Physical and cyber safety in critical water infrastructure
NATO Advanced Research Workshop
Oslo, Norway. 8-11 October 2018

CYBERWATER 2018
WATER SAFETY ADVANCED RESEARCH WORKSHOP

Possible application of EARLY WARNING SYSTEM (EWS) in the regional water management planning

8-11 October 2018, Oslo, Norway

[1]Prof. Igor CRETESCU,
[2]Dr. Zsófia KOVÁCS

[1]Technical University of IASI, ROMANIA
[2]University of Pannonia, HUNGARY

CONTENT

1. PROBLEM:
   - Special geographical situation – River Basin Management Plan (RBMP)
2. SOLUTION:
   - Sustainable (!) Automated online water quality monitoring system
3. CASE STUDIES:
   - Red Mud Disaster October 4, 2010, Hungary
   - Tisza River Basin Automated Water Quality and Early Warning Monitoring System /Baia Mare cyanide spill, January 30, 2000, Romania/
4. CONCLUSIONS

RIVER BASIN MANAGEMENT PLAN

1. SPECIAL GEOGRAPHICAL SITUATION

(RBMP)

THE DANUBE BASIN CHARACTERISTICS

The Danube River Basin District within the European

Characteristic numbers:
- 10%of Europe
- 801,463 km^2
- 83 million inhabitants
- 19 countries

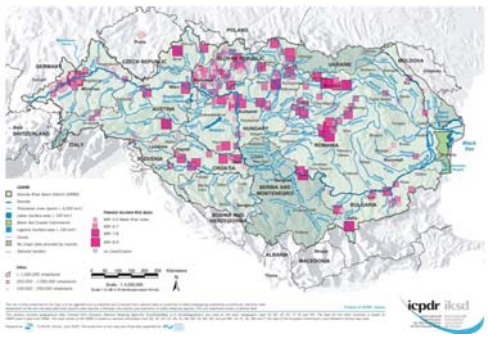
The Danube River stretches over 2.800 km (1.170 miles) across Europe and flows into the Black Sea.
DANUBE IS THE MOST INTERNATIONAL RIVER BASIN.

Adapted from ICPDR and EUSDR/PAS

DANUBE RIVER BASIN DISTRICT

Potential Accident Risk Spots

They all need international cooperation.



- ✓ to prevent accidental pollution and
- ✓ to improve response capability by compiling an inventory of all relevant "Accident Risk Spots".

Adapted from ICPDR

Hungarian River Basin Management Plan

the Danube River Basin

There is a special situation with RBMP in Hungary

INFLOW – 24 rivers entering into the country

OUTFLOW – 3 rivers leaving the country

96% comes

In Hungary **96%** of the surface water **comes from neighbouring countries.**

priority

The main **priority** is to build up the **network water quality monitoring system** of water catchment area.

Protection and management of water resources are the key elements of *SUSTAINABLE DEVELOPMENT*

AUTOMATED SURFACE WATER QUALITY MONITORING

2. FOCUSING ON

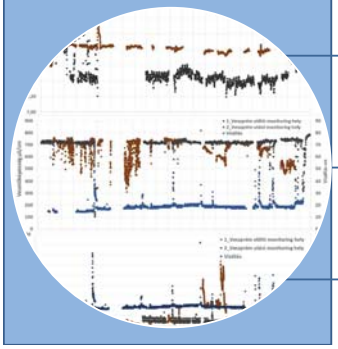
continuous surface water quality monitoring and indicator parameters

- ✓ LONG-TERM SUSTAINABLE OPERATION
- ✓ LOW OPERATION AND MAINTENANCE COST

Some of the pollution are time-varying and random events, in order to investigate them **it is essential to design and operate an automated continuous monitoring system optimized for given purpose.**

AUTOMATED SURFACE WATER QUALITY MONITORING

CONTINUOUS MONITORING



APPLIED SYSTEM

Investigation of the urban section of Stream (pollutant wave, intense rainfall)

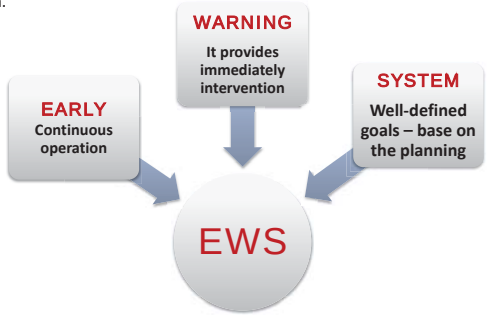
Investigation of the effluent of wastewater treatment plant

Measurement of the effectiveness of the remediation of Torna Stream

Automated Surface Water Quality Monitoring Early Warning System

The Early Warning System (EWS) is a key tool in surface water management, with a different mechanism.

Overall, the two components—early warning function and effect-based monitoring of water analysis—form a cost-effective integrated system, which could perform sampling, analysis of surface waters.



EWS principles

- viewpoint of prevention of catastrophes
- remote controlled
- continuously operating monitoring stations
- „**cookbook**" with various customization possibilities adaptable to given situations
- different warning scenarios can be worked out
- standardization of the
  - installation methods and
  - sampling techniques
- opened **framework** (EWS)

Indicator parameters

suitable physicochemical and toxicological

shared information

modularity

Expectations

- monitoring with
  - economical & minimal operating **costs**
- operational **reliability** and **availability** & robustness
- different capabilities of the involved **countries**
  - cross-border **cooperation**
  - pilot is focused on the Tisza catchment

CASE STUDIES

EWS=experiences /lessons learnt/

Application of EWS

RED MUD DISASTER

- After the disaster we applied an Accredited Water Quality Telemetry System (AVITAR)
- We were operating the AVITAR station for a year.

TISA RIVER BASIN

- 4 monitoring stations (Automated Water Quality and Early Warning Monitoring System) were financed by Hungarian Environmental Ministry & USAID program.
- Based on the experiences we have proposed an update model.

CASE STUDY

Red Mud Disaster October 4, 2010, Hungary

RED MUD DISASTER
INCIDENT

Ajka, Hungarian Aluminum Ltd., October 4, 2010. 12:30

Western containment wall of the red mud waste rezervoir (cassette No. 10) ruptured

*„**All over the world** the red mud catastrophe of October 2010 in Hungary **draw the attention** to the problem of red mud disposal sites, storage reservoirs and other wastes of mining origin that mean **serious threats to humans and the environment.**" in the news.*

RED MUD DISASTER
FACTS

~1 million m³ NaOH solution sludge flowed out

- pH ~13
- Dry matter content: 5-10% (~8%)

~100,000 tons of red mud flowed out
Flooded area 1017 ha (10 km²)

- Lower parts of Kolontár, Devecser, Somlóvásárhely (~4 ha)
- Agricultural area (>1000 ha)

www.wikipedia.org

RED MUD DISASTER
INTERVENTION

The water management task force initially **focused on neutralising** the caustic surface waters with addition of **acids** (e.g. acetic acid, hydrochloric acid) and **gypsum** into the Stream Torna, Rivers Marcal and Rába in order to **avoid the contamination of the River Danube**.

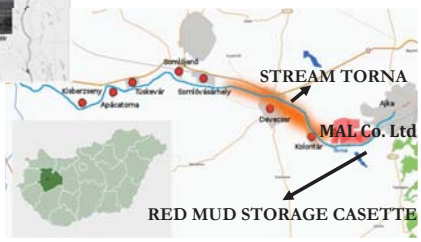
- ✓ To neutralize the strong alkaline pH **gypsum** was added starting from October 5, 2010.
- ✓ **Acetic acid** was added to reduce pH in order to prevent the unacceptable damage in the ecosystem of the Rivers.
- ✓ For this reason decision was made to construct so called "**riverbed barriers**" (artificially created obstacle under the water level) to stop the heavier fractions of contamination (the red mud and the precipitated materials) in the riverbed.

RED MUD DISASTER
MONITORING

Feedback:

- Monitor the effects
- Changes can easily be detected
- Rapid intervention can be implemented

The AVITAR measuring station was installed directly at the Stream Torna in Devecser about 8 km from the red mud storage cassette No.10.



RED MUD DISASTER
APPLIED AVITAR SYSTEM

EARLY WARNING MONITORING

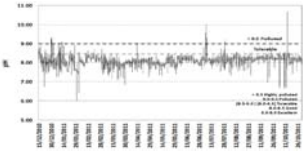
USE OF MOBILE STATION AND ACCREDITED WATER QUALITY TELEMETRY SYSTEM (AVITAR)

KMOP 1.1.1 R&D project 2008-2011

RED MUD DISASTER
APPLIED AVITAR SYSTEM

Main FEATURES of operation

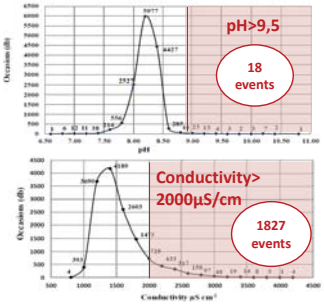
- ✓ **„quasi" accredited continuous monitoring station**
- ✓ **half-hourly/hourly frequency**



- *I operated a „quasi" accredited continuous monitoring station on the Torna-Stream in Devecser. For this I developed the accreditation criteria that the integration of the continuous monitoring system into the official procedure.*
- *half-hourly and later one hourly measurement frequency and the determination of the alarm level (pH 9,5) ensured the monitoring of the effectiveness of the inventories.*

Changing the water quality of the Torna Stream 15.12.2010.- 31.10.2011.

The number of measure 14 178 and exceeding of limit value:



RED MUD DISASTER

One year later.....

Before
28.10.2010.

After
30.09.2011.

CASE STUDY

4 stations of Tisa River Basin Automated Water Quality and Early Warning Monitoring System

/Incident: Baia Mare cyanide spill, January 30, 2000, Romania/

Tisa River Basin

the transboundary character

the Danube River Basin

Incident:

The **2000 Baia Mare cyanide spill** was a leak of cyanide near Baia Mare, Romania, into the Somes River by the gold mining company Aurul, a joint-venture of the Australian company Esmeralda Exploration and the Romanian government.

Facts:

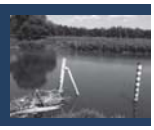
- 100,000 m^3 cyanide (After the spill, the Somes had cyanide concentration of over 700 times the permitted levels).
- Subsequent spills - contained waters (heavy metals: zinc, copper) hit the region.

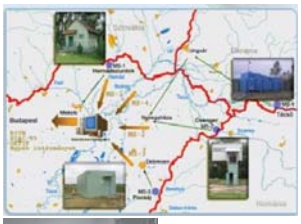
TISA RIVER BASIN
Automated Water Quality and Early Warning Monitoring System
4 monitoring stations (3 stations – HU; 1 station - UA)
2001

Protection and management of water resources are the key elements of *SUSTAINABLE DEVELOPMENT*

The implemented

Automated Water Quality and Early Warning Monitoring System





4 stations 3 rivers

Four stations were built up at 2000/2003 and located on the **three tributary rivers** where they enter the Hungarian part of the Tisza catchment.

highest pollutant loads

These rivers carry the **highest pollutant loads** and the system **ensures** their high frequency sampling.
Limit values for warning and alerting

Structure of a mobile station

problems occur

- **No flexibility**
- **High** maintenance **cost**
- Systematic control and **maintenance** of the stations are carried out **weekly**

www.rivermonitoring.hu

Sample events

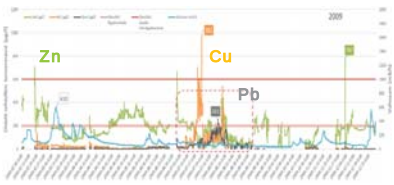
During the operation Automated Water Quality and Early Warning Monitoring System

Name of monitoring station: CSENGER
Name of River: SZAMOS
Measured parameters: dissolved Zn, Cu, Pb

Exceed warning limit:
Concentration: 600 µg/l
- Zn (2009-2014): 190 events

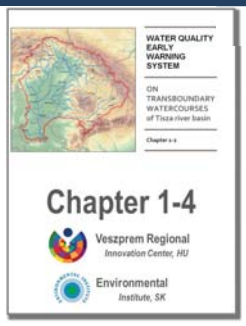
Concentration: 200 µg/l
- Cu (2009): 53 events
- Pb (2009): 11 events

Exceed alerting limit:
Concentration: 600 µg/l
- Cu (2009): 5 events



Tisa River Basin

Plan for update= STUDY



The aim of the study was

- Basic assumption: to lay down the basics of the strategy for the ***„BASIC" WATER QUALITY EWS***, and
- to define the ***FRAMEWORK*** of the extendable, configurable and specializeable automatic monitoring system, which includes installation, infrastructural and ICT elements
- Basic ***COOKBOOK*** approach: a catalogue system that recommends a pre-modelled, detailed and applicable scenario for particular situations.

It was introduced at the 7th meeting EUSDR PA4 Steering Group in 2014 (presenter: Zsófia Kovács)

EUSDR, PA4 Steering Group; 7th meeting, 2014

CONCLUSIONS AND FUTURE PLANS

AUTOMATED CREEPING SEDIMENT SAMPLER
R&D project

Sediments and ecological status of water bodies are interconnected.

Aims of the project

- Integrated automated quality monitoring system for surface water and creeping sediment.
- Measuring heavy metal concentration in different phases water bodies, creeping sediment and biota.
- Analysis of heavy metal dynamics between water and sediment phases.

HOMÉR

Creeping sediment sampler /Stream prototype/

BEWARE
R&D project plan

Aim of the project
Collaborative action to develop an advanced on-line freshwater biological system for monitoring water quality (BEWARE)
- 11 partners; 9 countries

- BEWARE **technology** is based on the **use of the valve gape movement of bivalves as a physiological endpoint, reflecting the animal's response** to environmental changes.
- BEWARE will offer a **sustainable and reliable technology** that could sense and report online the contamination of pristine **freshwater**, and alarm if the threshold of the contamination is exceeded the adjusted values, setting the stage for appropriate **policy decisions** that can saves life and reduce the costs of landscape reconstruction.

Based on the experience Biota Guard AS with help of IRIS Stavanger, Norway

Thank for your attention!

Dr. Zsófia KOVÁCS
E-mail: zsofiakovacs@almos.uni-pannon.hu

Prof. Dr. Igor CRETESCU
E-mail: icre1@yahoo.co.uk

References:

- Igor Cretescu, Zsófia Kovács and Sorin Mihai Cimpeanu (2016): Monitoring of surface water status in the Lower Danube Basin, River Basin Management, Chapter 10; InTech htttp://dx.doi.org/10.5772/64399
- Kovács, Zs, Yuzhakova, T., Lakó, J., Domokos, E., Kurdi, R., Horváth, E., Utasi, A., Vincze-Csom, V., Ráduly, I., Ráduly, L., Rédey, Á. (2012): Water Monitoring Following the Hungarian Red Mud Disaster, Environmental Engineering and Management Journal, November 2012, Vol.11, No. 11, 2047-2051
- Kovács, Zs., Yuzhakova T., Vörös, Cs., Jónap, K., Rédey, Á. (2012): New Direction in Terms of Water Quality Monitoring Application, Environmental Engineering and Management Journal, 11, 3, 597-602, 2012.

Acknowledge
We acknowledge the financial support of Széchenyi 2020 under the GINOP-2.2.1-15-2017-00070
We acknowledge the financial support of Széchenyi 2020 under the GINOP-2.3.2-15-2016-00016