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IDENTIFICATION OF WATER QUALITY AND DISTRIBUTION OF POLLUTANTS IN THE RIVER DANUBE ON A CITY LEVEL, BY MFA METHOD

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ABSTRACT: Material flow analysis is a useful method for the systematic assessment of flow of materials - substances that are used and transformed through a closed system in space and time. With application of MFA method we can control and determine water quality by the load of water that comes from pollutants and also we can determine sources and flows of pollution within the river network of smaller and larger rivers at all levels. The Danube River is used very intensively through various human activities that produce pollutants. Due to the great complexity of the Danube river system, hydrology, the main problem is the database. To make it easier to solve the problems and challenges the basic complement system has been incorporated in the MFA – material flow analysis. Using a different range, MFA analysis is carried out at different spatial levels, allowing the final formulation of different scenarios for different levels of accuracy. The importance of applying MFA analysis to quantify the problem of pollution of the river Danube is a transparent view of the results along with an understanding of the system. Spatially displayed and presented results of MFA analysis can provide a neutral but a quantitative picture of the system that is understandable for politicians and future investors.
KEYWORDS: water quality, pollutants, river Danube, MFA method

❖ INTRODUCTION

Large rivers in developing countries have more features as the ecosystem, economic base, a water resource and the recipient of streams, thereby providing the basis for the life of people around the riverbanks. Many of these rivers have a problem with the increasing pollution. Development of tools for efficient identification of river pollution, essentially a global water pollution problem, insufficient quantities of water and over exploitation of water can be effectively addressed [4].

Conventional large river management approaches are based on mathematical models that often require extensive evaluation of data, requiring large financial, technical and human investments. This approach is not sufficiently clear and transparent to investors and local decision makers to quantify those impacts of individual sources of pollution and implement appropriate measures to reduce pollution of rivers. This approach fails to provide clear priority measures to reduce pollution and to answer the following questions: What exactly is the most significant source of pollution and most efficient way to solve these problems [2]?

These study aims to apply Material Flow Analysis (MFA) to assess water quality problems and mitigation potentials in river basins.

❖ METHODOLOGY AND PROBLEM APPROACH

MFA – „Material Flow Analysis“represents a good method for the systematic evaluation of flows of materials – substances which are used and transformed over the closed system in space and time [1]. With applying MFA for water quality management we can determine the load of water that comes from different types of pollutants, and also determine the main sources and flows of pollution within the river network of smaller and larger rivers at all levels [5]. In order to apply the MFA analysis it is necessary to solve the following problems:

Table 1. The main problems and challenges for the implementation of MFA analysis [3]

Chalenge	Existing Conditions	Specific research questions
The variety of pollution sources	Various kinds of industry, households, …	What are the main sources of pollution, where are they located and they influence?
Quantification of complex hydrology	Complex water systems: Different levels and river flow rate speed, long retention time, limited selfpurification, undefined hydrological boundaries	How to integrate a complex water system in to the MFA?
Decomposition of the river system into simpler subsystems	The difficulty of determining the boundaries of the system because of the complexity of water flows.	How to set up and broken down MFA, in order to get the right solution and to be able to make the right decisions?
Involving the stakeholders	Intensive on-going process of stakeholder collaboration Involve key stakeholders in MFA process from the start	How to envolve the most important stakeholders in decicion making?

The variety of pollution sources

When we set the system boundaries, for example Novi Sad as the pollution source, it is necessary to determine the principal and if possible all sources of pollution. City of Novi Sad is a complex system. It is necessary to identify all the sources and flows of tested polluted substances which are passing and entering the system. Different parts of the city produce different amounts of pollutants.

Quantification of complex hydrology

Important fact is that the city of Novi Sad and most of the cities in Republic of Serbia has no systems for wastewater treatment. There are a lot of problems during the sample collection due to changes in the intensity of the river depending on the season. There are different degrees of self purification wich also depends on the condition of hydro system. Also, the system of the Danube River is very complex, there are a number of affluents and other systems that are directly connected and which directly affect pollution. The main objective and the basis for the MFA analysis would be the quantification of river flows, natural and anthropogenic impacts and mechanisms.

Decomposition of the river system into simpler subsystems

The main problem is to determine the appropriate level of complexity that would be suitable for MFA analysis taking all the elements of the system into account. In order to implement MFA analysis it is necessary to pass the following stages, presented in Figure 1.

Figure 1. Basic steps for MFA implementation

Database should include the results of water quality analysis, field observations, maps and geographical coordinates and hydrology. Analysis should include: water quality analysis, spatial analysis and hydrologic analyses MFA should include: an analysis of all systems, deficiencies in the data, necessary measures which should be conducted on the basis of the analysis [2].

The first phase requires to approximately determining the strategic point of spatial and hydrological analysis. First step in the MFA analysis is to determine the system boundary, the main process in the system and the mainstream in the system For example, Novi Sad, given the possible boundary proposed system (the simplest system):

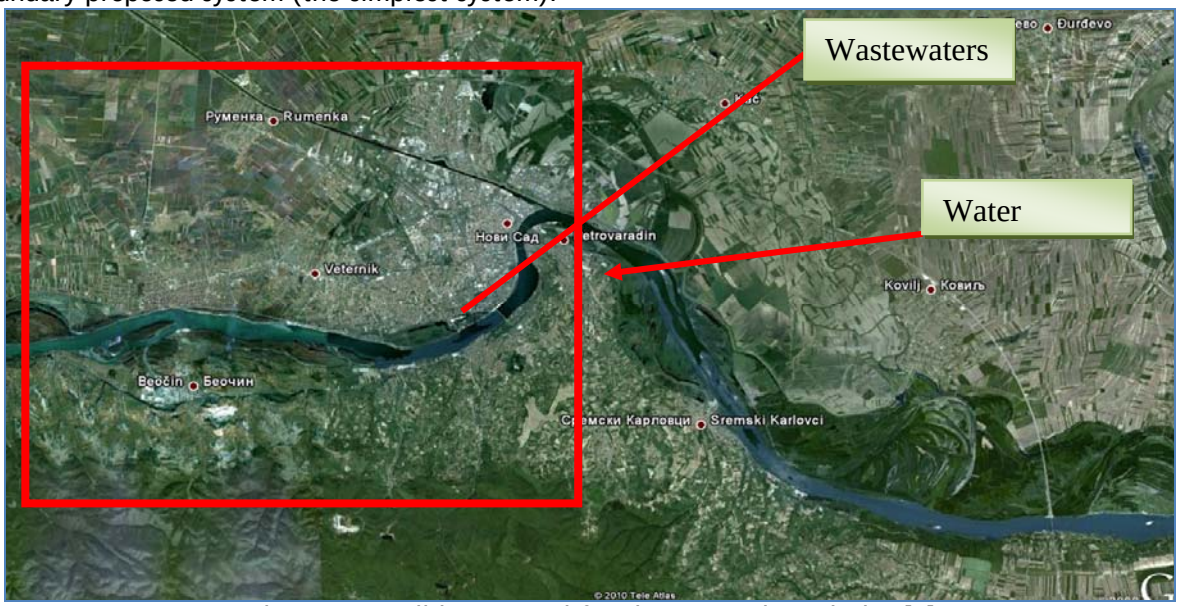

Figure 2. Possible proposal for the system boundaries [6]

As a second step in the MFA analysis it is necessary to identify the major processes that can be divided into smaller sub processes in the system such as: people, industry, health facilities, pollution that comes from other systems, a tributary...

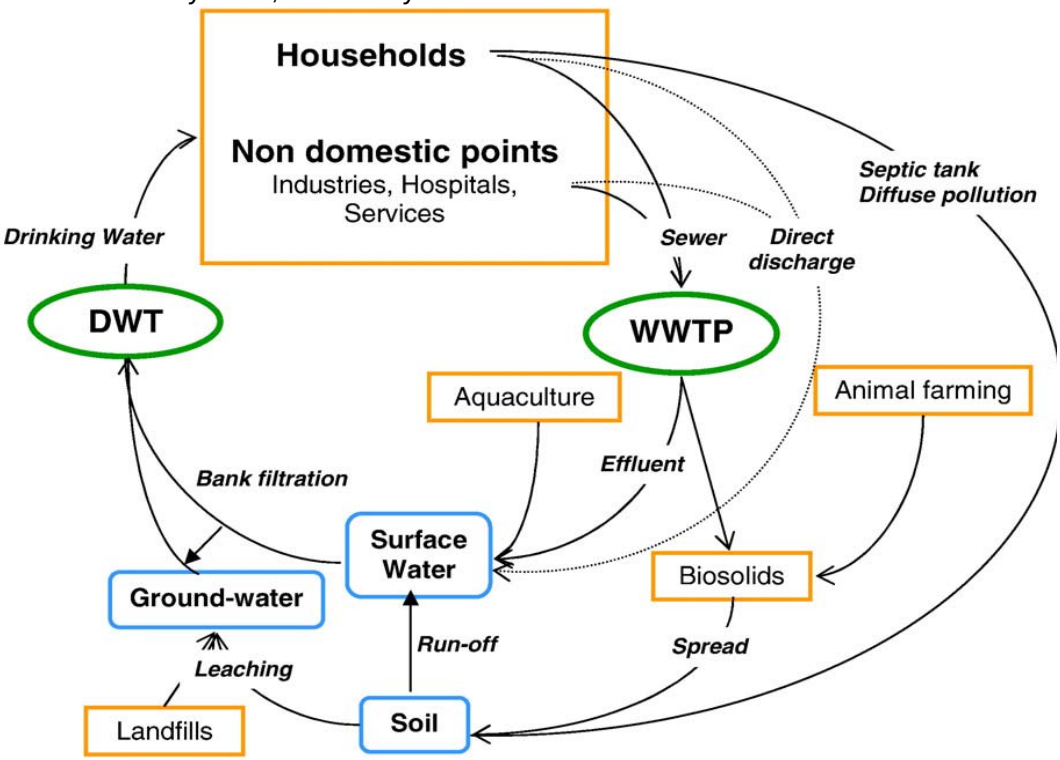

Figure 3. Diagram of main system processes and subprocesses

Flows between the different processes represent all input and output flows and supply goods that are in the system (stocks).

The next step is the identification of pollutants (indicators that are monitored) and selection of one or two pollutants from each group who are potentially the most powerful polluters. Indicators must reflect the key impacts on water quality, and be measurable by available equipment.

Involving the Stakeholders

Key MFA benefit is its potential to directly involve the concerned stakeholders in river water quality assessment and planning. Visualized material flows provide a transparent and neutral technical foundation for a participatory process of discussing and evaluating alternative scenarios with stakeholders [4]. Stakeholders should be involved in the MFA process from the start, so local perceptions can be adequately assessed system analysis and scenarios discussed, and strategies chosen with concerned actors.

❖ CONCEPTUAL APPROACH

Conceptual approach follows the MFA analysis, while at the same time satisfies the need for solution of various problems and challenges. MFA is iterative process where we initially use rough estimates, which are constantly upgraded and improved as more data becomes available, until we reduce the degree of uncertainty to the required level [3].

The primary assessment of water quality at strategic points, spatial and hydrological analysis and observations from the field are the basis for the first phase of the study. In a hierarchical approach, MFA is implemented at different levels (representative space – subsystem, oversaw river basin and the whole system).

Parallel with the implementation of the MFA procedure, the process of including investor aims at integrating the wishes and preferences of investors during the design of different scenarios.

❖ CONCLUSION

The importance of MFA methods in improving the quality of water is expressed through the pragmatism of the methods and possibilities of methods to simplify the complex system, although there are limited financial, human and technical resources, to identify key issues and to implement effective measures of remediation. In the initial phase of analysis of material flows - MFA can provide an overview in relation to the complexity of the river basin, providing a framework for data processing of

all data relevant to water quality. Completeness and consistency of data can be checked, and they can also identify the need for detailed studies.

In the form of a static model, the main pollution sources, pollution and the dimensions of interaction between the pollutants can be monitored at the level of the whole river basin of the river in the territory of Novi Sad. The second step is a dynamic MFA model and with that we can predict and evaluate long-term trends and possible consequences before they reach their occurrence. In this way a basis for standardized monitoring of the whole concept of the Danube River basin.

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