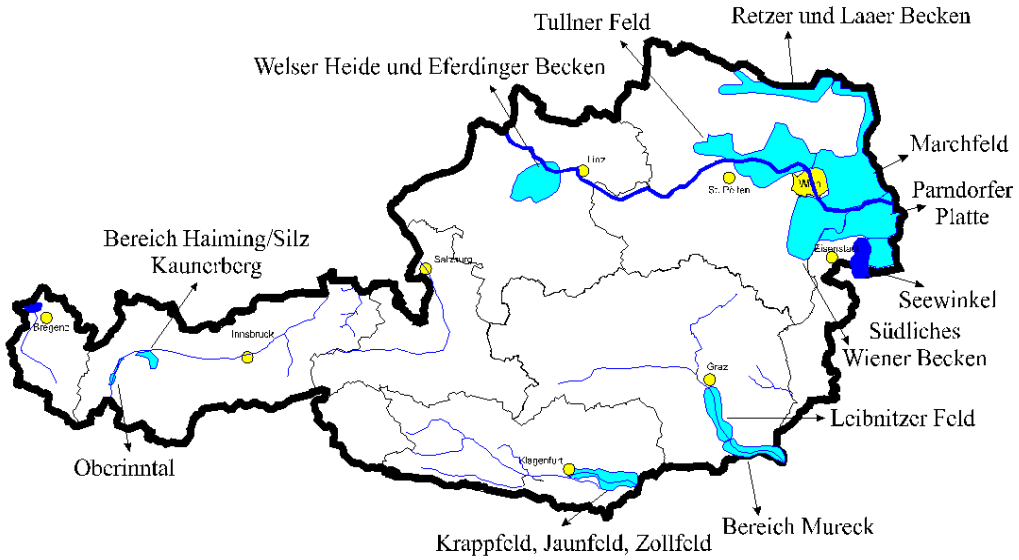

Figure 2: Irrigation areas in Austria

Nowadays, in average 4 % of whole water consumption are used for irrigation purposes. In the dry eastern areas this portion is up to 50 % and more (Figure 2). In most parts of Austria natural rainfall per se allows productive agriculture, but in order to optimise yields (especially maize, sugar beet, vegetables and industrial crops) and to minimize risk of crop loss in case of rainfall deficits during the vegetation period many farmers have irrigation equipments. However, in the Pannonian region of eastern Austria semi-arid conditions make irrigated agriculture significantly more productive than dry-land agriculture (Baldock et al., 2000).

The annual Austrian water balance with an average precipitation of 1 170 mm and 340 mm of surface and subsurface input of water shows a total water amount of 1 510 mm per annum. The output by surface and subsurface waters is nearly 1 000 mm. The rest of 510 mm is annual evapotranspiration.

Austria's potential irrigation area comprises almost 100 000 ha, but in fact only almost 50 % are irrigated because of crop rotation factors and climatic conditions (Table 1). From this more then 90 percent are irrigated root crops and vegetables. The rest is split in vineyards, orchards and grasslands.

Table 1: Irrigation areas in Austria (Statistik Austria, 2002)

	Arable area (1999)	Potential irrigation area (1995)		Irrigated area (1995)	
	[ha]	[ha]	[%]	[ha]	[%]
Burgenland	198 200	23 400	12	10 670	46
Carinthia	354 000	290	0.1	350	36
Lower Austria	96 900	64 600	7	30 210	47
Upper Austria	585 800	1 280	0.2	940	
Salzburg	316,600	100	0.03	40	
Styria	530 100	920	0.2	750	
Tirol	451 500	1 900	0.4	1 420	75
Vorarlberg	122 400	240	0.2	30	
Vienna	9 800	2 710	27	1 330	49
total	3537 900	95 440	3	45 740	48

The legal framework for irrigation is set by Austrian Water Act, which regulates on the one hand withdrawals from ground or surface water and on the other hand water quality. It was passed in 1959. In 1990 an amendment entered into force, which limits for example the duration of a permission for an irrigation system to 10 years.

During the second half of last century different kinds of irrigation systems have been developed. The most common devices in Austria are sprinklers in different sizes. For most crops movable sprinkler facilities are utilized. In orchards usually solid state sprinkler systems are installed which are used for frost protection but also for compensating precipitation deficits. In the 1990s first more efficient drip irrigation systems started up (especially for perennial crops, e. g. vineyards).

The aim of irrigation is obtaining an optimal plant available soil water content. Therefore time and water amount have to be chosen very carefully. Experienced farmers decide this according to actual precipitation and plant growth.

In future general irrigation amount will remain on the same level. Only in the Eastern part of Austria, especially in the Marchfeld Hochterasse and the Wachau region, an increase is expected. For example in Marchfeld area there are different projects where water cooperatives irrigate fields with areas from 2 000 to 4 000 ha. In Wachau region

projects about drip irrigation in vineyards are previewed for ensuring socio-economic standard of people living there.

One important aspect in future irrigation is to optimize irrigation water amounts. Therefore automatic irrigation control systems based on measurements of soil water content and GIS supported systems will be developed or improved and used in large scale.

SLOVENIA

Agricultural production in Slovenia in the past was extensive, big farm entities consisted of mainly forest and not arable areas (Maček, 1995). The unfavorable land structure of small parcels (Jamnik, 1938) prevented bigger technological development (Maček, 1995) thus contributing to extensive nature of Slovenian farms. Due to the high annual precipitation amount, agricultural land melioration on Slovenian territory mostly comprised of drainage systems and flood control, irrigation was and is a supplementary measure to ensure an reliable plant production with steady quantity and quality.

Before the First World War, implementation of melioration on arable areas was financed by Melioration Fund of Drava ban's county, which granted subsidies for hydro technical work, established by Melioration act (1884). The fund provided financing of wild stream regulations and drainage systems, but due to poor land structure Slovenian territory was rarely the beneficiary of the fund (Jamnik, 1938). If implementation of the irrigation system was considered, then it was in combination with simultaneous installation of drainage system (Jamnik, 1938). The first record of organized installation of irrigation systems is documented for channel system for flood irrigation on 25 ha of meadows in Prekmurje in 20th century's early thirties (Jamnik, 1938). River Ledava was routed into irrigation channels.

After the Second World War water management responsibilities were transferred to Ministry of Construction, then in 1960 to the organization of Water Communities. In 1974 a new Water Act transferred water management activities on water management enterprises. The amendment in 1989 dismissed the binding transfer of water management obligations on Water Management Enterprises. In 1990 the Republic Water Administration Board was founded, with branch offices for water counties.

The focus on implementation of drainage system as a melioration measure on arable land continued. In the 1970ies there was attempt to construct peach orchard with irrigation system in maritime Slovenia, but the plans were never completed (Adamič, 1986). First reports of modern irrigation systems being installed are dated back to 1978 (Juvan and Edelbaher, 2000) in east Slovenia.

From 1986 to 1989 storage lake Vogršček was constructed to boost intensive agricultural production in Vipava Valley, West Slovenia by ensuring water for 3 500 ha of arable land. The construction of large storage lake in West Slovenia was outset for more systematic approach to irrigation, evolving from program developed on the national level with general review of the state's needs and conditions for irrigation, to proposal and designs on the smaller scale with detailed plan for specific irrigation needs.

At the beginning of 90ies, a study "National Irrigation Programme" (NIP) has been prepared (Biotechnical Faculty, 1994) for the total area of 193 450 ha. NIP considered use of sprinkler irrigation. Slovenia was divided into five climate zones: Mediterranean climate, panonic climate, submediterranean climate, subpanonic climate and climate of the central Slovenia. Alpine region in the north and part of Karst forest area in the south under Dinara climate were considered as sixth climate zone, where no irrigation is required. Calculated average water net requirements for irrigation range from 300 to 4 000 m^3/ha per year, varying between crops and climate areas. Analyses of water sources availability have shown that there is enough water in surface waters in Slovenia for irrigation of 60 000 ha of arable land, without additional water reservoirs (Biotechnical Faculty, 1994).

The Slovenian government confirmed in 1994 "The Strategy of Irrigation in Slovenia" according to which every year 10 000 – 12 000 ha of new irrigation systems would be constructed in the following five years (Stražar, 2002). The proposal for the implementation of the first phase of the strategy outlined plans for 10 605 ha of arable land in total (Slovenia Irrigation Project, 1999). Country has been divided in eight irrigation regions for the criteria of the water sources (Figure 3). Areas from the first phase of "The Strategy of Irrigation in Slovenia" were verified with spatial plans of Slovenia in 1997. There have been 5 775 ha of irrigation systems in that time in Slovenia (Slovenia Irrigation Project, 1999). Smaller area (3 688 ha) has been defined for preparation of more detailed projects. By the year 2000 approximately 4 000 ha of new irrigation systems have been constructed in Slovenia, additional 300 ha by the year 2005, but none of them on areas, which have been taken into account in "Slovenia Irrigation Project".

Figure 3: Schematic view of irrigation regions in Slovenia

(1 Pomurje, 2 Podravje, 3 Savinja valley, 4 Lower Sava in Lower Krka, 5 Bela krajina, 6 Goriška brda, 7 Vipava valley, 8 Coastal region).

Seemingly systematic approach to the irrigation planning and construction of irrigation systems did not diminish the farmer's increasing demand for subsidies for the drought damages in dry years. To gain control over the situation, Ministry for Agriculture, Forestry and Food systematically surveyed all existing irrigation (and drainage) systems in the country. Register inclusion criteria was prepared minimal project documentation for irrigation system and formal construction process in progress. According to this criteria there are 10 000 ha of irrigation systems in Slovenia. The register has been established with the purpose to charge farmers with a reclamation fee for the maintenance of the system (drainage or irrigation). There is no information about the functioning of the irrigation systems, which have been poorly maintained and are consequently in very bad condition in general. The situation is worse with drainage systems and some irrigation systems as well (Stražar, 2002).

In 2004, 2 329 ha of agricultural land were irrigated, which is 15 % less than in 2003. According official state statistics (Statistical office of RS, 2005), majority (90 %) of the area was irrigated by sprinklers, and 10 % (i.e. 233 ha) by drip irrigation. On the other hand, the ministry for agriculture, food and forestry has a register about irrigation technologies in orchards. According to this data 45.1% of orchards are irrigated by drip irrigation (i.e. 337 ha) and 47.3% are irrigated by sprinkler irrigation (i.e. 353 ha). The average yearly water consumption is approximately 2 000 m^3/ha. In total 4.5 million m^3 of water were used for irrigation, the majority, i.e. 84.7 % from water reservoirs, 12.1 % from water streams directly, 2.6 % from ground water, and 0.6 % from other sources (Statistical Office of the Republic of Slovenia, 2005).

Legislation that manages the irrigation is complex and comprises of several acts and decrees (Čuden-Osredkar and Pintar 2003), pertaining both agricultural as well as sector for environment and spatial planning. The Agricultural Land Act, accepted in 1996, with several acts amending the Agricultural Land Act, the latest in 2003, defines irrigation as a melioration measure. The Agricultural Land Act differentiates between big irrigation systems, meant for common use under irrigation schedule and small irrigation systems, which use irrigation independently. Water act accepted in 2002 regulates water management with the goal of water protection and the water rights acquisition. Decree on the Water Fee (2002) establishes a method to determine the amount of water fee and method for the calculation, allotment and payment of the water fee as well as criterion for decrease or pardoning of the water fee payment.

To promote water efficient irrigation technologies, government gives priority for financial support to the irrigation project petitions that consider use of water efficient technologies (drip irrigation). High share of drip irrigation system applied in fruit orchard suggest good organization on the part of fruit growers who apply for financial support from the Ministry for Agriculture, Forestry and Food.

CONCLUSIONS

It is evident that events of the 20th century, especially second half, greatly influenced the state of irrigation as well as challenges and issues each of the countries are facing. The Czech Republic is facing the need for rehabilitation and modernization of irrigation systems. For that new economic tools, which would motivate the owners and users of irrigation systems to finance the maintenance and modernization of the systems, are

needed. A separate idea is the building of new, modern irrigation systems. The process is already happening on a small scale and suggests that the future irrigations systems will be small and flexible.

For Austria it is expected that the irrigation amount will remain on the same level. Only in the Eastern part of Austria, especially in the Marchfeld area and the Wachau region, an increase is expected.

The need for irrigation in Slovenia is growing, irrigation becoming a necessary measure to meet the demands of intensifying agricultural production and to ensure quality and yield. In spite of short tradition, the use of water efficient technologies is strongly presented on the market and applied in practice, as well as favored by governmental financial support programs. To further implement and solidify the perception of irrigation as helpful and valuable measure raising of public awareness would be necessary. In addition to promotion of irrigation, education about proper and correct irrigation methodology would be necessary, to diminish environmental risks, such as overexploitation of water sources and nutrient leaching from irrigated areas.

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