

Health risks due to the presence of lead (Pb) and copper (Cu) in a coastal area of Tabasco, Mexico

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Abstract

Aquatic environments are being impacted in Mexico and worldwide due to anthropogenic activities. Since some metals are accumulated in the environment while others are magnified in the chain trophy, they represent a risk to organisms living there as well as human settlements established in the zone. The objective was to identify the concentration of lead (Pb) and copper (Cu) in the water of *Barra de dos Bocas* located in Tabasco, Mexico. The water sampling was done at depths of 1, 3 and 5 m, obtaining a weekly sample of 500ml during the period between January and May 2007. The water samples were treated and analyzed according to Mexican Norm NMX-AA-SCFI-051-2001 using atomic absorption. In addition, pH and EC were determined. The Pb concentration varied in the range of $0.123\text{-}0.378\pm 0.062$ mg L⁻¹. The Pb levels were higher than those established in the Ecological Norm NOM-001-ECOL-1996, which indicates a Maximum Permissible Level of 0.2 mg L⁻¹. The Cu levels were within a range of $0.004\text{-}0.258\pm 0.023$ mg L⁻¹ which is below the Maximum Permissible Level indicated in the norm of 0.4 mg L⁻¹. The Pb may pose a problem to the aquatic environment and a health risk to humans

Keywords: heavy metals, lead, cooper, pollution, Tabasco, Mexico.

1 Introduction

Heavy metals can cause a different sort of pollution in any given environment. Some of them like Pb, Cu, Hg and Cd, are very toxic and widely distributed



overseas, which is a potential health risk to humans or to organisms in that environment [1–4]. In the case of Mexico's coastal areas, studies have considered the level of heavy metals [5–8] to evaluate the environmental impact and the effect on aquatic organisms [9, 10]. Mendez *et al.* [11] and Mendez *et al.* [12] carried out studies in the Gulf of Mexico, specifically in the Coatzacoalcos River, and found levels of Pb of 11.6 mg L⁻¹ and 29.4 mg L⁻¹. These results represent a cautionary situation because they are higher than those established in the Mexican Norm [12], which specifies a value of 0.006 mg L⁻¹ as a Maximum Permissible Limit (MPL).

Given this background, it is important to detect the levels of metals like Pb and Cu, because anthropogenic activities might accelerate this process in aquatic environments [13, 14]. Consequently, the metal presence in water could be a real issue for communities or the environment, specifically in the area known as *Boca de dos Rios* in Tabasco, Mexico, which has been altered by the oil industry for discharge purposes and by the touristic zone of Paraiso for dumping residual waste. One must remember that Tabasco is the most significant crude oil producer in Mexico. The objective was to determine the concentration levels of Pb and Cu in *Boca de dos Rios*. These results will help different levels of Mexican authority to take regulatory action against anthropogenic activities and to improve environmental legislation; but more importantly, to provide better health to the communities established in the zone and to those protecting coastal environmental quality.

2 Materials and methods

The study was carried out in the district known as *Barra de dos Bocas*, Tabasco, Mexico. This area is located between the lagoon named *dos Bocas* and the lagoon known as Mecoacan, at 18°16', 18° 26' North Latitude and 93°04', 93° 14' West Longitude. It corresponds to the physiographic province identified as Llanura Costera del Golfo or Zona Pantanosa de Tabasco and is also in the lower part of the Mezcalapa River (Figure 1). The zone is situated 50 km west of the border community and 68 km north of the community of Cardenas. The closest town is Puerto Ceiba, which is a settlement in the northeastern part of both lagoons.

The water sampling was taken from the lower part of the Seco River, in the direction of the Gulf of Mexico. We hypothesized that at this point, it was possible to find sediments and organic material coming from the tourist city of Paraiso. Also, in this area, it was possible to find some hydrocarbon as a byproduct of the oil industry in Tabasco. Water samples were taken at three depths; 1, 3, and 5 m and were obtained according to Mexican Norm [15] at weekly intervals during the period between January and May 2007. The water sampling and water analysis were completed to determine Pb and Cu concentration according to Mexican Norm [12].



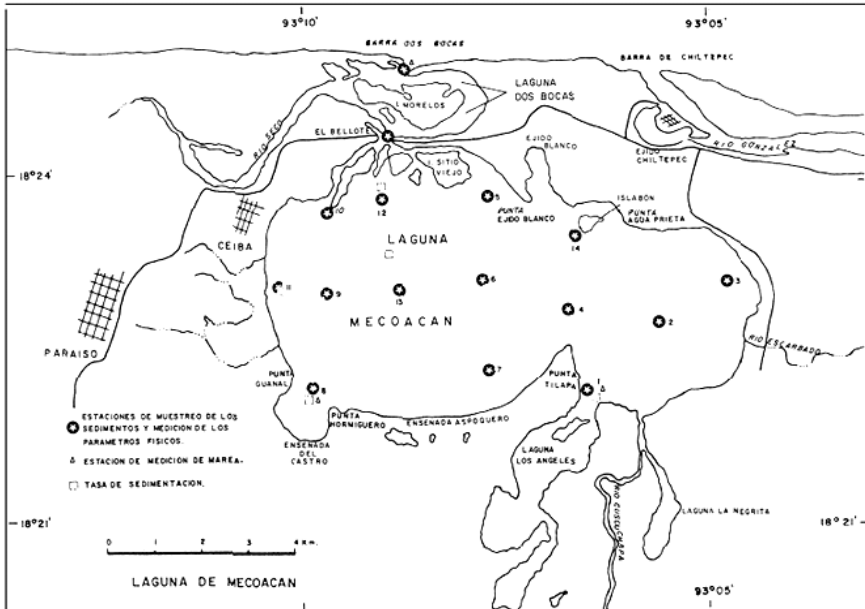


Figure 1: Map of Laguna dos Bocas showing the sampling points.

3 Results and discussion

Figure 2 shows five graphs (a)–(e) that point out the results of Pb concentration in the five sampling months and in the three depths. Figure 2(f) indicates the mean level per month and per depth. In all graphs, a horizontal line calls attention to the MPL established in Mexico's Ecological Norm for coastal waters (fishing exploitation, navigation and other uses) with the aim of comparing the concentrations found. In the January sampling, concentrations were noted in the range of 0.166–0.287 mg L⁻¹ in to 1 m depth (Figure 2(a)). These values were lower and were detected during the first three weeks because in the fourth week, sampling was observed in the higher concentration, reaching a value of 0.287 mg L⁻¹. In the samples at the 3 m depth, the concentrations were noted in a range of 0.266–0.378 mg L⁻¹, observing higher levels in the three week samples. As to water samples in the 5 m depths, the concentrations of this element were in the range of 0.260–0.301 mg L⁻¹ which is below the concentrations found at the 3 m depth.

In the February sampling, the concentration of Pb in 1 m depth was in the range of 0.184–0.222 mg L⁻¹ (Figure 2(b)). In water samples at 3 m, the concentration levels varied in the range of 0.209–0.290 mg L⁻¹ which is higher than those observed at 1 m. In the case of 5 m depth samples, the concentrations were in the range of 0.280–0.312 mg L⁻¹ which is higher than those noted in 1 m and 3 m depths.



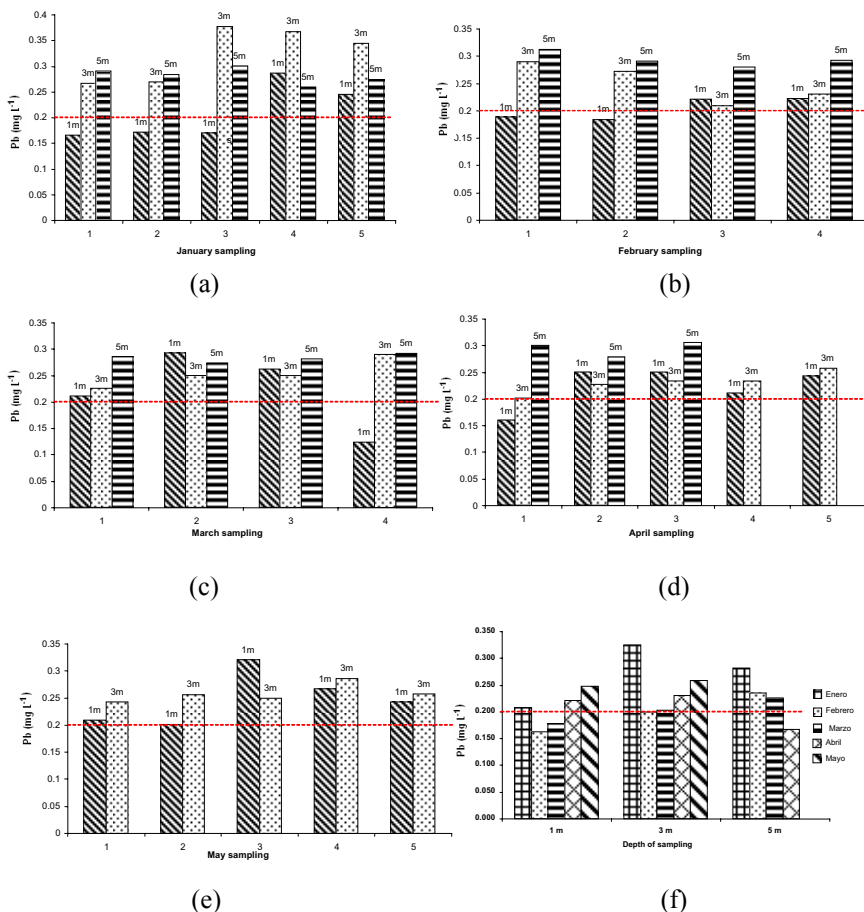


Figure 2: Pb concentration (mg L^{-1}) considering sampling month, sampling depth (a)–(e) and a concentrate of data (f).

In the March samples, the concentration level was as high as 0.293 mg L^{-1} at 5 m and was observed in the fourth week (Figure 2(c)). This level was slightly higher than those observed in 1 m (0.292 mg L^{-1}) and in 3 m depth samples. April concentrations at 1 m depth were in the range of $0.159\text{--}0.249 \text{ mg L}^{-1}$ while at 3 m, they varied from $0.201\text{--}0.258 \text{ mg L}^{-1}$ to $0.279\text{--}0.306 \text{ mg L}^{-1}$ at 5 m depth (Figure 2(d)). It was evident that higher concentrations of Pb were noted in the first weeks at 5 m depth. These results may be explained by the presence of sediments in the river that are considered critical to an aquatic environment [16, 17]; nevertheless, this metal was not found in the samples at 5 m depths during the last two weeks.

In the May samples, the concentrations were detected in the range of $0.201\text{--}0.321 \text{ mg L}^{-1}$ at 1 m depth and of $0.243\text{--}0.286 \text{ mg L}^{-1}$ at 3 m depth (Figure 2(e)).

It was also noted that Pb was not detectable at 5 m depths during the monthly samples. Figure 2(f) shows a concrete of the mean concentration of $0.123\text{--}0.378\pm 0.062\text{ mg L}^{-1}$ that is higher than the MPL pointed out in the Mexican Norm. The results reported in this study concerning Pb are higher than those reported in previous research that specify levels of $0.23\pm 0.14\text{ mg L}^{-1}$ in Laguna la Machona and levels of $0.24\pm 0.4\text{ mg L}^{-1}$ in Laguna de Mecoacan, in Tabasco [10]. Moreover, in Laguna de Terminos in Campeche, Mexico, levels of $0.25\pm 0.01\text{ mg L}^{-1}$ [3] were detected that are also lower than those reported in this research. The Pb level in water has been considered a potential threat to human life throughout Mexico, when it is analyzed that Pb concentration could be as high as 0.45 ppm, reported for the Laguna de Bustillos in northern Mexico [14].

The Environmental Protection Agency (EPA) of the United States has determined toxicity limits for concentrations of metals in aquatic estuarine and coastal areas [18]. For Pb, the MPL is specified in $5.8\text{ }\mu\text{g L}^{-1}$ as the mean concentration in four days. It is a well-known fact that high levels may cause toxicity in humans and even death. Therefore, it is noted that the present study results concerning water quality carried out in Barra de dos Bocas, are superior to the values specified in Mexican and international norms.

Figure 3 (a)–(e) shows the concentration levels of Cu due to sampling month, sampling depth and a concentrate of the mean information of this element (Figure 3(f)). In the January sampling, the levels of Cu varied in the range of $0.038\text{--}0.079\text{ mg L}^{-1}$ at 1 m depth and of $0.034\text{--}0.064\text{ mg L}^{-1}$ at 3 m depth. This element was not detected in water samples at 5 m depth (Figure 3(a)). Results of the February sampling are noted in Figure 3(b). Notice that the higher level was detected during the first week with a concentration level of $0.027\text{--}0.064\text{ mg L}^{-1}$ at 1 m depth. The Cu concentration at 3 m depth was in the range of $0.038\text{--}0.052\text{ mg L}^{-1}$, similar to the January sampling. Cu levels were not detected during this month at 5 m depth. During the March sampling, the Cu concentrations varied from $0.034\text{--}0.074\text{ mg L}^{-1}$ (Figure 3(c)) at 1 m depth while concentrations in the range of $0.036\text{--}0.046\text{ mg L}^{-1}$ were noted at 3 m depth. Figure 3(d) exemplifies the results of the April sampling. It is evident that, generally Cu concentrations increased after each week of sampling. The concentration level at 1 m depth varied from $0.031\text{--}0.065\text{ mg L}^{-1}$ while in the 3 m depth, changes were in the range of $0.051\text{--}0.107\text{ mg L}^{-1}$.

Water samples in May showed concentrations of $0.041\text{--}0.243\text{ mg L}^{-1}$ at 1 m depth and of $0.004\text{--}0.258\text{ mg L}^{-1}$ at 3 m depth (Figure 3(e)). A higher Cu level was noted during the last week of sampling with $0.243\text{--}0.258\text{ mg L}^{-1}$. General data for this element from January to May 2007 is shown in Figure 3(f). In general, the results reported here are higher than some previously reported in analogous ecosystems, such as in the neighboring state of Veracruz, Mexico, where 0.049 mg L^{-1} was reported and Campeche, Mexico with levels of 0.045 mg L^{-1} [19]. Nonetheless, in this particular case, the Cu concentration did not over estimate the MPL that is specified in Mexico's Ecological Norm that point to a level of 0.4 mg L^{-1} for coastal water. Moreover, the EPA has established a level of $2.9\text{ }\mu\text{g L}^{-1}$ that is higher than the values reported in the present study.



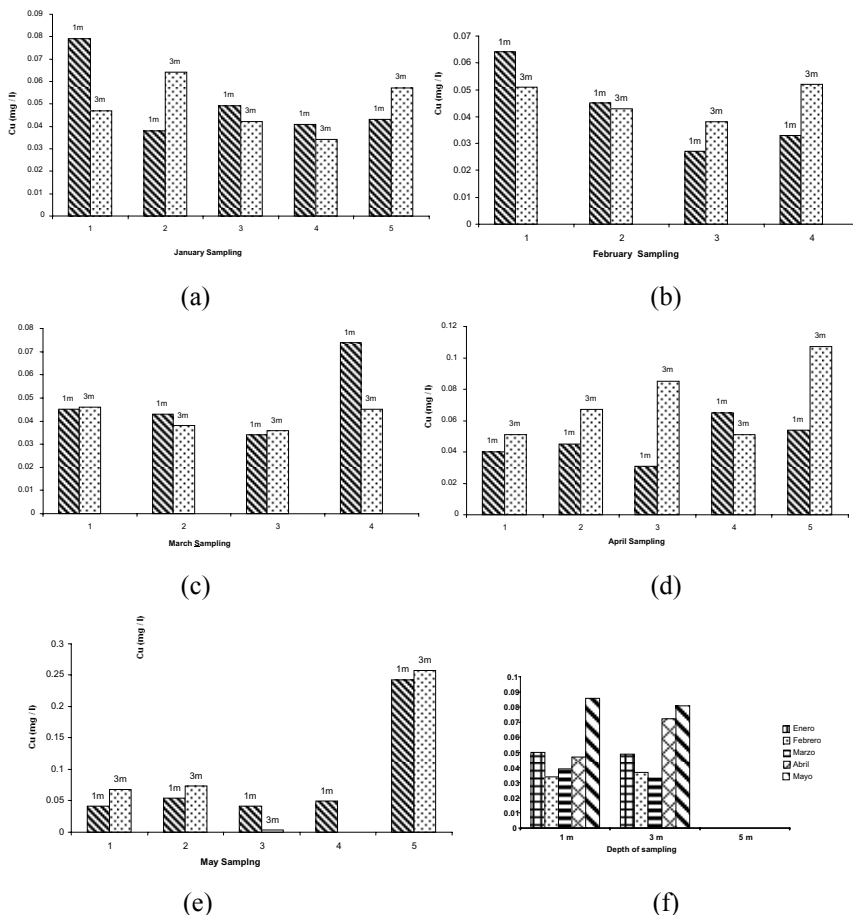


Figure 3: Cu concentration (mg L^{-1}) considering sampling month, sampling depth (a)–(e) and a concentrate of data (f).

The pH of seawater is lightly elemental ranging from 7.5 to 8.4 [20]. The results of this study show that pH values at 1 m depth ranged from 6.81 to 7.82 while at 3 m depth, they varied from 6.86 to 7.77. In respect to this parameter at 5 m depth, the values were from 6.78 to 8.03. So, pH values detected in this study agree with those values established as MPL in the Mexican norm for coastal water. Concerning the EC parameter, the values ranged from $0.09 \mu\text{S}$ to $0.63 \mu\text{S}$ which are normal but the highest values were noted in the April samples.

4 Conclusions

The Pb concentration noted in this study was higher than the levels specified in Mexican norms as well as the values reported as Maximum Permissible Levels



for the EPA in the United States. These results are of practical importance because the whole environment is being affected and they represent a red flag for the communities settled along this river who depend on this natural resource. On the other hand, the Cu levels are not higher than those reported in the Mexican and International standards.

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