



Children exposure to trace levels of heavy metals at the north zone of Kifissos River

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HIGHLIGHTS

- ▶ The study area was the north zone of the Kifissos River which is characterized by extensive anthropogenic interventions.
- ▶ The degree of exposure in primary school children to five toxic metals analyzing their scalp hair, is assessed.
- ▶ The concentrations of heavy metals in the Kifissos River show that the river is polluted.
- ▶ The heavy metal concentrations in the scalp hair were higher in the area of Kifisia.

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ABSTRACT

This study evaluates the exposure level of primary school children at three different towns in northern Attica, near the banks of the Kifissos River, defining referential values of toxic heavy metals. Concentrations of five toxic metals (arsenic, cadmium, mercury, lead and nickel) were analyzed in water samples from the Kifissos River as well as in the scalp hair of children aged 11 to 12 years old living in the study area. Chronic low-level toxicity of lead and cadmium came into view in recent years as a problem of our civilization. Exposure to concentrations of arsenic (As), cadmium (Cd), mercury (Hg) and lead (Pb) poses a potential threat to humans and can cause effects on children's renal and dopaminergic systems without clear evidence of a threshold, a fact that reinforces the need to control all the potential heavy metal emissions into the environment in order to protect children's health. The results were analyzed with the IBM SPSS Statistics 20 for Windows. The possible influence of sex and area was examined. Statistical differences were observed by *t*-test between the log-transformed hair concentrations of lead ($p=0.021$), arsenic ($p=0.016$) and nickel ($p=0.038$) in children's scalp hair from the municipalities of Kifisia and Kryoneri. ANOVA one-way test confirmed the difference of Pb concentration in hair between girls and boys from the municipality of Kifisia ($p=0.038$). The *t*-test confirms the difference of heavy metal concentrations in river samples between the municipalities Kifisia and Philadelphia in comparison with the samples from Kryoneri. The observations suggest that children living at the municipality of Kifisia are exposed to higher concentrations of heavy metals than the others. Despite all the confounding factors, hair can be used as a biomarker in order to determine the exposure to heavy metals, according to standardized protocols.

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1. Introduction

The metropolitan area of Athens has experienced a rapid expansion during the last six decades. The population increased from 1.4 million (1950) to 4.5 million (2010), and the town is facing serious environmental problems as a result of the increasing industrialization and traffic, but also related to its geographical relief (Chaloulakou and Mavroidis, 2002). The city of Athens and its satellite communities constitute a large urban agglomeration within the Attica basin which is about 600 km² large.

Kifissos River flows through the Metropolitan Athens area and is the main river of the city, reaching the Saronikos Gulf in the south. In addition to its springs in Parnitha and Penteli, Kifissos River collects also water from the Egaleo Mountain. From its source until Faliro, the river is 30 km long, but the total length of its most notable tributaries is over than 150 km. The River basin covers an area of 372 km² and is currently the most important natural system in the urbanized wider region of Attica. Hydraulic works have been carried out in Kifissos River since 1900, but the latest works were constructed based on a study of 1971 (Sarros, 2004).

The flow management of Kifissos River basin was initiated 35 years ago and accomplished in parts in 2004. The river has been partially trained in the past for discharges of 700, 900, 1100, and 1400 m³/s and return period of 1:50 years. These works do not comprise a coordinated flood control system because they have

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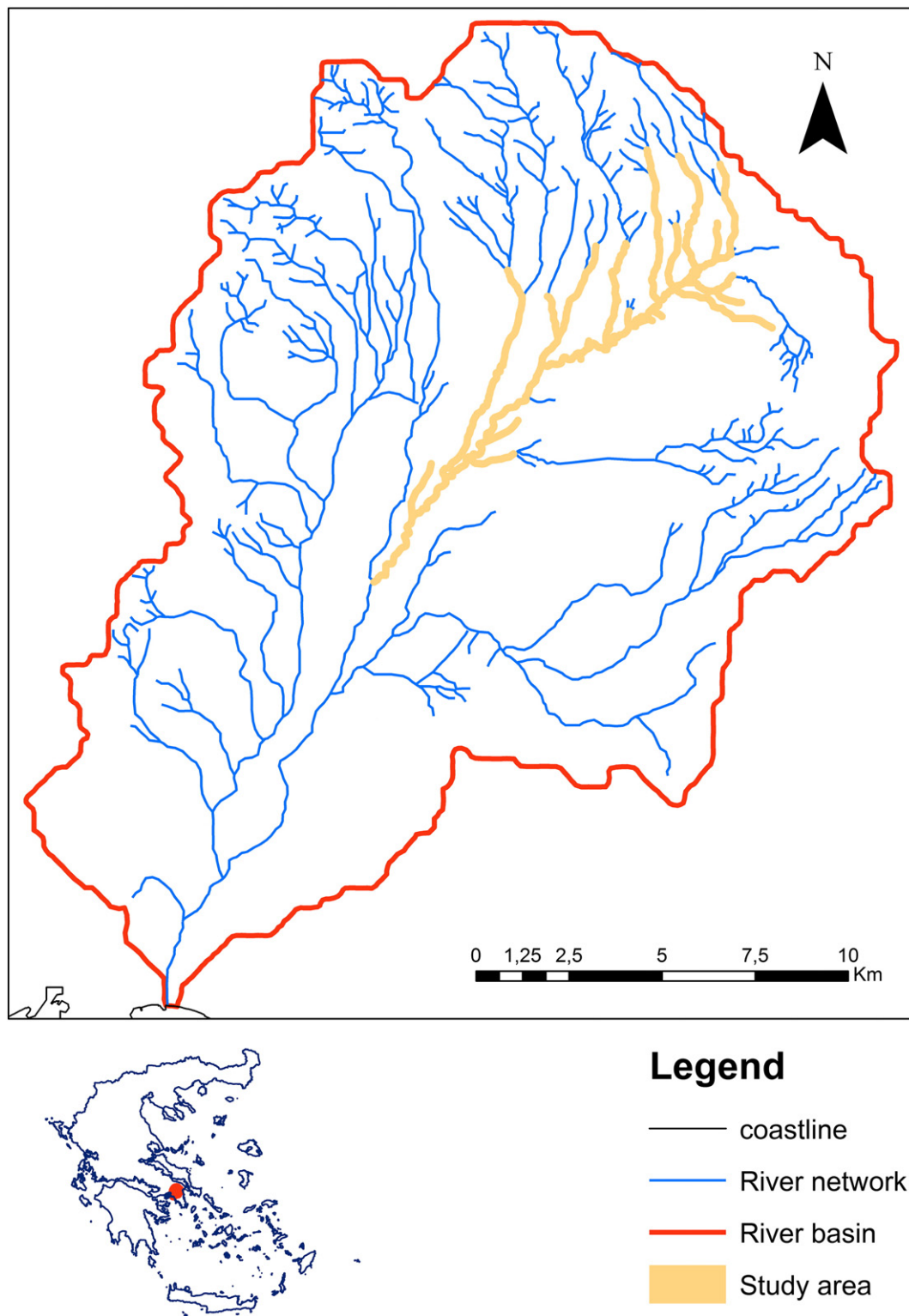


Fig. 1. The study area.

been constructed in response to specific road transportation needs. The latest and most radical intervention was the construction of a highway on top of the last 10 km of Kifissos (Mazi and Koussis, 2006). Thus, the river and its surrounding territory became dumping places for toxic industrial, domestic and institutional wastewater discharge and solid waste disposal.

Ten out of twenty trace elements are considered to be toxic for the human body. Of these, five metals, Pb, Cd, Hg, As, and Ni pose a

potential threat to humans. The health-related monitoring component of the global environmental monitoring system (GEMS) aims to assess human exposure to pollutants. The long-term objective of the biomonitoring is the assessment of human exposure to toxic metals (Lekouch et al., 1999; Shrestha and Oswald, 1987).

After exposure, chemicals are often eliminated from the body through urine, saliva, hair and the nails. The routes of excretion depend on the physicochemical properties of the heavy metals and

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