Assessment of potential ecological risk of Cr, Cd, Pb and As, in coastal sediments.

Nezha MEJJAD[1]*, Samira El Aouidi[1], Abdelmourhit Laissaoui[1]
[1]National Centre for Nuclear Energy, Science and Technology (CNESTEN), Kénitra, Morocco.

INTRODUCTION & AIM

Lagoon ecosystems provide multiple ecosystem services and contribute to human well-being (*Mejjad et al., 2020*). Various activities are practiced in coastal lagoons and play an essential role in socio-economic growth at local and national levels. Coastal tourism, fishing and aquaculture are the main activities practiced in such ecosystems (*Maanan et al., 2014; Benmhammed et al., 2021; Mejjad et al., 2018*). The uncontrolled development of these activities can lead to the depletion of natural resources due to increased pollution, overfishing, and overtourism (*Mejjad et al., 2022*).

The Oualidia lagoon is the oyster capital of Morocco and is well known for its oyster farming activities, where national and international tourists visit Oualidia to taste its exceptional oysters. However, the increase of human activities around this lagoon could reduce its environmental quality and threaten its ecological functions.

The sustainability of the natural resources of the Oualidia lagoon, including fisheries and oysters, mainly depends on various ecological factors, as for example the growth of oysters is affected by salinity, temperature, natural food availability (*Vidya et al., 2020*). In addition, the chemicals present in the lagoon water could affect the growth rate and quality of oysters.

Due to the importance of such a natural ecosystem, its conservation and protection requires continuous monitoring of its environmental quality. In this sense, we evaluate the potential ecological risk of Cr, Cd, Pb, Zn, Co, Ni and As in coastal sediment cores collected from the Oualidia lagoon.

Coastal sediments are a powerful tool for analyzing pollution levels and reconstructing history, so the results of the present study would allow a better understanding of the environmental quality of this coastal lagoon.

METHOD

Sampling and Analytical techniques

Two sediment cores were retrieved from the Oualidia lagoon in 2014. The sediment cores have undergone physical preparation, radiometric and chemical analysis using gamma spectrometry and ICP-MS respectively (Figure 1),

These sediment cores were also dated using lead-210 in order to study the temporal variations of the studied metals (*Laissaoui et al., 2018*).

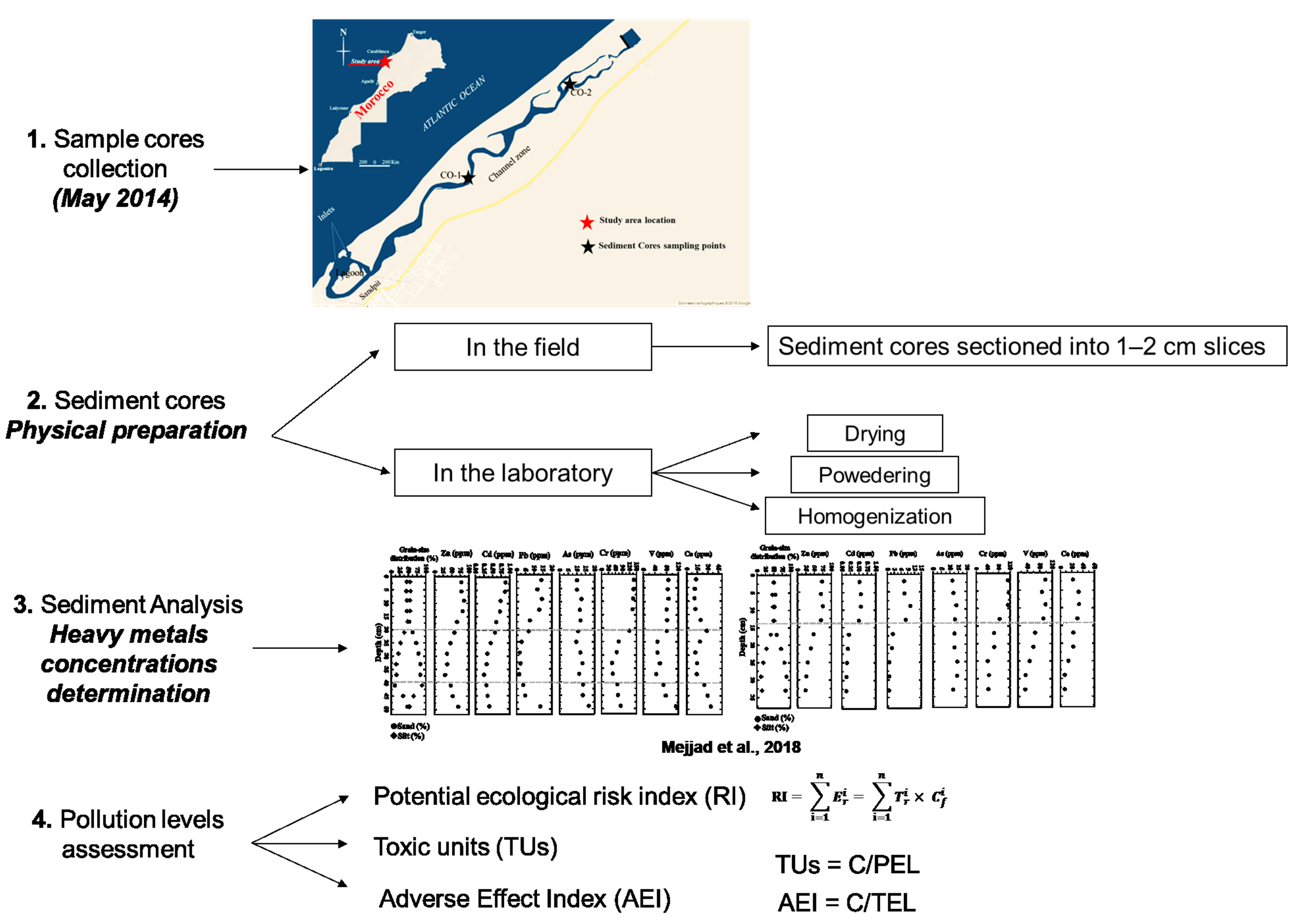

Figure1: The study flowchart.

RESULTS & DISCUSSION

The present study evaluates the potential ecological risk of Cr, Cd, Pb and As in coastal sediment cores collected from the Oualidia lagoon. These sediment cores were also dated using lead-210 to investigate the temporal variations of the examined metals (*Mejjad et al., 2018*). The potential ecological risk values of the studied metals indicate a moderate ecological risk in the first 21 cm and 15 cm of sediment cores CO-1 and CO-2, respectively. The Toxic Unit Index indicates low toxicity to the lagoon ecosystem (Table 1). The Adverse Effect Index (AEI) values indicate a probable effect on the biota due to the concentrations of Cr, As and Cd mainly in the surface layers. It should be noted that even if the concentrations of the other heavy metals are not sufficient to induce a negative biological effect, a continuous monitoring of the heavy metal levels in the lagoon is required, as the AEI values are close to 1 mainly in the surface layer.

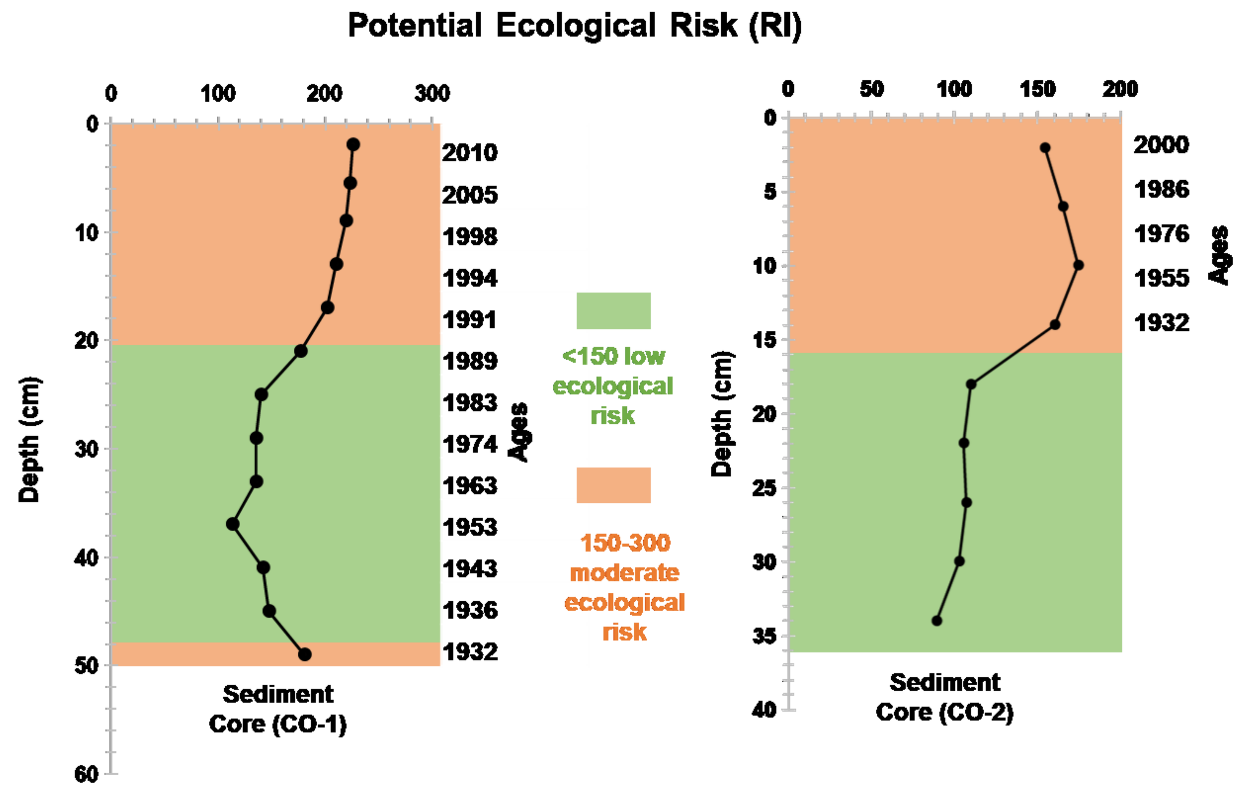

Figure2: The Potential ecological risk calculated for the total analyzed heavy metals.

Table 1: Toxic units (TUs) calculated for the total analyzed heavy metals.

ΣTUs < 4 low toxicity to an ecosystem
ΣTUs > 4 Moderate toxicity to an ecosystem

CO-1

Depth (cm)	TU (Cu)	TU (Zn)	TU (Ni)	TU (Cd)	TU (Pb)	TU (Cr)	TU (As)
2	0,16	0,29	0,33	0,21	0,13	0,87	0,24
5,5	0,16	0,29	0,32	0,20	0,11	0,86	0,24
9	0,17	0,32	0,31	0,17	0,13	0,85	0,30
13	0,16	0,30	0,30	0,17	0,11	0,83	0,28
17	0,12	0,24	0,25	0,14	0,07	1,09	0,29
21	0,10	0,21	0,22	0,14	0,06	0,74	0,26
25	0,08	0,17	0,17	0,11	0,02	0,46	0,23
29	0,06	0,13	0,13	0,08	0,02	0,41	0,29
33	0,09	0,14	0,19	0,08	0,02	0,28	0,32
37	0,05	0,11	0,11	0,06	0,01	0,30	0,27
41	0,08	0,17	0,18	0,08	0,03	0,43	0,32
45	0,09	0,19	0,20	0,08	0,04	0,44	0,32
49	0,13	0,25	0,29	0,10	0,12	0,52	0,40

CO-2

Depth (cm)	TU (Cu)	TU (Zn)	TU (Ni)	TU (Cd)	TU (Pb)	TU (Cr)	TU (As)
2	0,17	0,27	0,40	0,12	0,07	0,70	0,27
6	0,11	0,26	0,30	0,13	0,07	0,73	0,29
10	0,12	0,28	0,27	0,13	0,09	0,71	0,33
14	0,14	0,26	0,34	0,12	0,07	0,52	0,31
18	0,10	0,17	0,24	0,05	0,02	0,40	0,30
22	0,08	0,15	0,21	0,04	0,02	0,40	0,31
26	0,07	0,11	0,18	0,04	0,01	0,26	0,34
30	0,05	0,09	0,16	0,03	0,01	0,29	0,34

Table 2: Adverse Effect Index (AEI) calculated for the total analyzed heavy metals.

<1 not sufficient enough to induce a negative biological effect (or moderate impact is suspected).
>1 adverse effects on biota are probable.

CO-1

Depth (cm)	AEI (Cu)	AEI (Zn)	AEI (Ni)	AEI (Cd)	AEI (Pb)	AEI (Cr)	AEI (As)
2	0,16	0,62	0,90	1,29	0,46	2,65	1,38
5,5	0,16	0,63	0,86	1,27	0,39	2,63	1,38
9	0,17	0,69	0,84	1,08	0,48	2,59	1,75
13	0,16	0,66	0,80	1,05	0,43	2,54	1,61
17	0,12	0,53	0,68	0,89	0,25	3,34	1,65
21	0,10	0,47	0,60	0,84	0,23	2,28	1,48
25	0,08	0,37	0,45	0,66	0,09	1,41	1,33
29	0,06	0,29	0,34	0,51	0,06	1,25	1,65
33	0,09	0,30	0,52	0,48	0,07	0,87	1,81
37	0,05	0,25	0,31	0,37	0,05	0,93	1,56
41	0,08	0,38	0,48	0,47	0,12	1,31	1,87
45	0,09	0,42	0,54	0,52	0,16	1,35	1,85
49	0,13	0,55	0,78	0,60	0,45	1,58	2,32

CO-2

Depth (cm)	AEI (Cu)	AEI (Zn)	AEI (Ni)	AEI (Cd)	AEI (Pb)	AEI (Cr)	AEI (As)
2	0,17	0,58	1,08	0,76	0,24	2,15	1,58
6	0,11	0,56	0,80	0,82	0,25	2,22	1,67
10	0,12	0,60	0,72	0,81	0,33	2,16	1,89
14	0,14	0,56	0,91	0,73	0,27	1,59	1,79
18	0,10	0,38	0,66	0,30	0,08	1,23	1,75
22	0,08	0,32	0,56	0,26	0,07	1,23	1,76
26	0,07	0,24	0,49	0,22	0,03	0,78	1,98
30	0,05	0,20	0,42	0,19	0,02	0,87	1,96

CONCLUSION

The moderate potential ecological risk and the AEI values of the sediments recorded in the surface layers suggest that the development of human activities in the last two decades has contributed to the increase in heavy metal concentrations. Activities such as agriculture can be potential sources of Cd. Excessive use of fertilizers and pesticides may contribute to the increase of this heavy metal in the lagoon. This finding highlights the need for careful monitoring and remediation of Cd and As levels in this aquatic system, as it presents a high ecological risk value among the selected heavy metals.

FUTURE WORK / REFERENCES

- Benmhammed, Ayoub, et al. "Assessment of chronological records of Rare Earth Elements in Sidi Moussa lagoon sediment (north-western Morocco)." Environ Ecol Res 9.4 (2021): 186-195.
- Mejjad, Nezha, et al. "Geochemical, radiometric, and environmental approaches for the assessment of the intensity and chronology of metal contamination in the sediment cores from Oualidia lagoon (Morocco)." Environmental Science and Pollution Research 25 (2018): 22872-22888.
- Mejjad, Nezha, et al. "Does human activities growth lead to biodiversity loss in the Moroccan coastal lagoons? A diagnostic comparison study." Proceedings of the 4th Edition of International Conference on Geo-IT and Water Resources 2020, Geo-IT and Water Resources 2020. 2020.
- Mejjad, Nezha, et al. "Tracking natural and human impact on sediment dynamics using radiometric approach in Oualidia lagoon (Morocco)." International Journal of Environmental Analytical Chemistry 102.16 (2022): 4300-4315.
- Vidya, R and Jenni, B and Alloycious, P S and Venkatesan, V and Sajikumar, K K and Jestin Joy, K M and Sheela, P P and Mohamed, K S (2020) *Oyster Farming Techniques*. In: The Blue Bonanza: A Manual for on the job Training Programme for VHSE students on Advances in Fisheries & Aquaculture Techniques. ICAR-Central Marine Fisheries Research Institute, Kochi, pp. 79-92.