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21 NEW ELEMENTS OF WATER MANAGEMENT

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INTRODUCTION

Modern water management goes presently through difficult processes of adaptation to new tatgets stipulated by the needs of sustainable development. The process of change requires constant widening of necessary knowledge and activitiy of engineers and scientists dealing with water management. New targets require more itegrated actions, involving also new subject areas that are only indirectly connected with traditional water management issues. To these belongs, for example, management of raw materials, products and residuals, problems of soil pollution and resulting chemical contamination of agricultural products, presence of contaminants in food, influencing helth of population. Simultaneously, traditional goals of water management must be also be fulfilled while costs of maintenance and renovation of oldering water supply and sanitary systems increase parallel with age of constructions.
Sustainable develpment postulates require actions towards preservation and gradual improvement of water quality in local and regional surface- and groundwater reservoirs in all regions, protection of agricultural soils, forests and other ecological systems such as weltands, medows, rivers and lakes that constitute a base for maintaining biological diversity and, simultaneously, for food production and recreation of population in villages and cities. It may be notted that there is a general trend to widen the role of scientists and engineers dealing with water management to adress other, less typical areas, such as management of residuals, protection of rawmaterials and health protection of population. New understanding is growing among scientists and population that residuals, often classified as Agarbage≅, Apollution≅or Asolid weaste≅ may also constitute new valuable resnources, it may be visualized by following symmetrical equation:

Pollution = lost resources = pollution

Beginning with consideration of pollution problems one will arrive to the problem of lost natural resources. Starting with a problem of inefective use and lost natural resources, one will arrve to the problem of environmental pollution.

1. Drinking water

In many of European countries, age of present water supply systems is reaching, or it will soon reach, its expected life-time. It brings the necessity of large economical inputs for maintenance and renovations in order to maintain its functionality. Oldering water supply systems are exposed to chemical corrosion due to variety of substences present in urban suface runoff passing through the soil from contamianted urban surfaces. This brings further risks for water contamination and shortening of expected life-time of water pipes.

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Modern societies may be characterised by constanly increasing use of chemical substances in all branches. This brings further risks for drinking water contamination. Increasing verity and number of microorganisms in drinking water in many coutries is well documented and their toxic potential well known. For example, water-bourne microorganisms such as *Giardia Lambdia* and *Crysposporidium* bring dehydration of human organizm leading to intestinal disorders. Chemical substences called *Endocrine Disruptors,* mimic natural hormons and result in changes in a human organizm leasding to cancer, congenital defects and decreased immunnological resistance. Substences called *herbycides* and *pesticides,* used in plant protection against parasites, are constructed so that they are similar to natural hormons, but if they enter the human body, they also behave as *Endocrine disruptors. Chlorine,* used in many households and several orther liquids used in households as germ-killing sterilization agentsas, are known poisons, but its use only rairly leds to deseases. However, in a *chlorination process* Chlorine connects with some natural biogenic substances and forms a number of cancerogene agents from which *Trihalomethanes* (TTHM) are most known and connected with a risk of deseases in blader and anus. *Arsenik* in low concentrations is present in drinking water in several countries, among other in some regions of India and in several states in USA. Arsenik is connected with outbrakes of deseases and even death due to hart arest and pulmonary cancer. (Harbut, M 2000).

2. Wastewater and sludge Cadmium problem

Recently an intensive debate about the possible use of sewage sludge has been carried on within the international research community. For example, Priesnitz, (2000) states that sewage sludge has mutagenic effects, i.e. it causes inheritable genetic changes in organisms. The sludge contains heavy metals such as cadmium which accumulates in a human body during the life-time and can potentially, on a long run, cause kidney disease. Because there is evidence that heavy metals and persistent organic pollution can build up in sludge-treated soils, governments issue numeric standards for permissible concentrations of metals in soils. These standards limit permissible concentrations of Cd in sludge but plant uptake of cadmium can depend also on type of soil, rainfall volume and distribution in time, type of crops, time of growth and several other factors. There are large differences between permissible levels of Cd in sludge between countries. For example in Sweden the standard is 2 mg Cd per dry tone of sludge, while in USA 50 mg/dry tone is allowed. However for majority of other substances in sludge, many of them even not known, there is no standards nor information about their potential toxicity and accumulation pace. Cadmium content in commercial fertilisers is about 2-3 mg Cd per kg Phosphorous while in sludge Cd content is about 50 mg Cd per kg P (Lindgren 2000). It contains also many other compounds such as flame-protective chemicals, drugs, antibiotics, hormone-similar substances, bromines, dioxins, furans, PCB and others, many of the unknown. There are large differences in national standards with respect to permissible levels of cadmium in sludge, but there is no such standards for many other substances. All above mentioned and other persistent hazardous substances found in sewerage sludge will, sooner or later, enter surface water bodies and groundwater. In a longer perspective these substances may also enter agricultural products. Similar discussion in late 99-ties denoted hormonal substances found in many rivers and lakes in the country. No one can say what the long-term ecological effects and influence on human health will be.

The movement of metals and other toxins from soil into groundwater, surface water bodies, plants and wildlife is poorly understood. Soil acidity is considered as a key factor in promoting or retarding the movement of toxic metals into groundwater and accumulation in soils and crops.

The National Research Council (NERC) of the US National Academy of Sciences allows using sludge on agricultural land on a short-term, As long as soils are agronomically used. However, according Priesnitz (2000), Research clearly shows that under some conditions (which are not fully understood), toxic organic industrial poisons can be transferred from sludge-treated soils into crops: Lettuce, spinach, cabbage, Swiss chart and Carrots have been shown to accumulate toxic metals and/or toxic chlorinated hydrocarbons when grown on soils treated with sewage sludge. Thus, there is good reason to believe that livestock grazing on plants treated with sewage sludge will ingest the pollutants either through the grazed plants, or by eating sewage sludge along with the plants. Sheep eating cabbage grown on sludge developed lesions of the liver and thyroid gland (Priesnitz, 2000).
In conclusion, as yet there is no risk-proof methods of handling and use of wastewater sludges. Incineration, deposition, pelleting, and other methods that are coming, will anyway, sooner or later, result that potentially harmful substances will enter ecological systems and later on- human bodies. However, perhaps the largest error, or at least a bottle-neck of present water and sewerage systems, including water sanitation, is that these systems have no ability to safely recycle organic biogenic residuals from human settlements to agriculture.

Swedish example: Cd content in Swedish agricultural soil has during 19 Century increased by 30 %, in seeds of wheat it doubled and in kidneys of Swedish pigs and in human kidneys it increases by 2 % per year (Ahnland and Lundell, 1999).

3. Some problems connected with wastewater management

Municipal wastewater and solid wastes were traditionally considered as something unwanted, that should be in a simplest and cheapest way taken out form the cities and villages and, in a best case, deposited so that it would not bring any adverse health effects for population and environmental damages. From such understanding of human residuals emerged present water-related infrastructure in cities and other settlements, as well as infrastrcture for management of residuals, including stormwater facilities, wastewater treatment plants, solid waste deposit sites, or incinneration facilities. Presently a new trend may be distinguished: it is recognized that at lest part of residuals possess significant matrial and monetray values and, if rihgtly treated, can be changed into valuable secondary resources. It can be said that all present processes of change in understanding of problems and opportunities are a result of formulation of conditions and terms of Asustainable development≅. This notion has impossed important influence on understanding of new targets and duties standing in front of scientists and practitioners. In order to avoid missunderstandings it is worth to repeat formulation of the Afour basic conditions for sustainable development≅ according to Agenda 21 (UNCD 1992):

1. Damaging use of limited natural resources should be minimized.
2. Withdrowal of non-renewable natural resources should be stopped.
3. Physical conditions creating closed material flows should be maintained.
4. Withdrowal of regenerating resources should not exceede the spedd of their regeneration.

At stake is a lot, because these conditions decide about possibility to maintain present state of the natural environment and life-sphere of population.

4. Chosen problems connected with stormwater management

Stormwater systems existed already in times of ancient Roman civililisation. The main target was

to maintain mobility of people and wehicles. Modern cities are usually equipped with complicated systems for evacuation of stormwater from the city area. The target was to make the city less vulnerable in times of intensive rainstorms, to avoid innundations of streets and cellers, flooding basements etc.These functions are fulfilled even by simplest systems of underground conduits leding excess water volumes from the city area usually to nearsest river or other water bodies. Environmental consequences were however significant, because surface runoff carries not only water bur also pollutions that sediments in rivers and lakes changing their chemical and biological status. To give an example it is enough to say that from a small city of Lund in Southern Sweden (100 thousand inhabitants) togethert with stormwater 760 ton Cu, 171 ton Zn, 31 ton Pb i 27 ton BOD7 is woshed out to the small river Höjeå. Bottom of the river is covered with several metrs of polluted sludge that is gradually transported to near-by sea. Of couse, even more pollutants is transported uot to the sea from larger cities. This example, that is typical for the majority of present cities, cannot be considered as a unimportant problem, on the contrary, conditions of sustainable development require large investments to leasd to improvement Modern stormwater management, sometimecs called AEcological Stormwater Management≅ has been formulated and it is implemented in majority of Swedish cities as well as in other European cities.
This kind of stormwater management is based on introduction of many constructed elements such as artificial ponds, lakes and wetlands strategically placed in locations where stormwater sludge sediments on the bottom and can be periodically withdrown and deposited on solid waste hips. It can be said that these procedures do not constitute final solution of stormwater-generated evnvironmental pollution. Stormwater sludge is only concentratied, gathered and deposited. Perhaps future human generations will be wise enough to have a technology to disarm Achemical bombs≅ created by present methods of stormwater management.

5. Sanitary systems and separating toilets

General use of water closets and water-borne sanitation brings several problems. Costs of such solution are very high but biogenic substances present in wastewater are not utilized because wastewater sludge is contaminated with variety of non-organic substances and bacteria, which limits possible agricultural use. In order to make the use of Aclean≅ biogenic substances present in household watewater possible, in may European countries s.c. Aseparation sanitation≅ solutions are introduced. Solid parts of human feaces are separated from urine in specially for the purpose designed toilets. Urine is ment to be used fertilizer directly on the agricultural soil as fertilizer, solid parts are collected separately and after composting or another, more advanced process called bioconversion, also used as fertilizer on agricultural land. One problem with the use of urine as fertilizer is that it contains Cadmium that accummulates on argicultural land feertilized with urine. Questions conneted with benefits and risks with widespread use of human urine in agriculture is presently intensively discussed in many European countries but, as yet, there is no any generally accepted answer on this question.

6. The future - bioconversion

Solid wastes contain large amount of organic material that, if handled in a proper way, may constitute renewable resource, a source of clean energy and organic residuals that may be used as fertilizers instead of being wasted on solid waste deposits. In simple composting process only parts of organic material may be used, in more advanced process, called bioconversion, both solid and liquid organic residuals may be captured and utilized.in energy production and, as ferilizers, in agricultural production Thus, further development of technology providing bioconversion should be an additional target for present research and development. Since bioconversion denotes technology also dealing with liquid residuals, scientists involved in modern water management should find ways of cooperation in this area.

7. Economical risks

Taking into account present dynamic change of technologies applied in water and wastewater sector in many counties, an increasing number of experimental solutions in water supply and in other water-related technologies is to be expected to happened in a fear future. Such change and technological development is driven not only by scientists and idealism of population but also by politicians. In such climate, research institutions feel free to make more experiments with new type of water-related infrastructure and new forms of living for inhabitants. Expected benefits of such change are high but the costs of change will be immense and must be covered by the population.

CONCLUSIONS

Present water management is going through an intensive process of adaptement to the needs and conditions of sustainable development. However, both in water management as well as in present management of rawmaterials and residuals, several worrying processes and tendencies can be observed. Increasing variety of used rawmaterials, chemicals and products used in the society brings new risks for the human population manifested in increasing heath problems. This may, in perspective, lead to the necessity of revision and, possibly, significant change in approach in water management and in other sectors in order to adapt to requirements of really sustainable development. All these tendencies and threats should be known and carefully followed by scientists and practitioners dealing with water management.