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Original Research

Monitoring Water Contaminants: a Case Study for the Republic of Moldova

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Abstract

Water quality monitoring is a major issue toward maintaining safety and security for many countries. Due to many contaminants present in surface water in the Republic of Moldova, groundwater monitoring has become an exclusive source of drinking and potable water for many cities. In this investigation, we determined chemical contaminants in groundwater bodies of the Prut River basin for groundwater classification. For this investigation, monitoring wells were sampled by several field trials. The results of the chemical analysis have been used for the preliminary identification, characterization, and classification of groundwater bodies. The chemical content of water shows the current status of groundwater bodies under investigation, thus validating the study on the importance of groundwater monitoring. We examined several heavy metals in the groundwater from a national monitoring network. One hotspot (contaminated region) is the old Chismichioi pesticide deposit, which was studied for the assessment of actual status of the surrounding territory. It is also one of the largest deposits of toxic substances in the Low Danube Euro region. The following spectrum of persistent organic pollutants was identified in the samples: DDE, DDD, DDT, a-HCH, b-HCH, and g-HCH. Several other toxic organic substances were also studied at this site, including PAHs, triazine pesticides, and some other heavy metals. The general conclusion about the situation around the Chismichioi deposit is that the level of pollution from the time of the origination (in 1979) has not changed, in general. The zones with high pollution levels should be eliminated and recommendations have been made for the mitigation of the negative impacts to the environmental and water resources in this area of Moldova. At the conclusion of this extensive investigation, similar studies are planned for other locations and surface water sources. This will provide a valuable tool for the Republic of Moldova and may be extended to other regions as well.

Keywords: groundwater monitoring, heavy metals, safety, environmental risk assessment

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Background

Water management is important for countries with arid and semiarid climates. Climate change will most likely impact surface and groundwater balance and quality. Some models suggest that periods with extremely high precipitation or strong drought will occur more frequently and for longer durations. In this case, the respective integrated water resource management (IWRM) plays an important role in the economic development of every country. Undertaking the demand on water usage caused by agriculture is a main challenge to achieving the quality objectives of the Water Framework Directive (WFD) in Europe and in the Danube region. The WFD requires that an integrated monitoring program has to be established within each river basin district [1]. The Republic of Moldova has two principal basins that are transboundary, viz., the Danube River Basin with Romania and the Nistru River Basin with Ukraine. The Republic of Moldova has taken a decision to align its legislation more closely with that of the European Union. Within this context it also has taken on increased obligations in terms of river basin management.

Water resources are determined by a number of factors, including the amount of water received from precipitation, inflow and outflow in rivers, and the amount lost by evaporation and transpiration. The Republic of Moldova is located in southeastern Europe, in a region with insufficient precipitation, limited water resources, with tempered climate and relatively limited humidity [2]. In recent history, precipitation has become very unstable. As an example, 2007 was characterized by a strong drought with average precipitation volume of 62-170 mm (35-85% of yearly volume). Three out of every 10 years are drought-afflicted in Moldova. Within the same time period, tremendous downfalls also occurred with precipitation exceeding 200 mm per day.

Natural components include precipitation, river flow, and groundwater levels, and artificial components include abstractions and discharges. The quality and quantity of natural water resources is sufficient in general for the sustainable development of Moldova. There are transboundary rivers such as the Prut and Nistru, small rivers and lakes, and shallow and deep groundwaters. However, water resources are irregularly distributed throughout the country. The southern part of Moldova is in a semiarid zone with a deficiency in good water for different purposes: drinking, irrigation, industrial use, etc. It is noted that more than 30% of groundwater sources that provide the city with drinking water do not meet the quality requirements for chemical indicators and that more than 70-80% of wells are not suitable and often dangerous to use for drinking purposes. The shallow groundwaters in the greater part of the nation's territory are polluted by anthropogenic sources, in particular nitrates.

The semiarid climate in Moldova makes it necessary to use groundwater resources in conjunction with surface waters. The intensive utilization of principal aquifers is monitored by the national monitoring groundwater network. This activity is accomplished by nearly 180 boreholes for different aquifers. The main point of the monitoring strategy is to identify index or signature sites, which would ideally be at locations with long historical records and provide a good representation of conditions in the groundwater body. It would be necessary to show historical trends in water quality through analysis of chemical component data. There would, therefore, be a need to have data for the selected sites in electronic form, and to use chemical and physical sensors for the remote continuous monitoring of the water parameters.

The traditional approach to water quality monitoring consists of manual sampling in remote locations and the transport of samples to the laboratory for chemical analysis. This approach, although simple, is relatively non-technical and easily reproducible. However, it is time-consuming, has high labor costs, may be limited due to weather conditions, can give inconsistent results, and does not allow for the continual collection of data [3].

Examples of new technology and instrumentation are automatic monitoring stations that are already effectively used in a number of networks for monitoring the "capture" of various pollutants or temporal changes in toxicity [4-9]. Sensor technologies have emerged from environmental sciences in the last couple of decades as a promising tool and are still in their infancy. They now require validation. Water quality monitoring is currently based on standardized laboratory methods. Sensors, despite being developed more recently, do not have the same recognition capacities and are only seldom used, despite their advantages. Field validations are needed in order to boost their credibility [6, 10-12]. ISO standard 15839 (released in 2003) provides a consistent protocol for characterizing these sensors, and should facilitate their adoption for routine use by regulatory bodies. Further work is required to increase their operational period, and particularly to prevent bio-fouling and clogging. Other technological challenges include miniaturization of on-chip modules, cutting energy consumption, developing in-situ fuelling, eco-design, geolocation, communication checking, and data validation and transmission. It is equally imperative to improve data management [10]. The aim of this article is a series of case studies of pollution sources of groundwater quality in the Prut River and of the Chismichioi pesticide landfill in southern Moldova.

Analysis of Groundwater Quality Monitoring in Moldova

Groundwater status refers to both the quantity and chemical quality of groundwater. Contaminant levels in groundwater are used as the main measure of quantitative status. To achieve good groundwater quantitative status, the available groundwater resource should not show signs of depletion and the ecological quality objectives for groundwater-dependent surface waters should be met. Groundwater chemical status can be measured by determining the principal chemical composition and the