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Best Management Practices for Irrigation as a Function of Groundwater Quality

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Abstract. Sustainable development implies that the needs of the present generation should be met without compromising the ability of future generations to meet their own needs. This includes both the quantitative problems of water availability for the needs of society and the problems of water quality. Protection of groundwater reserves is a key issue that has gained considerable public attention in recent years. Water table management is a drainage practice in which a system of tile drains is used to keep the water table at an optimal level for a selected crop. As a part of CPSP (Country Policy Support Program), a Basin Wide Holistic integrated Water Assessment (BHIWA) model was developed. Best management practices are recommended methods, and/or activities designed to prevent or reduce water pollution while maintaining producer profits.

Keywords: Modernization of agro, food and water economy, management practices, environmental awareness, groundwater

1 Water Management

Arable agriculture land in the Republic of Macedonia is estimated at 612,000 ha. With development of more reservoirs, it is possible to secure irrigation of realistically 370,000 ha. To date, a total of 106 reservoirs of various sizes have been built, and they cover 163,693 ha of fertile arable land, i.e. 24.5% of the arable land. Out of the total land for irrigation (163,693 ha), 100,000 ha (61%) can be irrigated by sprinklers, and 63,300 ha (39%) simply by gravitation. Because of underdevelopment irrigation systems, land given for other purposes etc, it is realistic to expect irrigation of 126,617 ha (77.35% of the irrigation-covered land for which there exists a technical

documentation), or 19% of total arable land due to under developed irrigation systems and other land given permanently for other purposes. Exploitation level varies greatly, and it ranges from 40 to 70%. By completing the rehabilitation project for the system HMS Bregalnica, Tikves, and Polog, a significant increase of exploitation level is expected.

The largest irrigation systems are the following: Bregalnica (28,298 ha), Strezevo (20,200 ha), Tikves (19,225 ha), Strumica (16,717 ha) and Kumanovo (10,000 ha). Water supply for population and industrial facilities is usually performed by (separate) local water supply systems. Annual population demand for water is approximately 440 milion m^3 of water, and annual industrial demand is 534 million m^3 of water. Eightly four (84%) of the whole water capacity in Macedonia originates domestically, while are, or flowing in from the neighboring countries. There are three natural lakes in Macedonia: Ohrid Lake-total area 348,8 km^2 , out of which 229,9 km^2 in the Republic of Macedonia, Prespa Lake-total area 274 km^2 , out of which 176.8 km^2 in the Republic of Macedonia, Dojran Lake – total area 43 km^2 , out of which 27.4 km^2 in the Republic of Macedonia. There are 19 big and over 100 small water dams built for utilization of the 4,414 registrated springs and the hydro potential of the rivers. Their total volume is 1,854 km^3 of water. Also there are facilities (green house, spas, pools) in the Republic of Macedonia where geothermal water is used for heating.

2 Environmental Protections and Improvement

2.1 Water Protection

The Cadastre of Pollutants of Vardar River was elaborated in two phases: in the first phase, a poll was conducted through all the inhabited places and industrial facilities which are a constituent part of the urban areas along the Vardar river course, and in the second phase, based on the conducted poll, a selection of industrial capacities classified as pollutants and potential pollutants was made and complete technical documentation on the state of their waste waters was prepared. According to the knowledge acquired during the visit to the populated area and industrial capacities presented in the Cadastre of Pollutants of Vardar River it may be concluded that the state regarding the waste waters related in this recipient is critical to the extent of a catastrophe due to the following: central waste waters filtering stations do not exist in any of mentioned populated areas, the industrial capacities release their unfiltered waste waters partially in the urban sewerage systems and partially directly into the recipient, there are systems for filtering of waste waters at the level pre-treatment or complete treatment in a small number of industrial capacities (however, these systems are pretty old and non-efficient and some of them are even non-usable so that the waste waters are mainly released through the existing by-passes), in the inhabited places and industrial capacities there is a partially constructed sewerage infrastructure mainly of a mixed type through which the complete amount of fecal. Technological and atmospheric waters are released directly into the river, and the depositing of the communal and industrial waste materials in the towns is inappropriate and not well

organized (it is performed in places which do not satisfy the health department regulations so that they add to the pollution of the total environment, especially air, soil and ground water).

After the accomplishment of the Cadastre of Pollutants of the Vardar River, there exist, possibilities for realization of the second phase of the Programme of Measures and Activities for Protection of the Waters of Vardar River and its tributaries against pollution which involves elaboration of conceptual solutions for filtering of the total amount of waste waters from the inhabited places. For purpose of obtaining of the most favourable economic-technical solutions, it is necessary to elaborate several variant solutions of central filtering stations with an emphasis on measures to be taken for industrial waters.

2.2 Best Management Practices for Nutrient and Irrigation Management

Best Management Practices (BMP) are recommended methods, structures, and/or activities designed to prevent or reduce water pollution while maintaining producer profits. The goal of BMPs is to protect Vardar river valley water resources from degradation, while maintaining the economic viability of agriculture and related industries. Ideally, these practices will improve producer profitability at the same time soil and water is protected from contamination. Success with voluntary BMPs will depend upon how many farmers and agricultural chemical applicators actually use and promote them.

Having in mind these recommendations of BMPs and one may say the following about The Best Management Practices:

INTEGRATED CROPLAND CULTURAL PRACTICE (Crop Relation BMPs, Soil Management BMPs, General Nutrient Management BMPs), NITROGEN FERTILIZER MANAGEMENT, BEST MANAGEMENT PRACTICES FOR NITROGEN FERTILIZATION (Nitrogen Application BMPs, Fertilizer Handing and Storage BMPs), PHOSPHORUS MANAGEMENT (BMPs for Phosphorus Fertilization), MANURE AND ORGANIC WASTE UTILIZATION (BMPs for Manure Utilization, Manure Storage BMPs), IRRIGATION MANAGEMENT (BMPs for Irrigation Management, Flood or Furrow Irrigation BMPs, Sprinkler Irrigation BMPs, Chemigation BMPs).

3 The Main Strategic and Reform Objectives

It is necessary to design and create a modern, stable and dynamic agricultural sector, integration of the Macedonian agriculture into the global development processes, development of the rural areas and establishment of favourable economic conditions for the Macedonian farmers, improve the marketing of the agricultural commodities, development of the regional cooperation, and implementation of the action plan for execution of the Agreement for Stabilization and Association with the European Union. Significant improvement is achieved by carrying out the activities for reform and harmonization of the legislative to the one of the EU, as follows: private farmers are allowed to have access to public land by distributing 27,5000 ha of arable land to

new users, denationalization of land previously, nationalized from original owners, privatization of companies and transformation of agricultural cooperatives are in their phases, newly passed regulations now regulate usage of goods/assets of public interest, such as water, forests, pastures, agricultural land, fish farms and wildlife, veterinary and plant protection regulations are getting approximated with those of the EU. Border cross veterinary and sanitary inspection teams are trained and appropriately equipped. Institutional and financial support has been obtained for opening of 37 new veterinary facilities, with an aim to improve the quality of service and enhancing the competitiveness, a national system for identification and registration of livestock is getting introduced, structural changes have been made in the National Extension service, after the technical equipment process will be finished, permanent training of 78 agronomists will continue, as well as implementation of the state project for their (Extension service) subsequent privatization and self-financing by providing services on farms, support and encouragement to the formation of farmer associations, a total of 178 local associations have been formed by 2002, 14 regional unions and 9 national unions, all of these are united into a Federation of Macedonian Farmers, representing approximately 25, 000 farmers, the process of liberalization of the agricultural commodities market goes on, in accordance to the Agreement for Stabilization and Association with the WTO, free trade agreements have been signed with several countries in the region, the system for preferred crediting has been abandoned, and all subsidies, as well as stimulations that have been in place since 1996 have been terminated, after the subsidies have been abandoned, financial support to the agriculture continued through programs by which, during the period 1997-2001, a cumulative amount of 25 million EUR has been invested, in order to support the agricultural development, a Fund for agriculture has been founded, and a special Fund for water resources for the water management.

4 Water Table Management and Migration of Phosphorus

Agricultural practices have become far more aggressive and demanding for the environment. Intensive use of fertilizers (natural and chemical) has led to high nutrient concentrations in the fields. Transport of nutrients has also been discovered, as many water streams and lake became contaminated from agricultural sources. Among these, phosphorous has become a concern in past years, for its active role in water bodies. Water table management has obvious agronomical advantages, since if provides the crop the right conditions of soil moisture and of water input needs. However, its environmental impacts have yet to be fully evaluated.

5 Basin Wide Holistic Integrated Water Assessment Model

As a part of CPSP (Country Policy Support Program), a Basin Wide Holistic integrated Water Assessment (BHIWA) model was developed. The model has seven computation modules:

1. Actual evapotranspiration, quick runoff and natural recharge
2. Irrigation withdrawal
3. Irrigation returns
4. Evapotranspiration (ET) by sector
5. Domestic and industrial withdrawals
6. River water balance
7. Groundwater balance

In addition to these modules, there are worksheets to facilitate data inputs, and generation of aggregated results in the form of tables and charts.

6 Conclusions

People in the Vardar valley have a strong interest and extraordinary knowledge of their surface and groundwater resource. Agricultural producers are leading the effort to protect and wisely utilize the water that makes life possible for people, crops and wildlife ecosystems within the valley. The goal of this paper is also to prepare a review of Best Management Practices (BMPs) containing nutrient and irrigation guidelines and recommendations. It is also presented water management, environmental protection and improvement, the main strategic and reform objectives, water table management and migration of phosphorus and basin wide holistic integrated water assessment model.

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