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Interannual heavy element and nutrient concentration trends in the top sediments of Venice Lagoon (Italy)

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ABSTRACT

The elemental composition of surficial sediments of Venice Lagoon (Italy) in 1987, 1993, 1998 and 2003 were investigated. Zn and Cr concentrations resulted in higher than background levels, but only Cd and Hg were higher than legal quality standards (Italian Decree 2010/260 and Water Framework Directive 2000/60/EC). Contaminants with similar spatial distribution are sorted into three groups by means of correlation analysis: (i) As, Co, Cd, Cu, Fe, Pb, Zn; (ii) Ni, Cr; (iii) Hg. Interannual concentrations are compared by applying a factor analysis to the matrix of differences between subsequent samplings. A general decrease of heavy metal levels is observed from 1987 to 1993, whereas particularly high concentrations of Ni and Cr are recorded in 1998 as a consequence of intense clam fishing, subsequently mitigated by better prevention of illegal harvesting. Due to the major role played by anthropogenic sediment resuspension, bathymetric variations are also considered.

1. Introduction

Heavy metals, generally described as elements with a density >5 g/cm^3, such as lead (Pb), cadmium (Cd), zinc (Zn), mercury (Hg), chromium (Cr), copper (Cu), and iron (Fe), are among the main environmental threats to human health, being responsible for harmful effects depending on the type of metal, exposure time, concentration and degree of bio-accumulation in the food chain. Moreover, high contamination levels can seriously affect ecosystem equilibrium, compromising metabolic activities and community diversity. Trace concentrations of such elements are essential for organism physiology, but the development of industry and mining activities since the mid 19th century has rapidly increased metal pollution (Järup, 2003) to levels which may have adverse effects on biota and ecosystem. Therefore its reduction is a serious challenge, necessary in order to protect human health and to favour environmental conservation and recovery. However, background concentrations (naturally occurring) depend on local geological features and an universal threshold value cannot be established for all ecosystems (Ridgway et al., 2003). This renders the assessment of actual pollution levels and the determination of appropriate management policies very difficult. Despite the recent increasing efforts to regulate and manage the environmental impact of industrial discharges, past contamination still represents a significant ecological risk. Specifically, in coastal areas, dredging may be a serious hazard for aquatic ecosystems, as several studies demonstrate that dredged sediments may be responsible for increased toxicity and adverse ecological effects (see references in Han et al., 2011 and in Onorati et al., 2013 and references therein).

This study analyses the changes in heavy metal, carbon and nutrient levels in the surficial sediments of a coastal transitional ecosystem that has been affected for long time by significant contaminant inputs due to urban, agricultural and industrial discharges. Since the mid 20th century, the ecosystem of Venice Lagoon (North-western Adriatic Sea) has been exposed to several substantial anthropogenic pressures causing sediment pollution (Bellucci et al., 2000, 2002; Bernardello et al., 2006 and references therein; Guerzoni et al., 2007; Secco et al., 2005; Zonta et al., 2007), water contamination (Micheletti et al., 2011), eutrophication (Sfriso et al., 2003), overexploitation of biological resources (Pranovi et al., 2004), degradation of biota due to bioaccumulation of pollutants through the food chain (Raccanelli et al., 2004; Turetta et al., 2005; Sfriso et al., 2008), sediment erosion (Sfriso et al., 2005; Sarretta et al., 2010; Rapaglia et al., 2011) and consequent salt marsh losses (Molinaroli et al., 2009). On May 2003, the Italian National Authorities formally started the construction of a system to regulate tidal floods at the three inlets of the Lagoon

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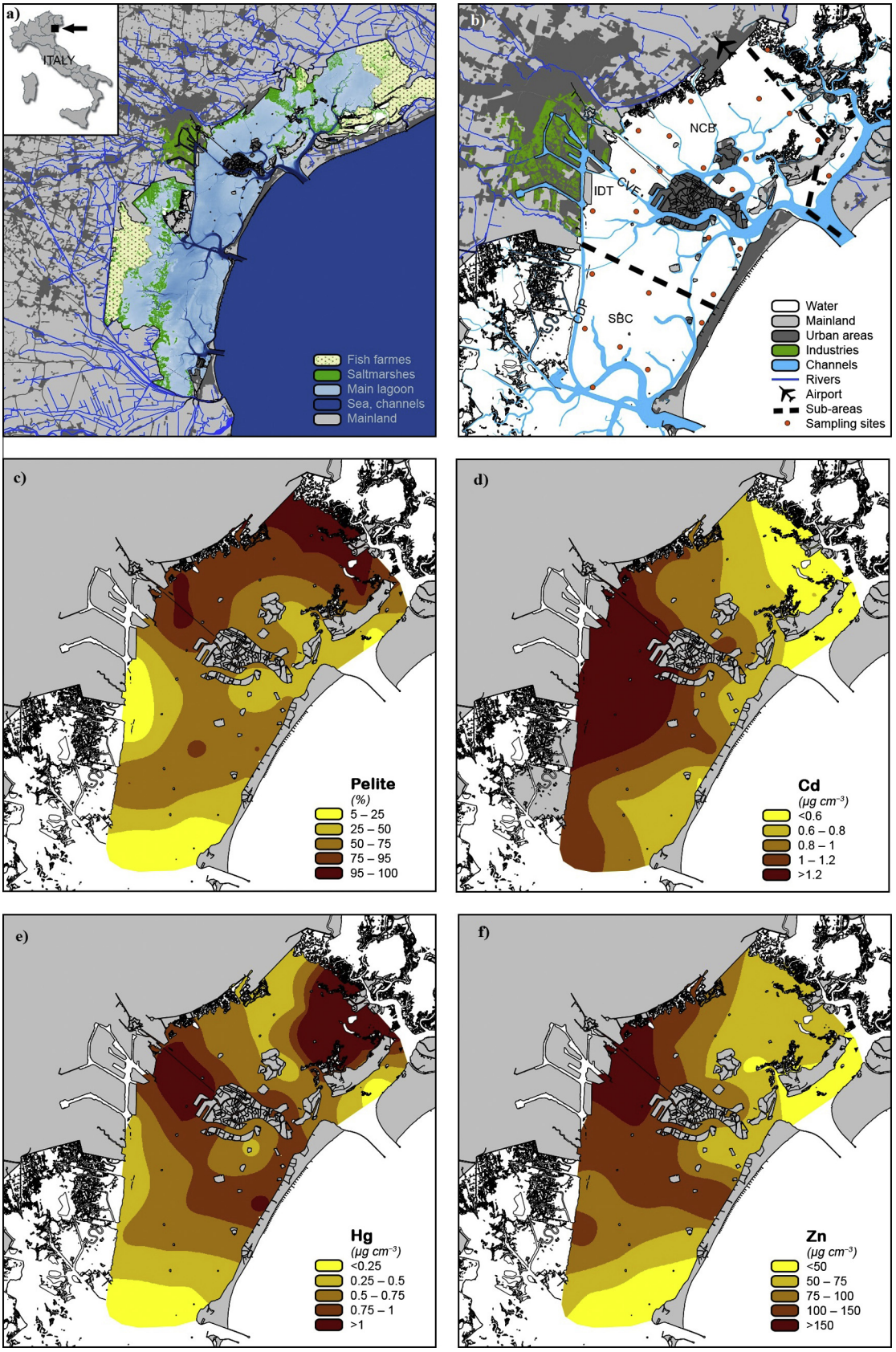

Fig. 1. (a) Map of Venice Lagoon, (b) Detail of the study area; (c) mud content (% pelite <63 μm); (d) Cadmium (μg cm^{-3}); (e) Mercury (μg cm^{-3}); and (f) Zinc (μg cm^{-3}). NCB = Northern-Central Basin; SCB = Southern-Central Basin; CDP = Canale dei Petroli; CVE = Canale Vittorio Emanuele II; IDT = Isola delle Tresse.