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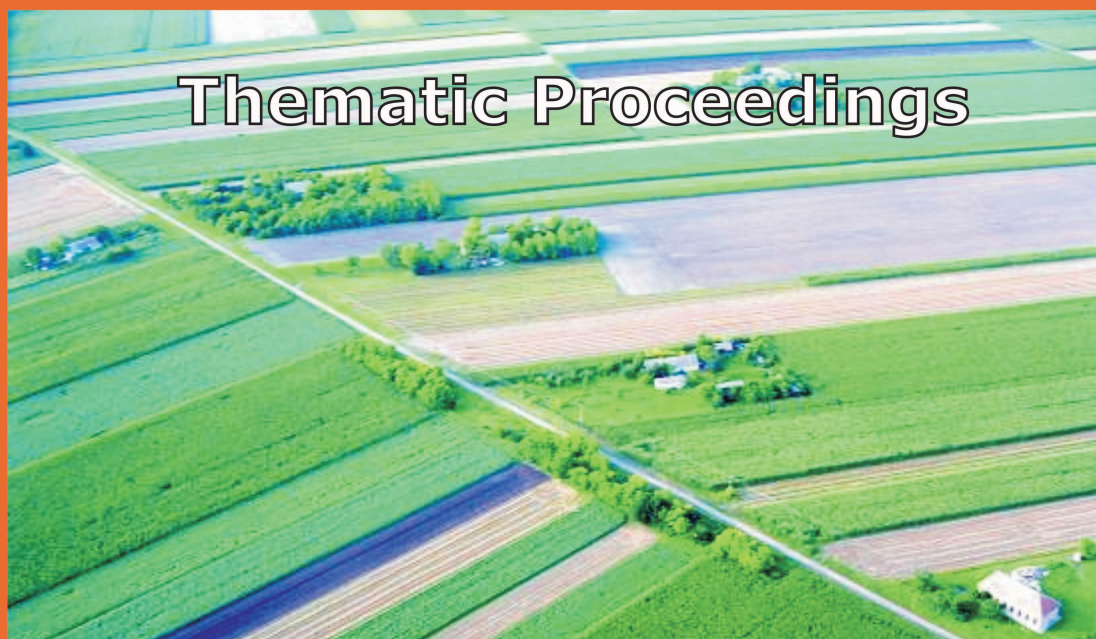
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AGRICULTURAL IMPACT ON WATER RESOURCES[1]

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INTRODUCTION

Pollution of water resources from agricultural areas became large problem not only in developed countries such as European Union but also in countries which are in the process of agriculture and industry development. Intensive agricultural production considers larger use of fertilizers as well as pesticides which through filtration and runoff reach surface and ground waters. Main water pollutants are nitrates, phosphates and pesticides. Increased concentrations of mineral fertilizers in water cause so called "water bloom", while use of pesticides contributes to increment of concentrations of substances which are toxic for living organisms. In waters loaded with pollutants, process of self-purification which is complex and natural process significant for water ecosystems, is very difficult and equilibrium between production and degradation of organic matter is violated.

AGRICULTURE AND WATER QUALITY

From the aspect of environmental pollution agricultural areas represent non-point or so called diffuse sources of pollution because the enter point of potential pollutants in water systems can not be precisely determined. Non-point sources are quite problematic because it is difficult to collect and treat pollutants before they enter in water systems. Point sources of pollution such as communal waste water mainly enter in rivers through system of pipes so it is incomparably easier to collect and purify them to a certain extent, before they are released in environment. Because of specificity of pollution from agricultural areas the most important is prevention of pollution which is being done directly on the fields. Polluting materials which by runoff and filtration through soil reach waters include eroded particles of soil (sediment), nutrients, pesticides, salts, bacteria, viruses and organic particles. Runoff of matter from upper parts of soil by activity of rainfall varies from type of soil, presents of vegetation, plant and animal residues, physical structure of soil, topography as well as intensity of precipitation and it is the most

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intensive in bare areas. Energy of rain drops activates disconnected particles of soil toward lower altitudes, first in the form of small grooves and after, if the amount and intensity of rain is large, through ravines. Vegetation, besides the fact it decreases negative mechanic activity of rain drops on the surface of soil, also decreases amount of water in the soil through evapotranspiration and in this way disables erosion. In bare surfaces runoff of soil is intense because there is nothing to accept the energy of water; particles of soil are moving, closing the soil's pore and in that way reduce infiltration of water in deeper parts of soil which influence on drastic loss of humus and other materials from soil. By activity of water erosion, nutrients are lost which decreases fertility and productivity of soil.

Sediment is on of the most important pollutants of water ecosystems from agricultural areas. Particles of sediment can easily deposit on the bottom of streams, changing their form and environmental conditions, which influence on the reproduction on animal and plant species. If the stream is smaller, activity of this process is faster and more intensive. Phosphorus, necessary for plant growth and component of many fertilizers, is being transported in the waters connected to the particles of clay. In the same manner many pesticides which are toxic for water life are being transported. After they enter water ecosystems they are being separated from sediment and accumulated. In surface waters in Europe even 50% of total phosphates are from cultivated areas (Merrington et al. 2002). Beside fertilizers the large problem is intensive animal breeding, especially in part of Europe where animal breeding is very developed (for example North and East Netherlands). Basic influences of animal breeding on environment and water ecosystems are contamination with phosphates, hard metals and lowering of water pH.

Nitrogen, necessary for plant growth and relatively inexpensive component of many fertilizers, in water is the most soluble in the form of nitrates. Half of nitrogen which is being used for crops ends up in ground waters (Mason 1996). Since it is soluble, nitrogen in the form of nitrates easily runoffs from upper layers of soil in water while ammonia is released in atmosphere in the form of gas. Nitrogen in the form of nitrates in the field as well as water stimulates plant growth and in this way causing eutrophisation of water ecosystems. From pastures and animal farms nitrogen enters the water in the form of ammonia which is toxic for water organisms. Loss of nitrogen from fertile soil can easily be reduced by using it only in necessary amounts and in time when crops need them. Nitrates in water are subject of interest because of application of Directive of European Union which regulates the amount of nitrates in drinking water. EU Nitrates Directive (Directive EC 91/676/EEC) has a purpose to minimize loss of nutrients from agricultural areas in river beds by limitation of fertilizers consumption in sensible areas. Directive has two important goals: reduction of water pollution by nitrates from agricultural production and stooping of pollution in the future.

Intensive runoff of organic materials and fertilizers lead toward eutrophisation of water ecosystems. This complicated process is easy to realise:

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- productivity and biomass of phytoplancton, algaes and macrophytes are being increased („water bloom");
- certain algae produce toxins and in this way pollute water;
- water does not have enough oxygen, especially after death of algae, which causes death of other organisms;
- fish species which are more demand for oxygen die (Salmonidae);
- canals for irrigation are being covered with vegetation which influence on their function (although it can also be caused by spreading of alochtone plant species);
- by creation of mud and unpleasant smell from decomposition of algae, the recreational purpose of streams is lost and if the river is a source of drinking water, expenses of purification are increased;
- growing of rich vegetation creates transport problems.

By runoff from cultivated areas pesticides reach the water ecosystems. If they enter in the sources of drinking water pesticides must be removed, which is complicated and expensive process. That is necessary because most pesticides or products of their degradation are toxic for water life. Possible negative effect of pesticides is inhibition of reproduction, suppression of immune system, disruption of hormone system, damage of DNK, cancer or even death. In agriculture one must apply faster degradable pesticides to prevent their accumulation in soil. Chemical means which are used in agriculture are usually mixed with water and spread on crops. According to Pimentel (1995), less then 0.1% of used pesticides reach target organisms. The last few years equipment that farmers use for spreading became more efficient and enabled better control of amount and method of pesticides application. The role of farmer is the most important because only they can insure that speeding doesn't carry out in poor weather or close to water. Large problem is also disposal of used material for speeding and pollution of water by equipment for spreading. We need to mention that some pesticides can be present in soil for a long time and that their often use can lead to accumulation in soil. It pollutes crops and reduces the number of soil organisms. In the developing countries basic problems in management of pesticides are: inadequate storing of pesticides and possible hazardous situations, deliberate release of pesticide surpluses in waters or use of pesticides for inadequate purposes.

For reduction of negative influence on environment and health of people, European countries adopted set of measures (FAO/ECE, 1991):

- reduction of pesticides use, up to 50% in some countries
- ban in using of certain active components
- revision of criteria for pesticides registration
- training and issuing of permission to individuals which use pesticides
- testing and approving of equipment for spreading of pesticides

- tax on use of pesticides
- promotion of use of mechanic and biologic alternatives to pesticides

One of the methods for reduction of amount of chemicals in the water is Integrated Pest Management – IPM, which considers application of ecologically accepted measures for destruction of pests. Pesticides are used only when losses, created by pests' activity, became too large (US Department of Agriculture, 2002).

It is interesting to mention that forest vegetation near coasts can be a puffer system for reduction of pollution from agricultural areas because it adsorbs nutrients and pesticides. Vegetation near coasts has well known effect on stability of cost, biodiversity and water temperature (Karr and Schlosser, 1978). Forest vegetation located in this way has four important functions:

- it reduces amount of sediments in water ecosystems
- reduces concentration of nitrates in ground waters (when ground water goes through puffer system 90% of nitrates can be eliminated)
- reduces concentration of dissolved phosphates in surface and ground waters
- it regulates quality and amount of light which reach the water as well as water temperature, influences in this way on biodiversity and food chains.

Degradation of water ecosystems can not be observed separately form activities on cultivated areas. Appropriate agricultural activities as well as preventive measures for prevention of pollutants runoff from fields is necessary for better protection of water ecosystems. Any strategy with goal to reduce water pollution will be successful only if it is applied on the farm level. Implementation of control measures will show as sustainable only if farmer realises that it is in his interest to proceed them. Integrative approach in water management allows assessment of role of agriculture in program for water management and protects from unrelated, inefficient and inadequate policy decisions in this area. Policy that needs to influence on farmer and agriculture production can include education as well as technical support.

WATER FRAME DIRECTIVE

By passing of Water Frame Directive (Directive 2000/60/EC), European Union has clearly defined its long-term policy in the area of water resources. This Directive introduces new principles and standards in creation of policy for sustainable use and protection of waters. Basic principles of Directive will have to be applied by EU members as well as candidates for accession in European Union. This document is a base for specific activities in water resources management in Europe. Main goal of Directive is to bring all natural waters in a „good shape" that is to provide good hidrological, chemical and ecological status of waters. This does not mean restoration of primary natural state of water resources but creation of sustainability of water resources. The main goal of Directive is stoppage of further

degradation of water resources. Directive gives large number of activities from which the most important are:

- Countries which are EU members need to reconstruct and protect all surface and ground waters and to provide „good shape" of waters in the next fifteen years;
- Introduction of water price policy in the way which will stimulate wise use of water and by that contributes to fulfilment of appointed goals of environmental protection. This policy will be applied according to adopted principles of water services price management and it should stimulate rational use of water. When price of water is being established every country must be aware of social, economic and ecologic aspects;
- Countries which are members of EU must prepare programs for management of river basins in the scope of their territory. In the case of international river basins, states must provide coordination of activities for preparation of unite management program;
- Application of these goals requires passing of new laws, regulative and administration.

With application of this directive, Republic of Serbia will accomplish one of the conditions for accession in European Union.

Project of United Nations and Global Environment Facility under name Danube River Basin project „Reduction of Pollution Releases through Agricultural Policy Change and Demonstrations by Pilot Projects" is very interesting. This project defines so called best agricultural practice which can apply in countries that with their territory include Danube River Basin. Project defines fifteen best agricultural practices which protect environment from large amount of nitrogen, phosphorus and chemicals. Advantages of best agricultural practices application on farms are:

- They have positive effect on water environment and farm production;
- They are practicable for climate, soil type, model for growing of crops and breeding of animals as well as for legislation of the region of application;
- They are reverse to bad agricultural practices which pollute and degrades production on farms;
- They are in accordance with agricultural policy and policy of environmental protection of EU.

Effective measure for reduction and prevention of water pollution is application of organic agriculture methods. In contrast to conventional agriculture, organic agriculture preserves soil, gives larger security from floods and larger absorption of carbon from the atmosphere (OECD, 2001). Methods of organic agriculture prohibit application of chemicals in control of pests on farms as well as use of fertilizers. In this way, pollution of water ecosystems from agriculture can easily be reduced.

CONCLUSION

Pollution of water ecosystems from agricultural areas became large problem both in developed regions as well as countries which are in the process of agriculture and industry development. Degradation of water ecosystems can not be observed separately from activities in cultivated areas. Appropriate agricultural activities and application of measures for prevention of pollutants runoff from fields is necessary for protection of water ecosystems. Any strategy which has the goal to reduce water pollution will be successful only if it is applied on the farm level. Implementation of control measures will be sustainable only if farmer realises that it is in his best interest to apply them. Implementation Water Frame Directive principles in domestic legislation will enable better protection of waters in our country. Also, effective method for reduction of water pollution is application of organic agriculture methods. In contrast to conventional agriculture, organic agriculture preserves soil, gives larger security from floods and larger absorption of carbon from the atmosphere.

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