

# The river basin-coastal zone continuum: heavy metal contents in stream and marine sediments, NW Aegean Sea (EUROCAT Project)

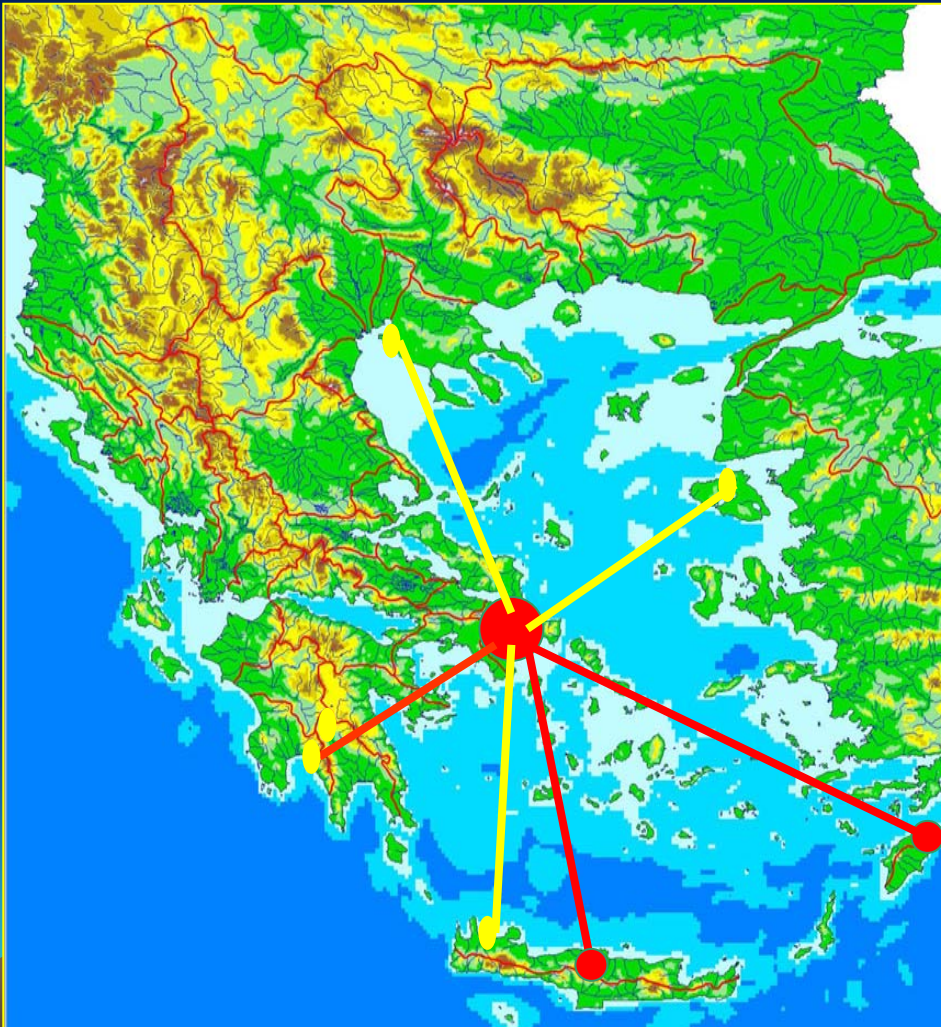
Aristomenis P. Karageorgis<sup>1</sup>, Nikolaos P. Nikolaidis<sup>2</sup>

<sup>1</sup>Institute of Oceanography, Hellenic Centre for Marine Research, 46.7 km  
Athens-Sounio Avenue, 19013 Anavyssos, Greece

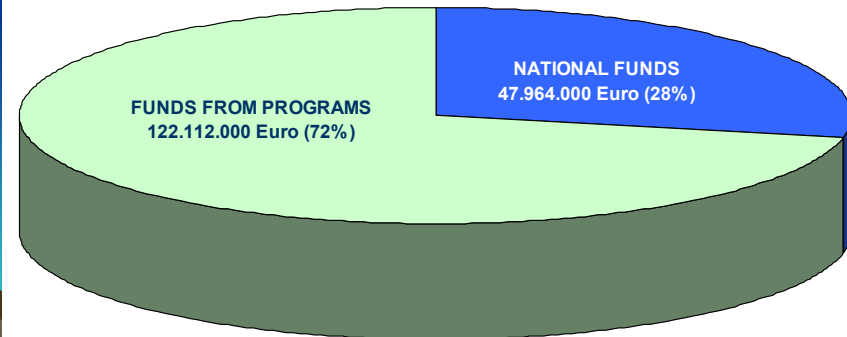
<sup>2</sup>Department of Environmental Engineering, Technical University of Crete,  
Polytechniopolis, 73100 Chania, Greece

E-mail: [ak@ath.hcmr.gr](mailto:ak@ath.hcmr.gr); [nnikolai@mred.tuc.gr](mailto:nnikolai@mred.tuc.gr)

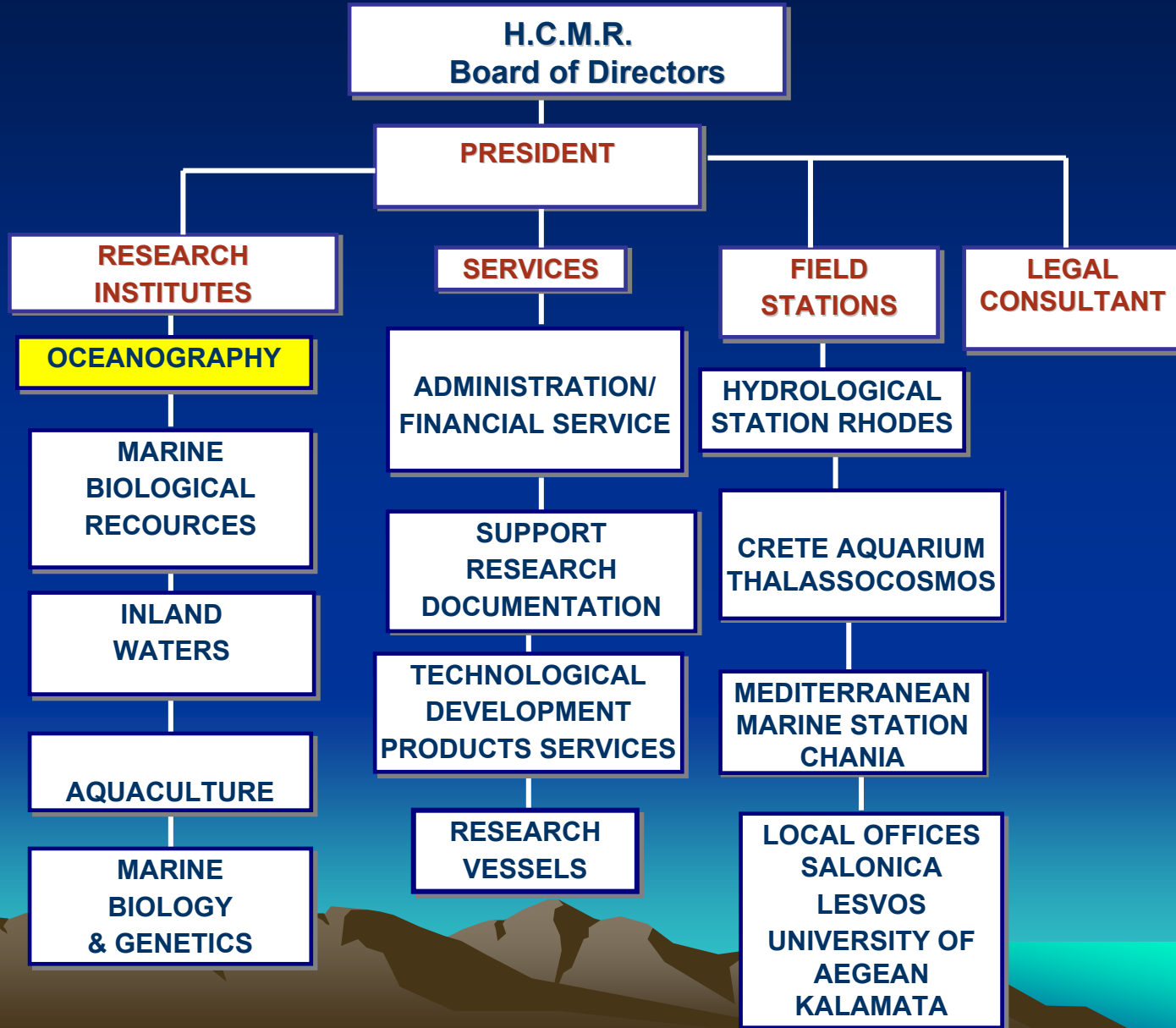
# Hellenic Centre for Marine Research Research-branches & budget



NATIONAL FUNDS - FUNDS FROM PROGRAMS  
H.C.M.R. 1996 - 2004



# HCMR structure



# HCMR-R/Vs *Aegaeo* & *Philia*



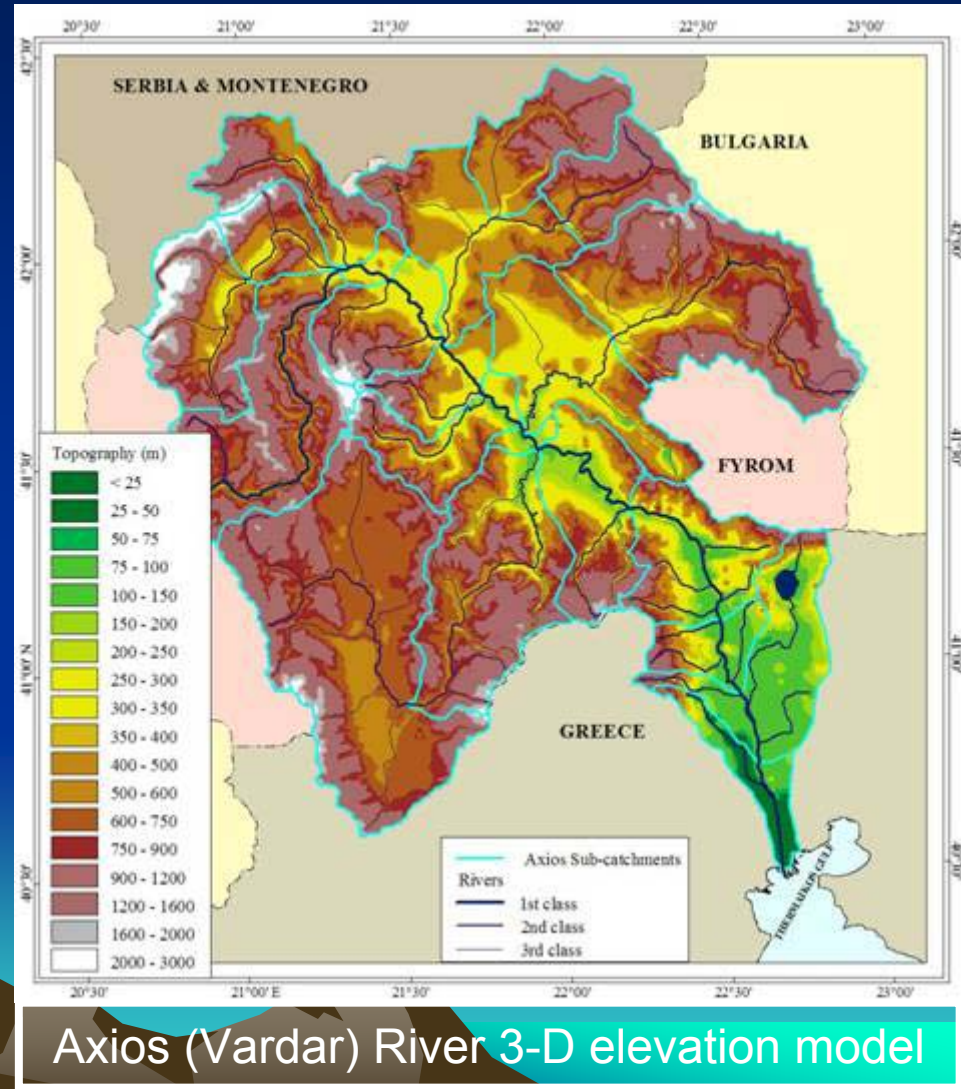
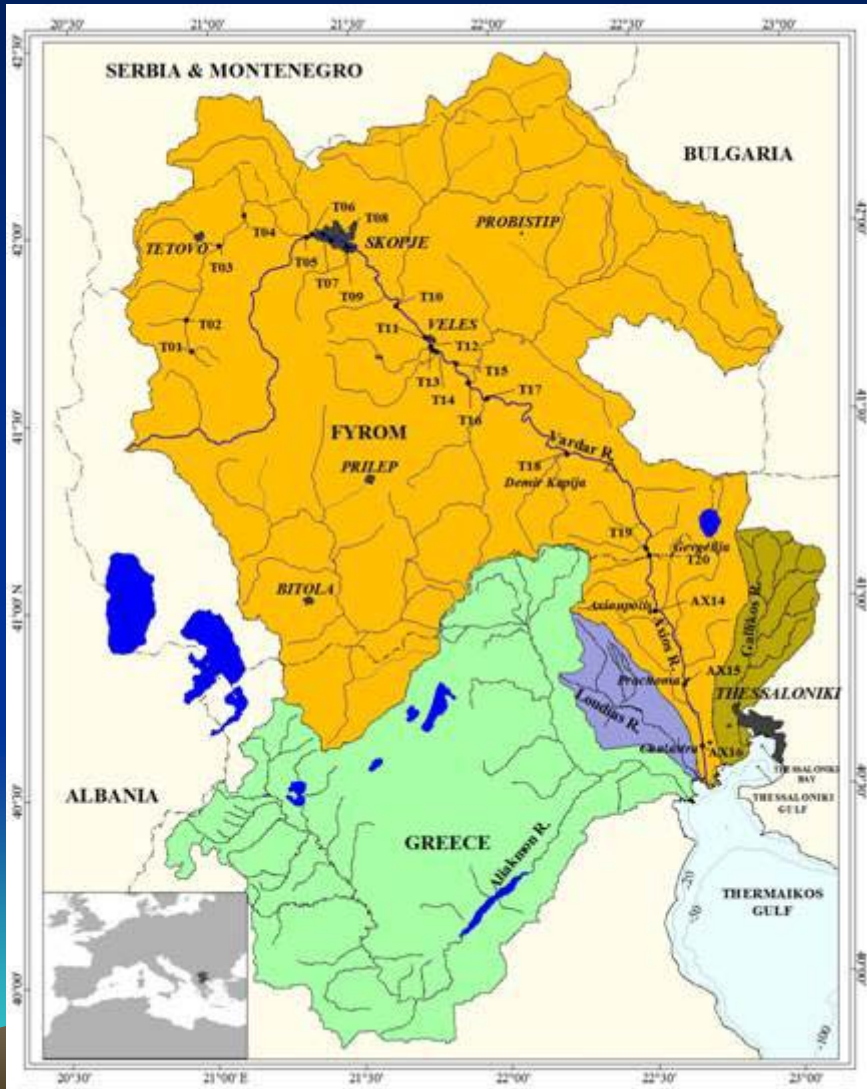
# HCMR-submersible *Thetis*



# EUROCAT



# Study area



Axios (Vardar) River 3-D elevation model

# Principal industrial hot spots in FYROM investigated by UNEP-2000

Ferro-alloy plant at Jegunovce ('HEK Jugochrom')

Jegunovce

Cr

Organic chemicals plant, Skopje (OHIS A.D.)

Skopje

HCH isomers, SO<sub>2</sub>

Lead and zinc smelter, Veles ('MHK Zletovo')

Veles

Pb, Zn, Cd, H<sub>2</sub>SO<sub>4</sub>

Zinc and lead mine, Probistip ('Rudnici Zletovo')

Probistip

Pb, Zn, Cd, cyanides

Metal resurfacing factory, Kicevo ('Tane Caleski')

Kicevo

Cr, Zn

Thermal power plant, Bitola ('REK Bitola')

Bitola

Heavy metals, SO<sub>2</sub>

Landfill site, Drisla, near Skopje

Drisla

Organic & inorganic pollutants

Fertilizer factory, Veles ('MHK Zletovo')

Veles

P, N

Copper mine, Radovis ('Buchim S.C.')

Radovis

Cu, organic pollutants

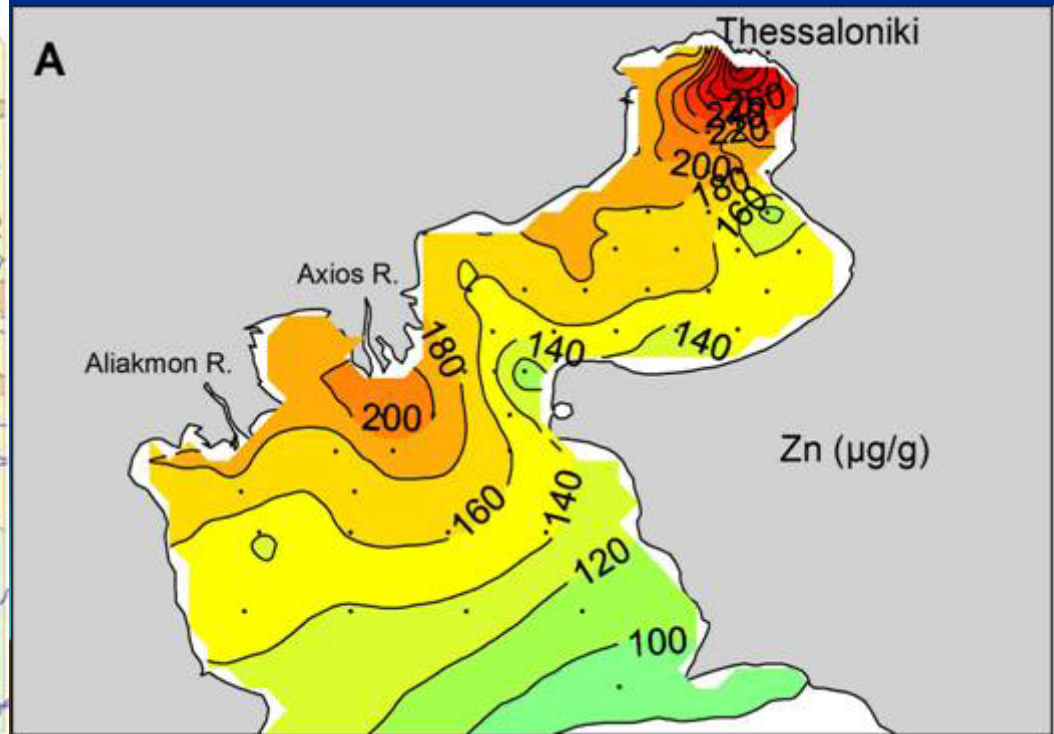
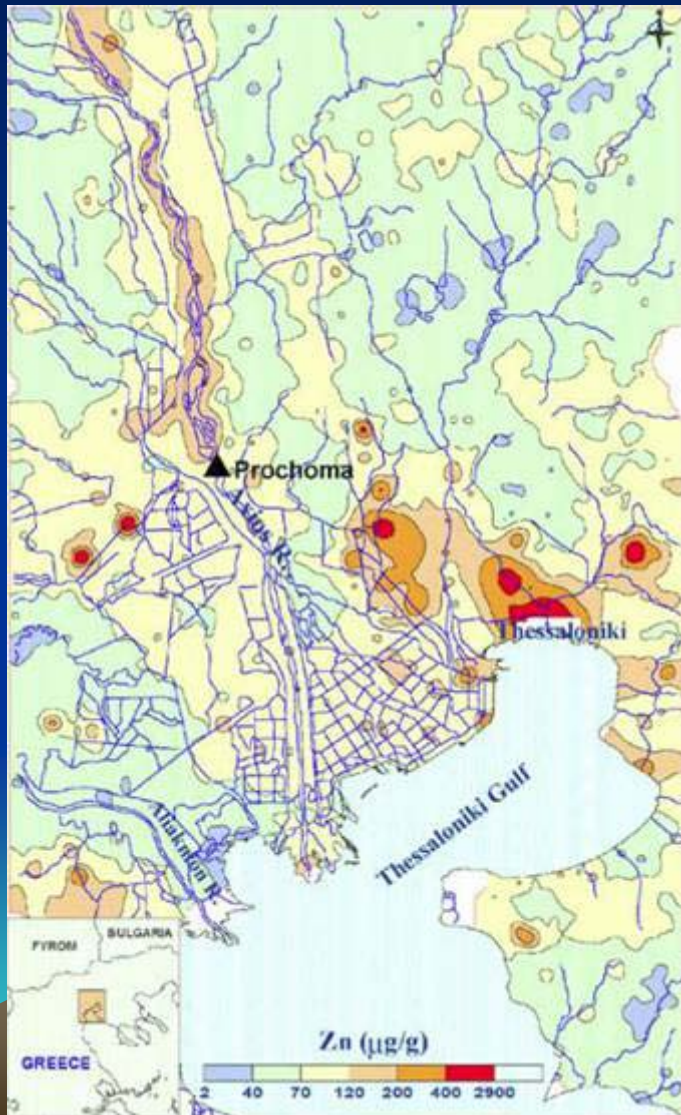
Lojane mine

Lojane

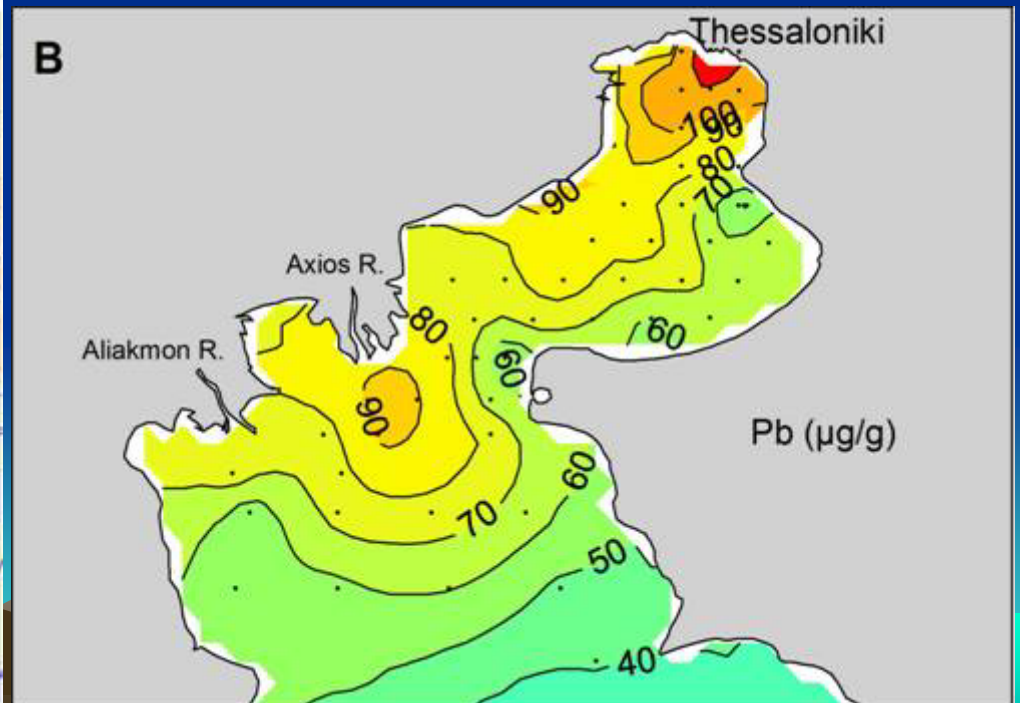
As, Cr, Sb



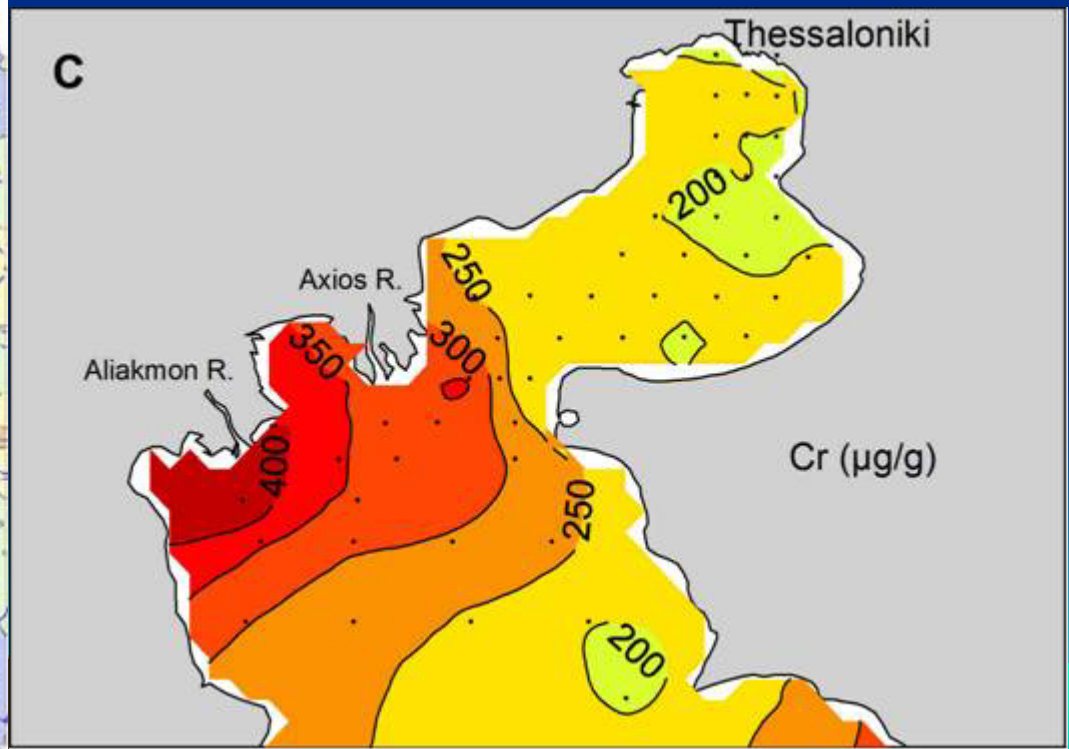
# Zn in stream and marine sediments



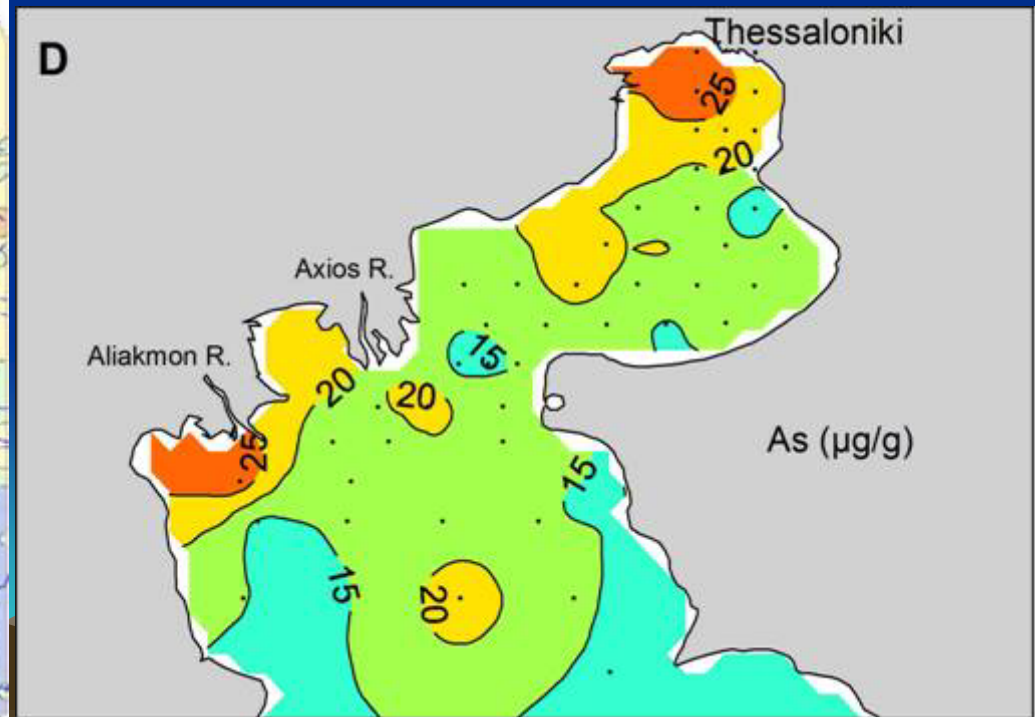
# Pb in stream and marine sediments



# Cr in stream and marine sediments



# As in stream and marine sediments



# Sediment quality assessment

- The sediment metal contents were compared against the **Direct Exposure Soil Action Levels (SALs)** Standards for residential use.
- A comparison of the sediment data for Axios River and Thermaikos Gulf with the SALs, reveal that the levels are not exceeded for copper, lead, zinc, cadmium and nickel.
- The SALs are exceeded for **arsenic** (27% of the data for river sediments and 100% of the marine sediments) and for **chromium** (42% of the data for river sediments and 100% of the marine sediments), if we assume that all chromium measured is in the oxidized form.



# Sediment quality assessment

- **Hexavalent chromium** is a known lung carcinogen and toxic through oral or dermal exposure (i.e. the standards are 100  $\mu\text{g/g}$  for Cr(VI) vs. 3,900  $\mu\text{g/g}$  for Cr(III)). In contrast, trivalent chromium is an essential trace element in human nutrition: Need for speciation!!!
- **Arsenic** concentrations exhibit a definite enrichment indicating a potential human health effect to direct exposure for the marine sediments.



# Conclusions 1

- Heavy metals in sediments: Zn, Pb, Cr and As levels appear to be elevated.
- A significant part of these metals originates in ophiolite complexes and other heavy metal-rich formations that are abundant in the Axios R. catchment.
- Smelting industries and mine tailings in FYROM should be considered as primary point sources of heavy metals in the area.



# Conclusions 2

- Marine sediments of the Thermaikos Gulf clearly reflect heavy- metal sources, namely the Axios and Aliakmon Rivers, as well as the city and industrial zone of Thessaloniki.
- Sediments quality criteria are exceeded for As and Cr, in both river and marine sediments.
- The need for Cr speciation and regular monitoring is highly recommended.



# Sources

- Karageorgis, A.P., Anagnostou, C.L., and Kaberi, H., 2005. Geochemistry and mineralogy of the NW Aegean Sea surface sediments: implications for river runoff and anthropogenic impact. *Applied Geochemistry*, 20(1), 69–88. DOI: 10.1016/j.apgeochem.2004.07.008.
- Karageorgis, A.P., Kaberi, H., Price, N.B., Muir, G.K.P., Pates, J.M. and Lykousis, V., 2005. Chemical composition of short sediment cores from Thermaikos Gulf (Eastern Mediterranean): Sediment accumulation rates, trawling and winnowing effects. *Continental Shelf Research*, 25, 2456-2475.
- Karageorgis, A.P., Skourtos, M.S., Kapsimalis, V., Kontogianni, A.D., Skoulikidis, N.Th., Pagou, K., Nikolaidis, N.P., Drakopoulou, P., Zanou, B., Karamanos, H., Levkov, Z., and Anagnostou, Ch., 2005. An integrated approach to watershed management within the DPSIR framework: Axios River catchment and Thermaikos Gulf. *Regional Environmental Change*, 5, 138-160. DOI: 10.1007/s10113-004-0078-7.
- Karageorgis, A.P., Nikolaidis, N.P., Karamanos, H. and Skoulikidis, N., 2003. Water and Sediment Quality Assessment of the Axios River and its Coastal Environment. *Continental Shelf Research*, 23(17-19), 1929-1944. DOI: 10.1016/j.csr.2003.06.009.
- UNEP, 2000. Post-Conflict environmental assessment-FYR of Macedonia. UNEP Report, 88p.

