TEMPORAL EXAMINATION OF URBAN WATER RUNOFF QUALITY IN CHANIA, GREECE

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ABSTRACT

The quality of the urban runoff of the city of Chania was monitored throughout the period 2011-2014. The city runoff ends up in a subsurface pipe made of stone and built during the Venetian period of the city. Runoff samples were collected at the pipe exit which is located in the coastal area of Koum Kapi. The samples were analysed in terms of pH, EC, DO, BOD, COD, NO_3^-, SO_4^{2+}, K, Na, Ca, Cu, Ni, Zn, Cr, Cd, Pb total & fecal coliforms, E. coli και enterococci. Conductivity values ranged between 280-550 μS/cm - samples having the higher EC values also showed high values of K -6 mg/l, Na 7-36 mg/l και Ca 8-50 mg/l. The low DO values of 2-4 mg/l in combination with the high BOD and COD values of 4-35 mg/l and 6-90 mg/l, respectively, indicate a significant polluting load in the runoff, despite of the low values of heavy metals. Throughout the study period, the microbiological load was considerably high, indicating that part of the runoff polluting load is due to manually added waste.

Keywords: coastal water, urban runoff, water pollution

1. Introduction

Urbanisation has gradually resulted in deterioration of the natural environment, mainly due to the increasing quantities of polluting urban stormwater runoff. The receiving bodies – lakes, rivers and often the sea – are facing a considerable threat from everyday urban practices and isolated events. The stormwater polluting load is a result of soil erosion, dust, debris and heavy metal deposition on roads, pet littering, car washing and other similar practices. This load primarily consists of heavy metals, increased nutrient concentrations, pesticides/insecticides (used in urban gardens and yards), oils, hydrocarbons and coliforms. (Jeng *et al.*, 2005, Gnecco *et al.,* 2005, Akratos, *et al.* 2004).

This work aims to estimate the polluting load of the urban runoff from the central pipe outlet of the city of Chania, Crete. Chania is a coastal city and urban runoff network is discharged in the sea. The main pipe outlet is in the city area of Koum Kapi, a busy recreational area, where locals and tourists make use of the adjacent beach.

2. Materials and methods

Koum Kapi area is located on the western part of the city and includes a popular beach, for locals and tourists alike (Figure 1). There is a sewer pipe exit at one side of the beach, where the majority of the city's runoff is discharged (Red arrow – Figure 1). The average total stormwater runoff volume that is discharged off this point is estimated at 350 x 10^3 m^3, depending on rainfall and general weather conditions. More important is the volume that is discharged during the dry season. It is estimated that approximately 60 m^3 of urban runoff is discharged daily from this pipe, unusually high for a dry season. This indicates that there may be illicit connections and/or discharges higher up the runoff pipe network. The study period from December 2011 to July 2014, water samples were obtained from the exit of the central pipe. The water samples were collected in sterilized vials and the following parameters were measured within 2 hrs of sampling: pH, EC, DO, BOD, COD, NO_3^-, SO_4^{2+}, K, Na, Ca, Cu, Ni,

Zn, Cr, Cd, Pb total & fecal coliforms, *E. coli* και enterococci (APHA, 1998, Stavroulakis *et al.* 2014).

Figure 1: Location of the central urban runoff pipe outlet (red arrow) at Koum Kapi, Chania.

3. Results and discussion

Throughout the study period, water sample pH ranged from 7.3-8.3, whereas conductivity values were between 280-550 μS/cm. Conductivity values at the higher end were followed by increased K, Ca and Na concentrations (Figure 2). The concentration of NO_3^- ranged between 0.8-10 mg/l, in good agreement with the values reported for the coastal city of Xanthi in the North of Greece (Akratos, *et al.*, 2004). Sulphate concentrations remained low (<70 mg/L) throughout the study period.

The DO values were low (2-4 mg/L), whereas BOD and COD values were in the range of 20-35 and 6-90 mg/L, respectively. These results demonstrate that the correlation between DO, BOD, COD values can be a safe guide for the tracking back of water pollutants discharged in the urban runoff network. As shown in Figure 3, COD>BOD at all times, indicating the presence of non-biodegradable organic substances. It is interesting to note that BOD values as high as 40 mg/L were measured (12/5/14). Values above 25 mg/L exceed the limit set by legislation for discharge of municipal waste (Greek legislation Official Gazette 192 B-1997).

The biological (bacterial) load throughout the study period was considerably high (Figure 4) and within the typical value range found in untreated municipal wastewaters (Stavroulakis, 2014). The high values of fecal coliforms, *E.coli* and enterococci indicate that there may be illicit connections of- or leakages from old septic tanks within the city boundaries. A full digital mapping of the urban runoff network and thorough internal examination of the pipes would determine the position and extent of illicit connections and leakages.

The concentration ranges of Cu, Ni, Zn, Cr, Cd and Pb in the urban runoff were 1.9-20.3, 0-5.5, 3.9-23.3, 0.2-6.4, 0-0.3, 0-4.2 ppb respectively, lower compared to those reported for the city of Xanthi (Akratos *et al.*, 2004).

The urban runoff network is often responsible for the quality deterioration of bathing waters, such as those examined in this work. The organic, inorganic and biological load that comes from non-point sources is often difficult to predict and prevent (Jeng *et al*, 2005). However, it is critical for the receiving water body where recreational activities and human contact take place (Jeng *et al.*, 2005).

It is imperative that a more strict legislation is implemented, in order to protect coastal areas from malpractices (Akratos *et al.,* 2004). Such legislation may include the development of total maximum daily limits (TMDLs) for each receptive body in combination with ISO 14001 or PERS (Port Environmental Review System) implementation for the marina or port. Such actions should be complemented by an education program, addressed to all citizens regardless of age or professional status. Citizen involvement is necessary in order to achieve the highest possible protection of coastal areas from urban runoff.

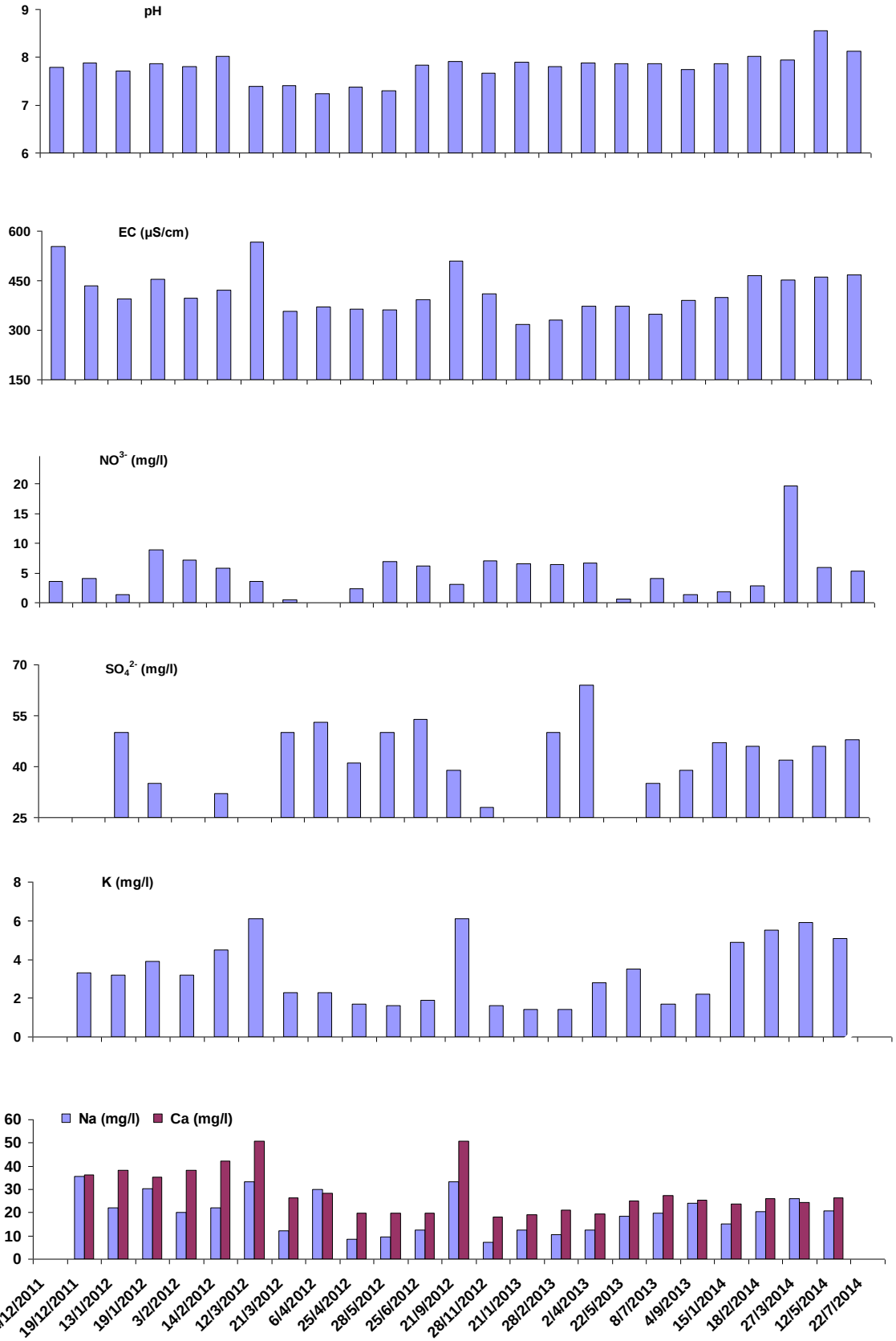

Figure 2: Measurements of pH, EC, NO_3^-, SO_4^{2-}, K, Na and Ca in the water at the central pipe outlet of the urban runoff network of Chania throughout the study period.

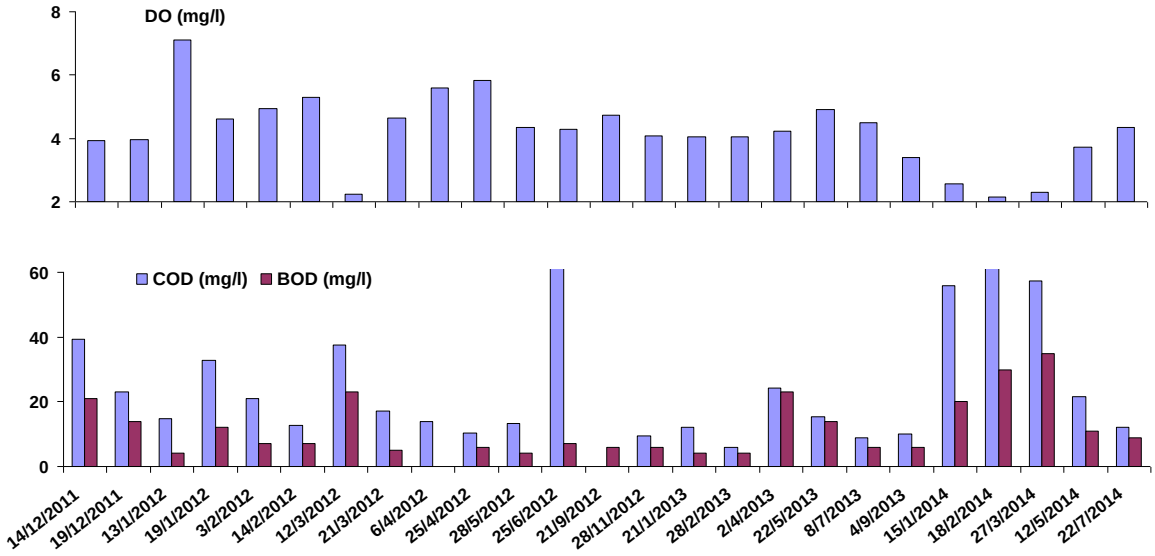

Figure 3: Measurements of DO, BOD and COD in the water at the central pipe outlet of the urban runoff network of Chania throughout the study period

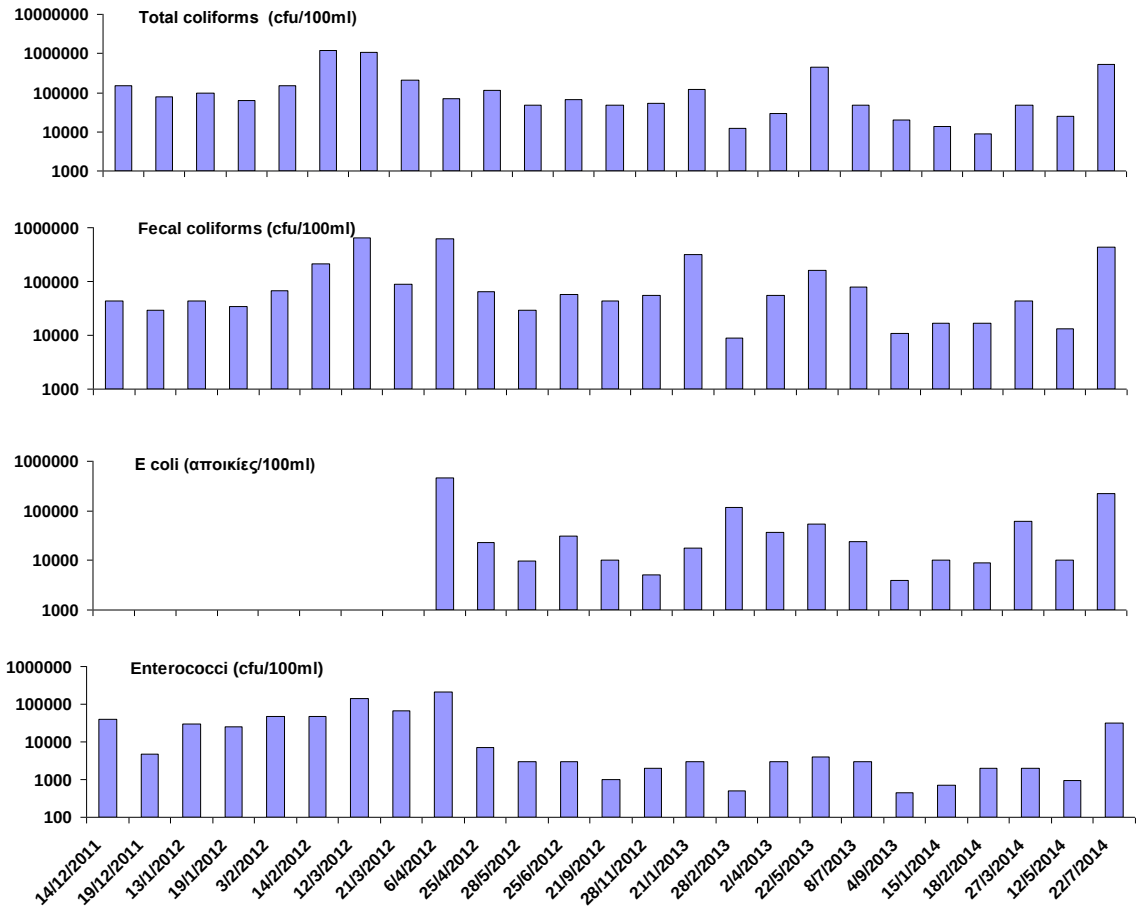

Figure 4: Measurements of total coliforms, fecal coliforms, *E. coli* and enterococci, in the water at the central pipe outlet of the urban runoff network of Chania throughout the study period.

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