



## Public health risk analysis through evaluation of drinking water safety

### Analiza rizika javnog zdravlja kroz procenu bezbednosti vode za piće

#### To the Editor

Some researches in US and China<sup>1,2</sup> have revealed a relationship between the increased risk of primary liver cancer (PLC) and the quality of surface water, suggesting that cyanotoxins (CTs) from water reservoirs containing cyanobacteria (CB) can trigger the development of PLC. The data obtained from similar studies in Serbia<sup>3-5</sup> confirm these findings. The highest PLC incidence has been found in Nišavski (31.4/100,000 inhabitants), Toplički (27.3/100,000 inhabitants), and Šumadijski (22.1/100,000 inhabitants) districts where CB blooms occur every year in most reservoirs for water supply *versus* Central Serbia on the average (14/100,000 inhabitants) (Figure 1).

especially distal ones, and has difficulties to cope with unpredictable harmful events.

An indicative example is the Vrutci reservoir case on the river Đetinja (the town of Užice, Serbia), the main source for the Užice Water Supply System (UWSS) which covers more than 60,000 inhabitants, which had experienced a visible bloom of potentially toxic CB at the end of 2013<sup>7</sup>. The ban on using water from UWSS was in force for one month and a half, which strongly affected PH. In addition to difficulties in determination of probabilities of such an event, it is not possible to determine the incidence and prevalence of diseases dependent on the drinking water hygiene<sup>8</sup>.

A research reported by Drobac<sup>9</sup>, after Vrutci reservoir CB bloom and water usage ban from UWSS, has provided

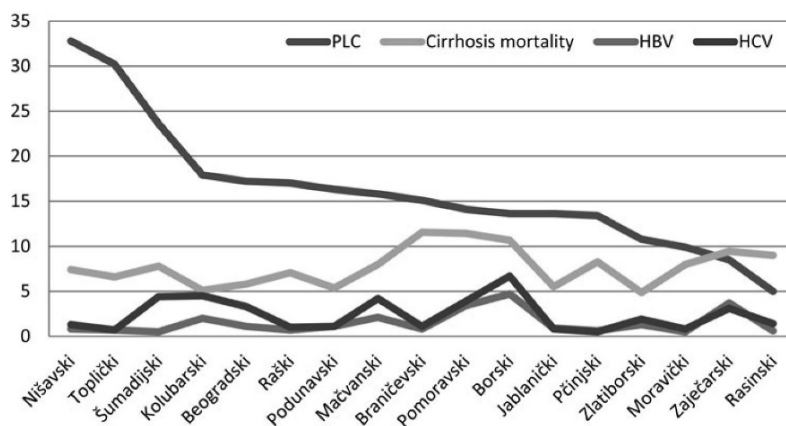


Fig. 1 – Comparison of incidences (*per* 100,000 inhabitants) of primary liver cancer (PLC), cirrhosis, hepatitis B virus (HBV), and hepatitis C virus (HCV) in Central Serbia regions from 2000 to 2006.<sup>5</sup>

The aim of this letter was to point out that the role of drinking water safety in public health (PH)<sup>6</sup>, and also to point out the relationship between distal (associated with social, environmental and engineering status) and proximal causalities (associated with microbiological or biological factors) of some water-related diseases.

The current PH risk analysis approach concerning drinking water is based on cause-effect relations and probabilities of unwanted events, i.e. human exposure to CTs. This approach fails to capture all of the risk factors involved,

valuable data on exposure to given hazards. During the water usage ban, the majority of respondents (out of 320 participants in the inquiry) did comply with restrictions, while some of them used water occasionally and daily (Figure 2). These data confirm difficulties in the exposure assessment.

It was evident from Vrutci CB bloom that the whole environmental and engineering sociotechnical structure has contributed to the event which was also extended on socio-medical structure of PH. Partitioned responsibilities in managing different aspects of water among the instituti-

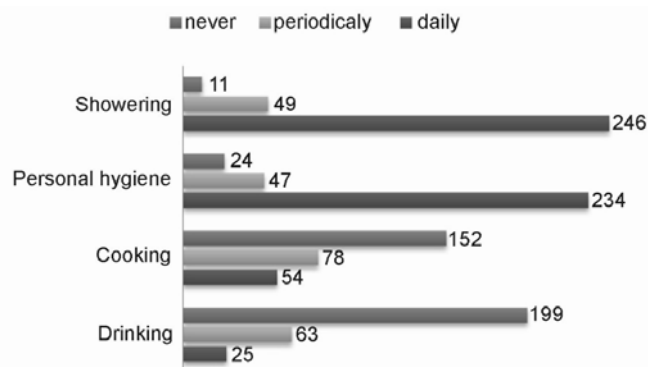


Fig. 2 – Water usage during Užice water ban (number of subjects participated in the inquire, totally 320).<sup>9</sup>

ons/actors at different governance levels (local, national) or at the same level (different departments or Ministries) or different professions (environmentalists, engineers, medical workers) had resulted in the failure of making effective and timely decisions, either to prevent or to mitigate the issue.

After a comprehensive analysis of the event, following aspects related to management, monitoring, reporting and regulation were identified as critical:

**Management** – the Vrutci reservoir was not protected from untreated waste water from the upstream settlements and rainfall runoff from the nutrient reach agricultural area; sudden (and unnecessary) water level changes did not favor Vrutci water ecosystem, while only CB, as the toughest, prevailed.

**Monitoring** – In spite of widely accepted recognition of the Vrutci reservoir as the most valuable resource, there was no regular monitoring; UWSS thought were not responsible, Serbian Environmental Protection Agency (SEPA) was short of funding. For example, for the year 2013, monitoring was not scheduled, in spite of the impaired ecological status of the reservoir observed from the monitoring in 2012.

**Reporting** – None of PH institutions along with SEPA did not report the case in their Annual Public Reports which is an obvious deficiency in communication. In addition, there is no Ministry of Health critical evaluation on the extent of conducted drinking water analyses. One may ask did anything happen?

**Regulation** – There is no specific regulations of CB monitoring and on the maximum permissible levels of CT concentrations present in waters used for drinking, recreation, aquaculture or irrigation<sup>5</sup>.

Experience and good management practice<sup>6</sup> had already shown that medical, environmental and engineering solutions, in isolation, cannot give a long lasting sustainable solution for preservation of human or PH.

The obvious deficiencies presented previously in PH decision making methodology have been augmented and complemented by paradigm shift. Breaking away from risk, which seeks for adverse events, we could look into safety, which seeks for proper way of doing things.

A novel approach, systems-theoretic accident model and processes (STAMP)<sup>10</sup>, originated from safety and resilience engineering, is proposed to expand traditional risk analysis which is primarily based on proximal factors to in-

clude distal factors originated from environment and engineering. STAMP views accidents (of any kind, like human exposure to CTs in this case) as the result of inadequate control rather than failure events. In that perspective, unacceptable losses can also be the result of interactions between sociotechnical system components, medical, environmental, physical and social, that violate system safety constraints.

Finally, one has to have in mind that since 1980, among the 83 water ecosystems examined in Serbia, 58 were found in algal blooming<sup>5</sup>, which is not an immediate PH hazard, but a clear indication that ecosystems are sliding towards unstable/unsafe status, which require stronger attention. Monitoring of health status of the population still remains the main task to determine trends and risk factors involved. However, addressing PLC issue, one should also have in mind that PH risk analysis dealing primarily with medical aspects must not overlook the environmental and engineering aspects, as well. PLC served as the motive of this letter, but also the other waterborne disease outbreaks caused by pathogens or other water-related diseases could be handled as well.

We are aiming at PH professionals, the Ministry of Health and the Ministry responsible for water resources management, to improve monitoring of reservoirs used for water supply, to improve the enforcement of the Water Law and Water Source Protection Zones as well as to support and strengthen both municipal and republic PH institutes.

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