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An approach for forecasting of public water scarcity at the end of the 21st century, in the Timiş Plain of Romania

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ABSTRACT

The balance between water demand and availability in Romania, as well as in many areas of Europe, will soon reach a critical level if predictions by simulated climate change scenarios are correct. The article is focused on the risk of water shortages, due to the climate change, in the Timiş Plain in Romania, a densely populated region, with 346,818 inhabitants. Estimates of future water availability for public water supply consider relevant socio-economic scenarios for major water users, estimate their future water demand, and assess water shortage for the main users. The water demand components were estimated for households, industries, services, and livestock, based on specific socio-economic assumptions. A non-probabilistic risk assessment, using simplified fuzzy sets mathematics, considers water supply, water demand and the consequences of water shortage. The results of the study revealed a vulnerability of the water supply and sewerage networks, an expected increase in households' demand, in the rural and in the urban, an expected increase for industrial and services water demand and a positive dynamic for the livestock water demand and finally a water shortage in the study area.

1. Introduction

Water supply is a key to civilization and development opportunities in a given geographical area. The assessment of water supply for domestic and industrial use calls for a wide-ranging approach, to define and determine the socio-cultural, demographic and economic benefits provided by the water. A number of studies emphasize the important role of the water availability in advancing and maintaining the living standards (Chiriac et al., 2001; Eberhardt and Pegram, 2000; UNEP et al., 2008; ENVIS Centre on Human Settlements, 2009; UN-Water et al., 2010). Other studies highlight the role of the access to the clean drinking water in improving the public health protection (Qilin et al. (2009) and reducing the child mortality (Günther and Günther, 2011; Mitrică and Mocanu, 2011).

Expected climate change in the next few decades, foresees some shifts in the intensity and occurrence of rainfall and temperature variations, of droughts and floods (IPCC, 2007), and shifts in crop-growing seasons. This may generate a wide range of impacts, including shrinking agricultural productivity and threats to the food security, increasing incidences of the vector-borne diseases and of the heat-related deaths, water scarcity, etc. (The World Bank, 2010). As a result, in recent years the EU Member States have expressed growing concern over the increasing frequency of extreme hydro-climatic events triggering long-term droughts and imbalances of water supply throughout Europe (Dworak et al., 2007).

Climate change over the 21st century is projected to reduce renewable surface water and groundwater resources in most dry regions intensifying competition for water among economic sectors and human habitat: rural areas will experience major impacts on water availability and supply, food security, agricultural incomes and in urban areas, climate change is expected to increase risks for people, assets, economies and ecosystems, including risks from water scarcity (FAO, 2008; IPCC, 2014; Mitrică et al., 2017).

Although at the national level, Romania has quite a sustainable system of water resources, at regional and local levels, one may notice water quantity problems related to climate change (aridity and drought, flooding). The most effective approach to address this problem is to reduce overexploitation and degradation, so as to maintain an adequate quantity and quality of freshwater for human use and to sustain aquatic and other ecosystems (OECD, 2008).

The balance between water demand and availability in Romania, as well as in many other areas of Europe, will probably reach soon a critical level as resulted from simulated climate change scenarios (European Commission, 2010). Combined total supply across the Eastern countries –Bulgaria, the Czech Republic, Hungary, Poland, Romania, the Slovak

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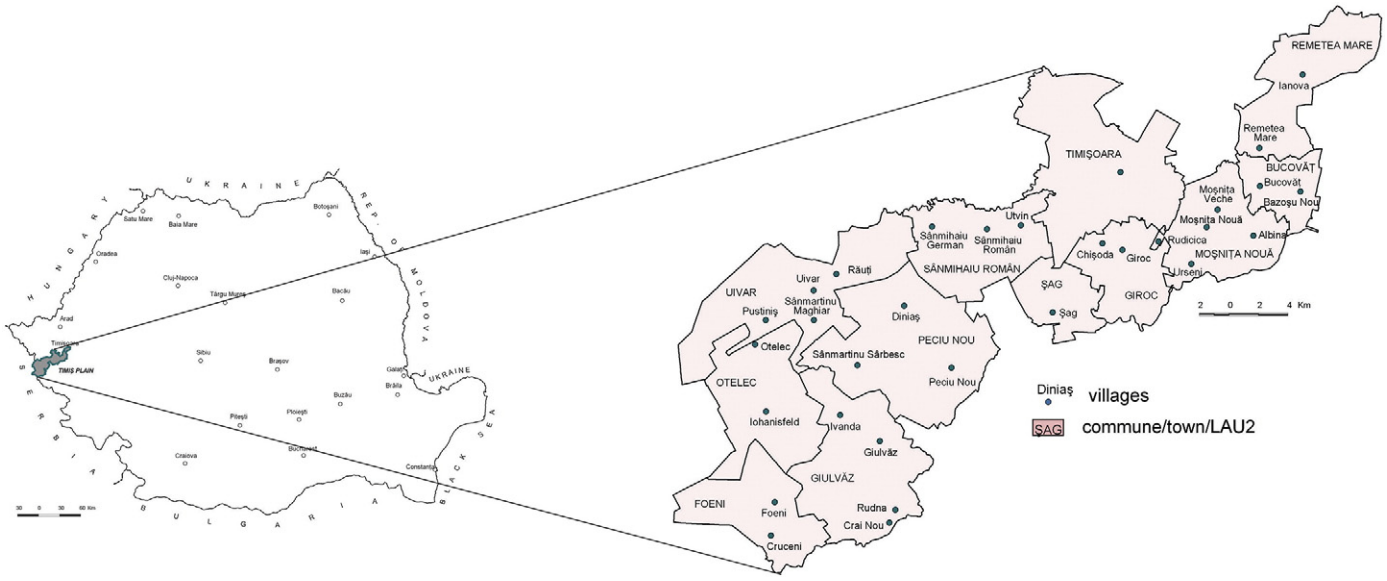

Fig. 1. Geographical position of the Timiş Plain.

Republic and Slovenia – declined by about 37% between 1990 and 2002–2005 (European Environment Agency, 2009). Under these prospects the economic and demographic users need to consider several aspects, among which the most important are: the efficient use of water from both surface and ground sources (efficiency improved by applying formal operating programs); checking water storage and transport facilities to reduce or eliminate water losses; ever greater application of recycling techniques (Bergstrom et al., 2001; Shaw, 2005).

The assessment of future water demand in the Timiş Plain, and the significance of the economic impact of possible water shortage are addressed in this paper. The legal framework and the institutions involved are also analyzed in order to assess future costs of water supply under different scenarios, and to provide information and recommendations to policy-and-decision-makers in the water sector.

A modular, yet simple, method is proposed for analyzing water supply risk, when water resources, water demand and the consequences of water shortages are estimated. The future water supply is estimated considering the current resources and their potential future evolution, projected based on the results of the climate change and hydrological scenarios. The future water demand is estimated based on expected demographic and economic changes, considering the most relevant socio-economic assumptions regarding the main water user categories (household, industry, services and livestock). Thus, the water demand components, on the main user categories are forecasted, and then by their aggregation results the total water demand. Finally, both the estimated water supply and demand are compared to assess the water shortage, when it is the case.

2. Study area

The Timiş Plain, part of the Banat–Crişana Plain, is situated in the western of Romania covering 739 km^2 (Fig. 1). The Timiş Plain corresponds to the south-eastern margin of the Pannonian Depression, the largest intra-montane basin of the Alpine-Carpathian. The Pannonian Basin extends in Austria, Hungary, Romania, Serbia and Croatia. The aquifers, hosted by Neogene-Quaternary formations, extremely reach in arsenic, represent a source of drinking water for about 650,000 people, which is the largest European group affected by high arsenic levels (Jimenez et al., 2009).

The main feature of the Pliocene-Quaternary pile is the high variability of grain-size and petrography from the former shore area (Carpathians in the East) to the distal portion (the present-day Serbian

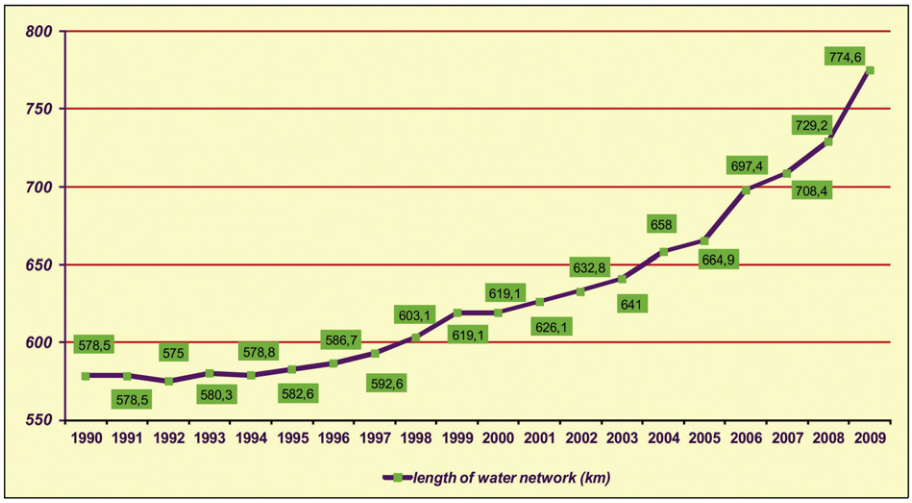

Fig. 2. Growth of the water supply network, 2000–2009.