Principles of Integrated Water Resources Management in Municipalities and their River Basins

Expert Document of Slovak Association of Towns and Villages (ZMOS)

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1. Introduction

Availability, sufficiency and presence of water in the environment and landscape are basic preconditions for life, social and ecological stability as well as economic prosperity. In addition, water is a strategic and irretrievable natural resource.

Water problems are caused mainly by:

1. Unequal distribution of water in space. Rational approach to water use can be achieved by adaptation to its natural presence in the landscape. This needs to be taken into account during further development of towns and villages.
2. In a given area, water supply varies throughout the year. This phenomenon is closely connected to the change of water quality. Excess volume of water during floods creates problems to local inhabitants, farmers, industries and municipalities. On the other hand, water shortage also creates problems during dry periods. Ideally, water resources should be available without significant changes in a sufficient quality and quantity throughout the year. An optimal state of water resources can be achieved through long-term and sound water resources management on the level of local municipalities as well as on the river basin level. Also, quality of water resources can be influenced by protection against pollution through strict waste water treatment, elimination of soil erosion, point or diffuse pollution sources or by other preventive measures.

Efficient management of water resources can be achieved by using the following principles:

1. Subsidiarity, according to which problems should be solved on the lowest possible level. Therefore, the role of local municipality in management of natural resources, including water, is indispensable.
2. Solidarity, according to which all stakeholders dealing with water management should not undertake such measures and activities in the upper part of the river basin that increase flood risks, deteriorate water quality and cause water scarcity in the downstream and vice versa. Therefore, local municipalities should proactively start cooperation with other stakeholders within boundaries of their respective river basins.

The main reason for compilation of the presented “Principles of Integrated Water Resources Management in Municipalities and their River Basins” (hereafter referred to as “Principles”) was absence of such principles in Slovakia. So far, absence of the principles has:

- complicated implementation of European Community directives in Slovakia and excluded public, local municipalities and land users from solving vital water management problems in the landscape
- left solving urgent water management problems of the most local municipalities into infinity
- caused inefficient use of public funds for investments which were could not be controlled by public or local municipalities, even though they were primary beneficiaries
- limited increase of competitiveness of settlements and regions

Therefore, the presented principles present a unique document, bringing benefits to communities, land users and local municipalities. It promotes improvement of water resources and prevention of deterioration and depletion of available water resources in the given area. The principles are stemming out of a detailed analysis of individual public policies in the area of protection and use of water resources; analysis of drainage conditions in the landscape; analysis of the needs of individual municipalities as well from theoretical-expert knowledge

of ecosystem and economic causalities of water cycle in the landscape. The principles enable to ensure better, cost effective and more systematic sustainable water resources management in the long-term.

A need to formulate the principles is stemming from the necessity to reflect wide decentralisation of competencies[1] and reform of public administration in the last two decades and also to address the most important global challenges such as climate change and supply of quality water for the population in close and distant future. In addition, the principles support ongoing evaluation of existing support and motivation tools as well as sustainability of investment and running costs for different areas of water management and economic activities influencing drainage regime in the landscape.

Currently, there exist enough theoretical tools to apply "good water management practice" based on integrated water resources management. However, a strong sectoral approach and the support to isolated policies, concerning water resources and their management in the landscape still prevail in reality. So far, local municipalities have not dispatched a sufficient conceptual and methodological backup as well as coordination tools to introduce principles of integrated water resources management into practice.

The process, which started with preparation and adoption of "ZMOS Strategy in the Area of Flood Defence and Protection of Towns and Villages against Floods[2]" (hereafter referred to as "ZMOS Strategy") in fact has triggered preparation of the principles. As a part of the preparation of the ZMOS Strategy, ZMOS experts also participated in the formulation of a new water paradigm[3], an expert document describing ecosystem and economic causalities of water cycle in the landscape. The principles were developed on the basis of a synthesis of current experiences and in close cooperation with the ZMOS Permanent Working Group on Integrated Water Resources Management which during its first ten meetings in 2008 addressed a broad range of principal questions concerning management of water resources in the landscape. Since adoption of the Strategy in April 2007, ZMOS has facilitated multi-sectoral cooperation and mutual cooperation of all main stakeholders in the area of water management which resulted into compilation of the necessary background documentation and information for formulation of the principles.

[1] The following original competences of local municipalities are the most important in the area of water management: supply of drinking water and treatment of waste water and also acquisition of landscape planning documentation. In the frame of transferred competencies from state administration, local municipalities deal with protection against floods, especially by coordination of respective activities on the level of village or town.

[2] On 26 April 2007, 17th Plenary Session of ZMOS approved with a resolution in the point II.8, a proposal of the Strategy as a basis for expert discussion and further steps of the Association of Towns and Villages in this area.

[3] "Water for the Recovery of the Climate - A New Water Paradigm", Municipalia Inc., September 2007

2. Analytical part

2.1. Identification of significant water management problems

Identification of significant water management problems in river basins belongs to compulsory part of EU Water Framework Directive implementation in Slovakia[4]. Current surveys and analyses of the ZMOS identified following most significant water management problems on the level of local municipalities and their respective river basins.

In the area of physical status of the landscape
- high level of soil erosion and damaged water retention ability of basins and micro-basins
- loss of functional vegetation in the landscape
- high flood risks due to improper land structure and undesirable economic, technical and operational processes, carried out in the landscape
- deterioration of the environment and damage to ecosystems on the whole territory of local municipality
- climate change, decrease of ecological stability and protection against negative effects of water, increase of water shortage in the landscape

In the area of water quality
- inadequate level of waste water treatment, lack of complex and complete waste water treatment systems
- point and diffuse pollution of ground and surface waters caused by lack of efficient protection and prevention measures at pollution source
- water surfaces and water courses sedimentation and their pollution with waste, coming from different sources

In the area of water availability
- lack of public drinking water supply or easily accessible source of drinking water
- water shortage (underestimated volume of available water during development of towns and villages, extension of dry periods, decrease in stocks of water resources as a result of climate change and overall management in the landscape)

In the area of water economics
- regulatory restrictions on water pricing
- high costs for construction and completion of existing drinking water and waste water treatment systems
- inefficient rainwater management and use, especially in the urban environment

In the area of institutional capacity
- absence of coordination bodies for integrated water resources management on the national level, river basin level and also on the level of local municipality
- inadequate communication among stakeholders dealing with water policy (policy and decision-making bodies versus broad spectre of water users)
- absence of specialised expert and advisory body for municipalities on integrated water resources management

[4] In December 2007, Ministry of Environment has published a tentative review of most significant water management problems through Water Management Research Institute website. Ministry of Environment is responsible to consult the draft review with main stakeholders (municipalities, industry and agricultural sector) by June 2008.

In the management area

- principles of integrated water resources management are not applied in practice
- inadequate administration of small water courses
- lack of area protection of water resources in the landscape
- lack of new forms of management and cooperation to improve rainwater management and elimination of soil erosion
- non-existence of local water planning which should become an obligatory background document for elaboration of local landscape plan

Example No 1: A typical water management problem of the local municipalities - treatment of waste water in agglomerations

The current approach to development of projects for construction of public waste water systems in agglomerations lacks principles of integrated water resources management, analysis of economic sustainability and proposal for alternative, decentralised systems for drainage and treatment of municipal waste waters. So far, one of the main criteria for development of projects within agglomerations has been to use financial resources from the given fund rather than assessment of economic feasibility of the project. Therefore, local municipalities have invested huge amounts of financial resources into development of projects with a questionable result. Generally, agglomeration projects are based on construction of the centralised systems for waste water treatment, out of which a large amount of financial resources are assigned for transport of waste water in a sewage system in-between local municipalities. In such centralised systems, waste water is treated in one central waste water treatment plant. These projects (whether they are in different stage of project documentation development, construction permit or different construction stages) have to be re-evaluated against the principle No 6 (see page 13). A large part of project documentation, land preparation or so far constructed infrastructure will be further used to build up sustainable waste water treatment systems. A need to change prepared projects and some projected parameters has to be applied in most projects. One of the advantages is that these changes will bring benefits in form of public funds savings which might be used to build up waste water treatment plants in local municipalities lacking waste water treatment, sewage system or both.

In cases when the project documentation for public waste water treatment and sewage system has not yet been prepared, Global Water Partnership Central and Eastern Europe recommends book entitled “Sustainable Sanitation in Central and Eastern Europe: Addressing the Needs of Small and Medium-Size Settlements” especially for rural municipalities. During development of the waste water treatment project, the publication advises to use “Open Wastewater Planning” methodology. The Open Wastewater Planning proposes several alternatives of the possible solution, which are later finely tuned by an open dialogue between local municipality and experts, in order to find the most efficient solution, in line with environmental regulations and at the same time, socially acceptable for local inhabitants.

Example No 2: A typical water management problem of the local municipalities - protection of the land against floods and decrease of flood risks

There exists a contradiction between existing knowledge on flood causes and implementation of the policy to eliminate or resolve flood causes in current flood protection practice. Currently, Slovak Water Management Enterprise with its branches (river basin administrations) deals with protection of the landscape against floods. For the protection of land, it uses mainly line elements, connected to river bank line, flood area boundaries or retention area. In the daily practice are therefore solved mainly consequences of floods, not their causes. Floods also occur as a result of isolated management of activities influencing drainage regime in the landscape. Agricultural sector including farmers and forest administration is the most accountable for flood risks in the range of 60 to 70%. Other sector, significantly influencing flood risks, are local municipalities (in the range of 10 to 15%), in case they drain rainwater through public sewage system. A state of the river basin network (depending on range

of water courses adjustments) and measures for protection of the landscape against floods contribute to increase or decrease of flood risks with 15 to 30%. Farming and forest practice contribute to elimination of flood risks to a limited extent. River basin administration has no competencies to influence this unfavourable condition. Similar reasons have led local municipalities to passively bear consequences of unsuitable management of water resources and soil on their own territories and respective river basins. This is more paradox given the fact that billions of Slovak crowns have been earmarked annually for direct payments on surface. An example of such unsuitable practice and lack of integrated water resources management in the protection of landscape against floods is practically zero emphasis on surface flood prevention measures in the given area where surface run-off is originated and shaped. The current financial rules cause delay in reimbursement of costs for rescue and other works in case of floods and therefore obstruct operation of villages with limited budgets and early remedy of the area after flood events.

2.2. Ecosystem context of water cycle in the landscape

We have to closely monitor water with regards to soil and water regime changes in the landscape, which are co-formed by structure and surface of the land. In parallel, it is necessary to monitor water cycle in nature and river basin from the point of view of sun energy flows and transformations. The energy coming from sun causes evaporation of water in the landscape and is also a primary energy source for dynamic process in ecosystems. Inadequate evaporation from land surface therefore shifts a significant part of transformed sun energy from energy used for evaporation into energy notably heating the landscape. It thus changes energy streams in the landscape which influence change of micro-climate with many negative consequences (See Chapter 2.4 Implications of traditional water resources management in the landscape). A synergic effect to the above mentioned phenomenon as well as increased ground water abstractions, improper agro-technical practices and global climate change is a continuous decrease of stocks of water resources in the river basin (in the long term) and especially water stored in soil profile and ground waters. The soil profile and its background are the most significant and the biggest natural retention area in river basins and landscape which more than ten times exceeds retention volume of all water reservoirs in Slovakia and immediate volume of water in the whole river network in the country.

2.3. Economic context of water cycle in the landscape

Water resources management is influenced or provided by different sectors, economic activities or parts of infrastructure which influence run-off conditions in the landscape. We present the basic overview in the table bellow.

Type of infrastructure / network / system or unit	Quantification in volume / surface	Share of public resources
Hydro melioration systems	Approximately 450,000 hectares and hundreds of kilometres of drainage channels	Costs for construction of the systems and internal debts of existing hydro melioration systems
Irrigation systems	Approximately 350,000 hectares	Costs for construction of the systems, price of water used for irrigation
Urbanisation of the environment	Annual increase of build areas in the landscape	Costs for construction of public spaces, buildings and infrastructure (especially transport infrastructure) and its share on total construction in the landscape
Farming practices	Agricultural land acreage	Costs for payments per area, other

		subsidies and compensations
Forest management	Forest land acreage	Costs coming from public resources, other grants and/or compensations
Waste water treatment, rainwater drainage from reinforced surfaces	Current level of connection to public waste water treatment system is approximately 54%	Costs for waste water treatment systems build up and costs for treatment of waste waters
Disinfection and supply of drinking water	Current level of connection to drinking water system is approximately 84%; extraction of water for preparation of drinking water	Costs for drinking water systems build up as well as secure of preparation and supply of drinking water
Water courses adjustments	8,125 km of adjusted water courses, protection dikes in the total length of 3,127 km	Costs for realisation of water courses adjustments and related constructions; investment plan of Slovak Water Management Enterprise for flood defence projects in the total amount of 25 billion SKK (€806 million)
Water courses administration (Slovak Water Management Enterprise, State Forests, other water courses)	Length of administered water courses network 38,183 km, out of which 8,125 km adjusted	Costs for administration and maintenance of water courses network
Water courses administration - state and army forests as well as other administrators	Other small water courses in the length of 18,717 km, out of which 4,247 km has not been settled	Costs for construction and maintenance of water courses network and other related investments

In the system of water management financial support and financial tools, there is also Environmental Fund (in the form of grants and loans) and the co-financing from European Union funds for water management sector (in the shortened programming period 2004-2006 through Operational Programme for Basic Infrastructure and in the current programming period 2007-2013 through Environmental Operational Programme).

To the above mentioned costs of the public sector, we have to include also financing of the state institutions, dealing with water management, such as Water Management Construction, Slovak Water Management Enterprise, Slovak Hydrometeorological Institute, Water Management Research Institute and others. A significant part of economic side of water resources use and protection forms payments for abstraction of drinking water and deriving waste waters, paid by water utilities and operators of small municipal drinking water and waste water systems.

Economic causalities has to be perceived in the context of damages from natural disasters

Assessed period	Type of accrued damages	Extent of damages
1997 - 2006	Flood damages	17 billion SKK (€548 million)
2007 - 2013 (estimate)	Flood damages and damages from drought, forest fires, whirlwinds and other natural disasters	35 - 100 billion SKK (€1.129 - €3.225 billion)

As we can see from the above mentioned table, there are sufficient financial resources in the system. However, the system is lacking integrated approach to harmonise funding schemes, to save public expenditures and at the same time to solve need for protection of water and soil in the landscape.

2.4. Implications of traditional water resources management in the landscape

- Advancing soil erosion in the landscape
- Decreasing biodiversity and presence of functional vegetation in the landscape
- Deteriorating quality of available water resources and increasing investment costs for drinking water supply
- High costs for construction, operation and reproduction of public waste water treatment plants and especially for centralised sewage systems
- Drying up and warming up the landscape
- Changes in the long term precipitation levels and stocks of water resources in the landscape, time and spatial changes in the distribution of precipitation (in the area as well as during the year), increasing trend of extreme weather events occurrence and their consequences (floods, droughts, heat waves, forest fires, etc.). The changes are caused by modifications of original water regime during transformation of the landscape
- Low awareness of water and soil users about their co-responsibility for sound protection of water resources
- Minimising influence of the community and local municipality for management of water resources in their cadastre area. Municipality and the community rather passively bear consequences of inadequate protection and use of water resources and soil in their own territory and respective river basin

3. Synthesis part

3.1. Formulation of integrated water resources management principles

3.1.1. Public interest in the area of protection and use of water resources on the territory of local municipality

The public interest in the area of protection and use of water resources is a strict protection of soil and water as well as sustainable water resources and soil fund management on the territory of individual settlements and their respective river basins. The public interest can be also defined as a provision of drinking water to local inhabitants, waste water treatment, minimising flood risks in the river basin and within municipalities and finally, provision of appropriate system for the protection against floods.

3.1.2. Definition of integrated water resources management

Integrated water resources management (IWRM) is a complex process of water resources use and protection which respects water cycle in ecosystems and stability of water regime in the landscape. In addition, it can be used to assess impacts of water abstraction from ecosystems and back to nature. The most internationally used definition of IWRM is as follows: IWRM is a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems“[5].

3.1.3. Principles for sustainable protection of cadastre areas of towns and villages against floods

These principles can be defined as fundamental objectives to secure sufficient quantity and stability of the water resources in the given territory. They were defined in the ZMOS Strategy as follows:

- Principle of spatial protection of water and soil in the river basin
- Solidarity principle (water tolerance principle)
- Partnership principle
- Subsidiary principle
- Sustainable solution principle
- Principle of auto-regulation of the processes in nature

Also, they are a basis for the presented principles which create suitable conditions for improvement of qualitative and quantitative regime of water in the river basin. They are a pre-condition to achieve a good water status and also a good status of soil in river basins, human settlements and communities. The ZMOS Strategy mentions that a temporary exemption can be applied in case of protection against floods, when flood wave comes from neighbouring countries.

[5] Global Water Partnership Technical Advisory Committee (TAC): TAC Background Papers No. 4: Integrated Water Resources Management; © Global Water Partnership, 2000

3.1.4. Principles of integrated water resources management in municipalities and their river basins

1. Principle of spatial protection of water resources in landscape and prior implementation of spatial flood prevention measures in river basins

In nature, water cycle has almost no boundaries. The only natural boundaries are boundaries of the river basin. Each and every cadastre of the municipality in fact presents a sub-basin, a part of the river basin. If water resources in the river basins are not protected according to the principle of spatial protection of water resources, it leads to disruption of water cycle in landscape and subsequently to a negative change of water regime with many consequences.

In the landscape, technical measures such as redundant straightening of water courses or unreasonable water drainage by melioration systems and channels should not be applied to speed up water drainage. Therefore, existing system of water and rainwater management should be principally changed and respect the following steps:

1. Retention of as much as possible water and rainwater in the landscape "in situ" through:
   - Implementation of surface anti-erosion measures and
   - Implementation of measures to improve water retention capacity of the river basin
2. Water courses shall drain only natural surplus water from the river basin

The following measures shall be applied in the system of flood protection:

1. prior implementation of spatial flood prevention measures:
   - anti-erosion measures
   - water retention measures
   - as well as other prevention measures (e.g. economic) to decrease flood risks
2. up to date documentation which enables implementation of necessary measures in case of floods:
   - up to date flood defence plans
   - determined and prepared flood areas
   - determined and prepared flood corridors in settlements and retention areas within and outside human settlements
   - technical objects for controlled discharge of water into flood area
3. secondary technical facilities for the protection of land:
   - technical and various supplementary protection measures of surface, line and point nature such as dry polders, adjustment of river banks and dikes. However, this should be applied only in case the measures mentioned in the points 1 and 2 have been exhausted.

Basic structure of costs for flood prevention measures in landscape

Main costs related to implementation of flood prevention measures include:
A. costs for development of studies, plans and projects
B. costs for implementation of flood prevention measures in municipalities[6].
C. costs for maintenance of realised measures.

[6] Average one-shot costs are approximately 6,000 SKK (€195) per hectare, out of which within local municipality approximately 10,000 SKK (€325) to 100,000 SKK (€3,250) per hectare and outside local municipality approximately 2,000 SKK (€65) to 50,000 SKK (€1,615) per hectare.

2. Principle of respecting importance of rain water as well as the role of landscape in rain water distribution

Water and soil are the most valuable assets of the local municipality. Rainwater is a primary source for replenishment of water resources in the landscape and ecosystems. Rainwater which falls down to its cadastre is therefore an asset which has to be protected and rationally used.

In distribution of rainwater, landscape has three basic functions:

1. optimally infiltrate water to the soil profile and underlay, based on their natural physical parameters
2. create favourable conditions for water evaporation from soil, plants, water bodies and surfaces
3. drain only natural surplus water from basin through the river basin network

Transformation of the landscape changes its natural functions (usually non-reversible and negative) and therefore influences water regime from balanced to mainly imbalanced. Water regime is then influenced (qualitatively as well as quantitatively) by water courses adjustments, hydro-melioration and drainage systems (drained water should be monitored and balanced), build up of surfaces with solid and water proof material (build up areas are growing each year), irrigation systems (positive only when do not deteriorate physical and chemical parameters of soil and watered grounds), soil and forest management practices, rainwater management in build up areas of towns and villages, ways of waste water treatment and sewage, water abstraction for preparation of drinking water and other purposes.

Rainwater in urban environment should not end up in sewage system but be available for infiltration into underlay, watering of public green spaces and other plants in town or village, evaporation, or accumulation along buildings and build up areas. Later, temporarily surplus water can be used for different purposed such as watering, increase of urban space humidity or as a utility water. Temporarily surplus water can be therefore used to prolonge evaporation or infiltration of rainwater into soil in dry periods.

Rainwater used for evaporation in urban areas has positive cooling effects. Use of this principle is closely related to increase in share, number and quality of plants and green spaces which depend on sufficient water supply for watering and energy from sun. In urban space, better watered plants and more humidity are better from point of view of hygiene and also create better health conditions for local inhabitants.

Example No 3: Development of water resources in the cadastre of local municipality
In the territory of local municipality with an average area of 1,750 hectares and average annual precipitation 750 mm, falls 13.125 million m^3 of water per year. Therefore, 7,500 m^3 of water falls down on one hectare of arable land. Similarly, roof of an average individual house (10x10 meters ground plan) retains 75 m^3 of rainwater annually. If we count a theoretical price of raw water in the amount 10 SKK (€0.30) per m^3 then its value in financial terms presents a significant potential of the territory. However, this potential can not be fully used because half to two thirds of water evaporates and one third derives through ground water and surface waters. These figures differ depending on soil type, its state as well as use and development of water resources. This is only an illustrative example which intends to increase awareness of the public and local municipalities to actively use the potential which they have indirectly at their disposal, offered for free from the nature.

3. Principle of cooperation and merging land and building owners and co-owners in order to protect and use rain water and to protect soil against erosion

In order to protect and use rainwater and soil against erosion in towns and villages or in the landscape, it is advisable to establish cooperation with property and land owners, including co-owners. For urban environment, water communities with similar principles as communities of flat owners could offer platform for cooperation. In the landscape, Water Farms can be an alternative to Water Communities. **Water Communities** will be created in order to efficiently manage rainwater in towns and villages and could be represented by associations of flat owners, owners of neighbouring properties and municipalities. **Water Communities** will be focused on raising funds for building and operation of storage accumulation and use of rainwater systems, such as infiltration, watering of public green spaces and use of utility water. **Water Farms** will be based on introduction of active rainwater harvesting into existing farming practices in open landscape and on multipurpose use of water. Therefore, Water Farms might have a positive role in agricultural land. They will support anti-erosion and water retention measures and positively influence development of vegetation cover. These water surfaces could be used for recreational purposes, fish farming, and breeding of water fowl or biomass production.

4. Principle of assessment of an impact of planned construction, investment and economic activities on water cycle in the landscape

During landscape planning, Strategic Environmental Assessment and issue of construction permits, it should be assessed to which extent the planned construction, building or activity contribute to reduction of some functions of landscape, specified in the point 2. It is also necessary to assess whether building contractor, investor or an operator of planned activities proposes compensation measures, e.g. accumulation of rainwater from roofs, infiltration into soil, and creation of public green spaces or water reservoirs to support evaporation into local environment. However, compensation measures have to be analysed from point of view of their environmental impact and applicability for a given location.

5. Principle of reassessment of present land adjustments which influence water balance and water regime of the landscape during future implementation of integrated water resources management

Current changes of landscape influence water regime to a various extent either negatively or positively. Therefore, it is necessary to identify the most important interventions in the local municipality which negatively influence landscape water regime. The next step would be to propose measures to eliminate negative consequences or to remove reasons of the negative interventions into local environment. The measures will be proposed during preparation of the local integrated water resources management plan. This principle enables positively influence water regime, consisting of surface, ground waters and rainwater, within local municipalities. At the same time, it is necessary to investigate positive or negative impacts of surface waters flowing into cadastre of the local municipality. If necessary, it is advisable to propose and discuss remedial measures with representatives of municipalities located upstream, in order to put an end to any unfavourable conditions which might occur. The goal of this principle is to limit and eliminate unnecessary water draining from cadastre of the local municipality. However, this principle shall not be applied against interests of people, living downstream. Naturally, all the principles should be planned and implemented in line with valid legislation and regulations.

6. Principle of sound waste water treatment and economic analysis of the most cost effective system of drinking water supply and waste water treatment and sewage system

In order to avoid pollution of surface and ground waters, waste water has to be treated on the whole territory of local municipality. Local population, municipality and the region will benefit from strict treatment of waste waters and healthy environment. The best approach is to treat waste waters as close as possible to the source of pollution. To provide for public drinking water supply and waste water treatment including sewage system, it necessary to carry out economic analysis of investment and operational costs per equivalent inhabitant. According to the basic economic principle, the most efficient solutions per one equivalent inhabitant have to be supported. This will also answer a basic question of the most appropriate system - centralised or decentralised - for waste water treatment in the given community or local municipality. In practise, the calculation has to take into account different conditions - municipality with waste water treatment plant and sewage system, without sewage system but with waste water treatment plant, without sewage system and waste water treatment plant, with sewage system in construction and combination of above mentioned situations. Similar approach has to be applied during calculation of investment and operational costs for public drinking supply system.

To apply the principle during proposals for waste water treatment and discharge and drinking water supply, it is necessary to use "Open Wastewater Planning". It means that the designer should prepare several alternatives considering environmental and health criteria. Then, local population will have an opportunity to discuss and select the most appropriate alternative to suit the best specific conditions and real needs of the local municipality. In case of waste water treatment[7], it recommended to prepare at least one "traditional" solution consisting of the waster water treatment plant and the public sewage system. The next options should represent alternative or decentralised systems for waste water treatment. Economic analysis shall be a necessary part of the study. The final draft of the study should be again discussed between local inhabitants and the designer team. Result of the dialogue will be a final decision on the waste water treatment and sewage system. Realisation project for waste water treatment should be therefore prepared only after this stage.

The proposed process might seems to be long and complicated, however, ensure transparency and ownership of the local population which has been informed about economic and environmental alternatives and in fact participated in the selection process. There is a high possibility that local municipality will be satisfied with the project because it will not differ from its expectations regarding construction and operational costs and technological effectiveness of the waste water treatment system.

Through Open Wastewater Planning, we can control from the very beginning fulfilment of a requirement to store water in the landscape. Also, we should avoid drainage of rainwater by the public sewage system. Using of this principle create better conditions not only for renewal and reproduction of existing drinking water and waste water treatment infrastructure but also for active use of rainwater in the landscape.

[7] Igor Bodík, Peter Ridderstolpe: Sustainable Sanitation in Central and Eastern Europe: Addressing the Needs of Small and Medium-Size Settlements; © Global Water Partnership Central and Eastern Europe, 2007

During designing of a new or reconstruction of existing waste water treatment systems, we have to take into account the following proposals or principles

- Split municipal waste water from rainwater as well as water from special businesses (industrial plants, hospitals, etc.)
- Minimise diluting of waste waters
- Support nutrient recycling
- Minimise or eliminate drainage of rainwater into the public sewage system - if possible, all rainwater should be used in the territory of village or town
- Achieve at least minimum quality for treated water, defined by the legislation
- If possible, not to derive treated water directly into streams but to infiltrate it into selected green spaces, use it for watering of biomass production fields, etc.
- Insist on observing high quality of construction works and building materials by the contractor
- During reconstruction of sewage system networks, it is necessary to gradually reduce number of connections for rainwater draining and to support revitalisation of the local environment through use of rainwater
- In case of "traditional" waste water treatment plans, to build up only economically feasible lengths of sewage system networks

During designing of public drinking water supply systems, it is necessary to use economic criteria, i.e. the lowest price for construction and operation of the drinking water supply system per one user and:

- To maintain and keep prescribed drinking water quantity and quality
- To ensure necessary renewal of the network, protection of water resources and investments into development of new technologies
- To minimise water losses in the pipe network
- To build only economically feasible lengths of drinking water supply networks

7. Principle of water efficiency and water recycling

During water resources management, it is logical and effective to return used water back to local ecosystems and to minimise discharge of treated water into recipients. Waste water treatment systems should use the following chain: water-soil-nutrients-energy, which enables self-financing many activities in the presented chain. On the local level, public buildings, public infrastructure buildings or stakeholders (farms, schools, etc) might build up their own closed systems for use of rainwater, waste water treatment and recycling of used and treated waster, e.g. for irrigation of technical plants. Use of recycled water and rainwater should be calculated into the total water consumption per equivalent inhabitant.

8. Principle of establishment and implementation of real water pricing

Price of water should take into consideration real costs for drinking water provision and supply to households including relevant reserves for renewal of drinking water supply and waster water treatment systems. Therefore, regulation of water price should not distort free market and limit ability of drinking water/waste water treatment systems operators to secure necessary renewal of infrastructure and to create reserves for investments. Large scale implementation of more sustainable water resources development, management and use in line with principles mentioned in this document, will create stable conditions for

replenishment of water resources. In addition, sound waste water treatment and elimination of pollution caused by waste dumps and other point or diffuse pollution sources may reduce pressure for future increase of price for preparation and distribution of drinking water. Integrated water resources management, realised according to the presented principles will contribute to continuous improvement of ground and surface waters quantity and quality in the landscape and therefore limit unnecessary transport of drinking water over long distances. We can also take into account positive development of water balance in the territory of local municipalities and subsequently in the river basins.

9. Principle of preparation and approval of municipalities integrated water resources management plans as a local part of river basin management planning process

One of the basic preconditions for integrated water resources management is to include local element into water planning in the flowing order: municipality-river basin-national level. The principal rules and instructions should be developed first on the national and river basin level (sub-national). This approach is also in line with legal responsibilities of the Slovak Republic towards European Commission. EU Water Framework Directive supports elaboration of integrated water resources management principles and rules on the local level.

Preparation of local integrated water resources management plans is closely related to analysis of the actual status of sub-basin, i.e. river basin on the territory of the town or village, assessment of the status and finally a proposal of measures to eliminate unfavourable conditions and to reach good water status. On the local level, integrated water resources management plans should be prepared in cooperation and consensus with all stakeholders, they should respect integrated management principles and present a public interest in the area of water protection and use on the territory of local municipality. Local level, i.e. level of the local municipality is the most appropriate level to put principles of integrated water resources management into practice. Therefore, it is advisable and necessary to prepare a methodology for local municipalities on how to prepare integrated water resources management plans. It should be also in line with the methodology for the preparation of EU Water Framework Directive river basin management plans

Proposal for optimal system of water planning in Slovakia

National level	Water plan of Slovakia	Responsibility of the Government of Slovakia
Basin level	River basin management plans	State Administration, State Enterprises and Institutions
Local level	Local Integrated Water Resources Management Plans*	Initiative of Local Municipalities

* including planning of activities which are formulated in above mentioned principles

3.1.4. Main tools of integrated water resources management

ZMOS Strategy defined four main tools to implement the Strategy in practice:
1. preparation and implementation of flood defence measures in the local municipality
2. establishment of ZMOS Competence Centre to act as a support, methodological and advisory centre for towns and villages
3. establishment „River basins self-administration“ as a platform for cooperation of towns and villages within hydrological basin boundaries and also for advocating principle of solidarity in the river basins
4. formulation of a new water paradigm – expert document describing mechanisms of floods causes and a new approach to elimination of floods and related damages

The following main tool for implementation of integrated water resources management are linked to the tools as defined in the above mentioned ZMOS Strategy:
1. Methodology for preparation of integrated water resources management plans of municipalities, including its design, distribution, awareness raising and broad application in practice
2. Establishment of multi-sectoral coordination bodies for integrated water resources management on the national level, river basin and local level
3. Decentralised information system for spatial coordination of self administration of river basins, it development and access
4. Projection of integrated water resources management plans of municipalities into landscape plans, Plans of Economic and Social Development, budgets of towns and villages as well as into their generally binding regulations

3.2. Program of measures for solving the most significant water management problems in local municipalities and their river basins

Physical status of the landscape
- a need to eliminate flood risks through preparation and implementation of flood defence measures:
  - preparation and implementation of surface anti-erosion measures in the landscape; implementation of the best farming practices
  - preparation and implementation of the measures in order to increase water retention capacity of the river basin and the landscape
- restoration of the functional vegetation in the landscape and improvement of agricultural land structure
- rainwater in the landscape has to be actively used to support surface and plant evaporation, infiltration into soil, public green spaces watering and other purposes with the overall aim to minimise its drainage by public sewage systems
- put an end to ineffective water drainage from the river basin; restoration of landscape water cycle
- implementation of integrated water resources management in the landscape and fulfilment of all requirement of the EU Water Framework Directive

Water quality

- sound treatment of waste waters in all settlements and communities
- elimination of soil and ground waters point and diffuse pollution sources
- sound protection of soil fund (introduction of Best Farming Practices), prevention measures, cleaning of water courses, surface water and their respective river basins from waste

Water availability

- creation of conditions to ensure economically viable and sustainable access of local inhabitants to drinking water supply
- preparation and implementation of strict flood prevention measures in order to improve water regime in the landscape as well as stocks of water resources

Economic tools

- in the shortest possible time, to introduce real water prices through continuous deregulation and to solve social aspects related to water price increase
- apply open planning during designing of waste water treatment systems which could help to fully assess possible alternatives and to identify economically acceptable solutions, especially in small rural settlements
- create and develop new support and motivation tools (through new grants systems, bonuses, charges and adjustments of priorities in the Structural Funds Environmental Operational Programme, Rural Development Programme, etc)
- recycle water to possible maximum extent, and strictly implement measures for local use of water

Institutional problems

- establishment of multi-sectoral coordination bodies on the flowing levels:
  - national level (ZMOS / Ministry of Agriculture / Ministry of Environment / Slovak Water Management Enterprise / State Forests / representatives of private landowners and farmers / Slovak Agriculture and Industry Chamber / Association of Flat Owners, etc.)
  - river basin level - river basin administration, local municipality representatives (river basin self-administration) as well as other social and economic partners in the river basin (farmers, forest administration, non-governmental organisations, industry)
  - local municipality level - cooperation of social and economic partners, local inhabitants, land and building owners and co-owners
- support to regular dialogue, communication and sharing of experiences. Activity of expert groups for updating water legislation and innovation of support and motivation tools
- preparation and establishment of ZMOS Competence Centre to support expert capacity building in regions, to advise and further develop expertise

Management level

- acceptance and application of integrated water resources management principles in the territory of local municipalities and their respective river basins. Update of water legislation, conceptual and strategic documents in the area of water management and agriculture. Updating and increasing efficiency of financial support and motivation tools
- re-evaluation of small water courses administration system and increase efficiency of their administration efficiency
- set up environmental goals in the area of water protection according to EU Water Framework Directive. Assessment of investment, construction and economic activities an

impact on water cycle in the landscape. Revaluation of current landscape adjustments influencing water regime and water balance in the given area
- preparation, establishment and activation of Water Communities within local municipality and Water Farms in the landscape. Public participation, including land and building owners and users during planning processes and management of water resources
- preparation and implementation of anti-erosion projects and measures for water retention in the local municipalities and their respective river basins. Preparation and approval of municipal integrated water resources management plans as a local part of river basin management plan and water plan of Slovakia

3.3. Summary of main activities and framework plan for future activities

Since the last ZMOS General Assembly in 2007, ZMOS has made the flowing achievements in the area of integrated water resources management:
- Prepared and presented expert document "Water for the Recovery of the Climate - A New Water Paradigm"[8]. The document was presented during the conference "Water and Climate in Europe" on 17 September 2007 in Bratislava
- Organised presentations and public discussions about the "Strategy of ZMOS in the Area of Flood Prevention" in the occasion of more than 20 conferences and seminars
- Raised awareness on water resources management on www.zmos.sk and www.municipalia.sk specialised websites and on weekly Obecné noviny, dedicated to local municipalities
- Organised a joint meeting with main stakeholders dealing with water resources protection and management on 19 February 2008 at the ZMOS Office. The meeting participants included representatives of Ministry of Environment, Ministry of Agriculture, Slovak Water Management Enterprise, Association of Water Utilities, Global Water Partnership Slovakia, ZMOS Office and Council as well as ZMOS Deputy representative
- From January to April 2008, 12 meetings of the Permanent Expert Group of ZMOS for Integrated Water Resources Management, were organised
- Prepared and carried out questionnaire survey on the state of water resources protection and use in the territory of local municipalities
- Investigated possibilities to create an information system including geographic information system for spatial data processing concerning water resources on territories of individual municipalities and river basins

The following mechanisms have to be used in order to implement integrated water resources management principles into practice:
- update of water legislation and use of existing legislation[9] - in the period of 2008-2009
- analyse existing financial tools, propose and possibly advocate new support and motivation tools - in the period of 2008-2010

[8] The document is available online on www.vodnaparadigma.sk

[9] The following existing legislative tools can be used: Environmental Impact Assessment, Strategic Environmental Assessment, landscape planning and preparation of Territorial Systems of Ecological Stability (USES) plans, land use planning and building permits, land reforms and implementation of European Communities Directives.

- actively cooperate in updating of conceptual documents in the area of water management and agriculture - continuous
- support spatial coordination and decentralisation through creating and running information system for river basins self-administration, using Geographic Information Systems (GIS), spatial data collection and analysis - in the period of 2008-2009
- build up necessary human resources through education, increase of engineering and designing expertise in the regions, and to raise awareness on integrated water resources management - continuous

3.4. Integrated water resources management benefits

- surface protection of water against pollution
- surface protection of soil against soil erosion
- improve of water resources management in the area of individual towns and villages
- more efficient use of public administration funds
- increase of public participation during water planning processes
- all land and soil owners in the given area should take co-responsibility for the protection and use of water resources and soil fund
- Accelerate and increase economic efficiency of the following:
  - achievement of good water status according to the EU Water Framework Directive requirements
  - completion of public drinking water supply and waste water treatment systems
  - decrease of flood risks through improvement of landscape structure and water planning
- secure treatment of waste waters in local municipalities regardless of their size as soon as possible and in the most cost efficient manner
- improvement of opportunities to recover new water sources or to complete and maintain existing water resources in order to secure drinking water for local inhabitants
- extensive contribution to elimination of negative consequences of climate change in the landscape through elimination of causes of local and regional climate change. The climate change is a result of water regime change during adjustments of natural landscape into cultural landscape without compensation, adaptation or other protection measures to secure stability of water regime and to protect water cycle in the landscape
- development of cooperation among local municipalities and all sectors including land and property owners located within natural river basin boundaries
- improvement of integrated spatial planning and construction permits
- decrease regional disparities since the presented principles can be applied in the territory of local municipalities and communities regardless of their size as well as within land users
- the expected saving of public funds (state and municipality) on the projects for design and construction of public waste water treatment plants (including sewage systems), public drinking supply systems and flood defence measures against the current (traditional, not integrated) approach is 40-50%. The estimate comes out from the comparison of national and international economic parameters of proposals.

4. Conclusions

The presented principles[10] present innovative conceptual and expert document[11] of local territorial self-administration[12], describing harmonised approach for optimal assurance of local municipality tasks in the area of flood protection and prevention, drinking water supply, waste water treatment and improvement of the environment in general.

The principles are summarised in the document which:
- create a solid conceptual base for further theoretical and practical elaboration of questions concerning integrated water resources management in the landscape
- make possible to fully develop necessary educational and information activities in regions and municipalities
- make possible a broad implementation of the principles in daily work

[10] The text has not been subject to language editing

[11] The Association of Towns and Communities of Slovakia thanks the Global Water Partnership Slovakia for the translation of this document *Principles of integrated water resources management in municipalities and their river basins* into the English language (May 2008).

[12] The document was presented during a seminar "Integrated Water Resources Management in the territory of local municipality", organised as expert side event during Coneco 2008 Expo and subsequently discussed and approved during the joint meeting of expert sections for environment and agriculture of the ZMOS Council on 3 April 2008 in Bratislava. On May 15, 2008 the 18th General Assembly of ZMOS took into account *Principles of integrated water resources management in municipalities and their river basins* as strategic document and basis for expert discussion and further steps of the Association of Towns and Communities of Slovakia in this field.

5. Annexes

Tab. 1 Framework of the most significant water management problems and measures for solving of the problem

Most significant water management problems	**Measures for solving of the problem**
Physical status of the landscape	
High level of soil erosion	Preparation and implementation of area anti-erosion measures in the landscape; improvement of soil management
Damaged water retention ability of basins and micro-basins	Preparation and implementation of measures to increase water retention capacity of river basins and micro basins
Loss of functional vegetation in the landscape	Restoration of the functional vegetation in the landscape with an emphasis on public green spaces watering (within local municipalities) and improvement of agricultural land structure (outside local municipalities)
High flood risks due to improper land structure and economic activities, including agricultural practise	Elimination of flood risks through preparation and implementation of flood prevention measures
Deterioration of the environment and damage to ecosystems on the territory of local municipality	Implementation of integrated water resources management principles in the landscape and also during renewal of water regime. The measures will lead to restoration of ecosystem and increase of biodiversity
Climate change, decrease of water security and stability of the landscape	Elimination of ineffective water draining from the river basin and restoration of landscape water cycle
Water quality	
Inadequate level of waste water treatment, lack of waste water treatment	Strict treatment of waste waters in all settlements and communities
Point and diffuse pollution of ground and surface waters	Elimination of soil and ground waters point and diffuse pollution sources
Water surfaces and water courses sedimentation with deposits and waste	Strict protection of soil fund, prevention measures, cleaning of water courses, surface water bodies and their respective basins from waste
Water availability	
Missing public drinking water supply	Creation of conditions for economically viable and long-term sustainable access of inhabitants to public drinking water supply
Water shortage (extension of dry periods, decrease of water resources stocks in the landscape)	Preparation and implementation of strict flood prevention measures in order to improve water regime in the landscape as well as stocks of water resources
Water economics	
Regulatory restrictions on price of water	In the shortest possible time, introduction of real water prices through continuous deregulation. Solving of social aspects after deregulation of water price

High costs for construction and completion of existing drinking water and waste water treatment systems	Decrease costs of waste water treatment and drinking water systems to a realistic level through investigation of the most costs effective model for waste water treatment and drinking water provision for the given local municipality or a community. A recommended tool is application of the "Open Waste Water Planning" methodology
Inefficient rainwater management and use, especially in the urban environment	Rainwater has to be used to support evaporation from the landscape and plants, public green spaces watering, infiltration into soil and other purposes. Drainage of rainwater by the sewage system has to be reduced to a minimum
Underdeveloped support and motivation tools (financial and non-financial) for implementation of integrated water resources management into practice	Use Open Waste Water Planning as a tool for complex assessments of alternatives, including economic analysis. Creation and development of new support and motivation tools (through new systems of grants, taxes, bonuses, charges, realistic water price and adjustments of priorities in Structural Funds Environmental Operational Programme and Rural Development Programme)
Institutional problems	
Absence of coordination bodies for integrated water resources management on the national / river basin / local municipality level	Establishment of multi-sectoral coordination bodies (based on legislation and agreed with state administration): - on the national level (ZMOS / Ministry of Agriculture / Ministry of Environment / Slovak Water Management Enterprise / State Forests / representatives of private landowners and farmers / Slovak Agriculture and Industry Chamber / Association of Flat Owners, etc) - on the river basin level - local municipality representatives (river basin self-administration), non-governmental organisations and main social and economic partners in the river basin - on the local municipality level - cooperation of social and economic partners, land and buildings owners and local inhabitants
Inadequate communication among stakeholders dealing with water policy	Support to regular dialogue and communication in order to exchange experiences. Activity of expert groups for updating water legislation and innovation of support and motivation tools
Absence of specialised expert body for municipalities on integrated water resources management	Preparation and establishment of ZMOS Competence Centre to support expert capacity building in regions, to advise and further develop expert activities
Management area	
Absence of integrated water resources management principles application in practice	Acceptance and application of integrated water resources management principles in the territory of local municipality and their respective river basins. Update of water legislation. Update of conceptual and strategic documents in the area of water management and agriculture. Update and increase efficiency of support, financial and motivation tools
Inadequate administration of small water courses	Re-evaluation of small water courses administration system, its modernisation and increase of efficiency

Lack of surface protection of water resources in the landscape	Set up environmental goals in the area of water protection according to EU Water Framework Directive. Assessment of an impact of investment, construction and economic activities on water cycle in the landscape. Revaluation of current landscape adjustments influencing water regime and water balance in the given area
Absence of new forms of management and cooperation to improve rainwater management and elimination of soil erosion	Preparation, establishment and activation of Water Communities within local municipality. Preparation, establishment and activation of Water Farms in the landscape. Participation of local municipalities, including public, land and building owners and users during planning processes and management of rainwater.
Non-existence of local water planning	Preparation and implementation of anti-erosion and water retention measures in the area of local municipalities and their respective river basins. Preparation and approval of municipal integrated water resources management plans as a local part of river basin management plan and water plan of Slovakia

Tab. 2 Moving to integrated management of rainwater and surface water in the landscape

Traditional planning management of rainwater and surface water in the landscape	**Integrated management rainwater and surface water in the landscape**
Drainage systems	Ecosystems
Reactive - solving problems	Proactive - solving consequences (preventive)
Led by technical teams within one sector	Led by inter-disciplinary teams
Property protection	Property and land protection
Pipes and transport	Imitating natural processes
One sided decisions without assessment of alternative solutions and public participation	Decisions based on consensus, assessment and selection of alternative solutions in cooperation with public
Privilege of state organisations and institutions	Partnership with others
Focus on extreme rain and storm activities	Rainwater integrated into active use in the landscape
Classical hydrological modelling. Calculations of water balance do not take into consideration changes of multi-annual and long-term volume of water in the system (river basins); changes of water regime and their impacts on energy flows in the landscape	Modelling based on area, land and individual micro-basins water balance, taking into consideration changes of multi-annual and long-term volume of water (especially ground water) in the river basin system; changes of water regime (and especially surface of the landscape) and their impacts on changes of energy flows in the landscape
Economic thinking based on cumulating of costs	Economic thinking based on cumulating of benefits
Thinking focused on maximum (top) flows in the water course	Thinking focused on volume of water in the river basins and its spatial distribution in the landscape