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Using the chironomid index to assess the impact of human activities on some agro-pastoral dams in the Tchologo region of Northern Ivory Coast

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ABSTRACT

The aim of this study is to assess the impact of human activities on water quality using the chironomid index of aquatic macroinvertebrates. The study was carried out in the Tchologo region, where five agro-pastoral dams were studied: Mambiadougou, Noumousso Torla, Korokara in Ouangolo-dougou and Sambakaha in Ferkessédougou department. Data were collected by season from June 2016 to June 2018. Aquatic macroinvertebrates on the bottom were collected using a Van Veen bucket. Those attached to aquatic macrophytes were sampled using a 1 mm mesh vacuum sieve. Water quality was assessed using the Chironomid Index. The results showed that the Mambiadougou and Noumousso agro-pastoral dams are highly polluted, with Chironomid Index values above 75%. The Korokara and Sambakaha agro-pastoral dams are moderately polluted, with Chironomid Index values between 20% and 75%. Finally, the Torla agro-pastoral dam is slightly polluted, with a Chironomid Index value between 5% and 20%. This study has highlighted the influence of human activities on the ecological quality of these hydrosystems. These results will serve as a basis for better management of agro-pastoral dams in the Tchologo region.

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INTRODUCTION

Dams are areas of water regulated by structures that allow the control and use of water resources (Cecchi *et al.*, 2007). They contribute to the socio-economic progress of the regions concerned and play a crucial role in responding to water scarcity caused by climate change (Cecchi *et al.*, 2007). The construction of agro-pastoral dams in West Africa, and particularly in Côte d'Ivoire, has its origins in the period of drought that affected these regions between 1970 and 1990 (Aka, 2003). The aim was to ensure food self-sufficiency and food security. Unfortunately, these water reservoirs are under heavy human pressure. Indeed, these water bodies are receptors of pollutants of various origins (domestic or industrial waste and effluents, run-off from cultivated land (ONEP, 2008). This has been observed in dams in the Tchologo region of Côte d'Ivoire. Years after their construction, public health problems emerged in northern Côte d'Ivoire. These included waterborne diseases such as dysentery, cholera, typhoid, malaria, schistosomiasis and paratyphoid (Labbo *et al.*, 2003; Alhou, 2007). An ecological assessment of the dams in the Tchologo region was therefore necessary. However, when monitoring surface waters, it is essential to limit the effort and cost (Micha and Noiset, 1982). Based on these criteria, aquatic macroinvertebrates appear to have many advantages over other organisms (Micha and Noiset, 1982; Warwick, 1986). The main objective of this paper is to use aquatic macroinvertebrates to determine the ecological status of a series of agro-pastoral dams in the Tchologo region of northern Ivory Coast using the chironomid index.

MATERIALS AND METHODS

Study area

The dams studied are located in the north of Ivory Coast in the Tchologo region, specifically at Ouangolodougou and Ferkessédougou (Fig 1). This region has a subtropical climate. These two climates have two seasons: a dry season from November to March and a rainy season from April to October (Aimé *et al.*, 2021.). The hydrological regime in the north is characterised by a single flood (August to October), a low water period in November, June and July, very little run-off in the months preceding the high water period (April and May) and a very pronounced low water period with very little run-off (December) or none at all (January, February and March) (Goula *et al.*, 2006). To carry out this work, five (05) agro-pastoral dams were selected in the Tchologo region of northern Côte d'Ivoire. These dams are Torla, Mambiadougou, Korokara, Noumousso in the department of Ouangolodougou and Sambakaha in the department of Ferkessédougou. The criteria used to select these stations were the perenniality of the water, the accessibility of the station in all seasons, the diversity of habitats and the availability of resources.

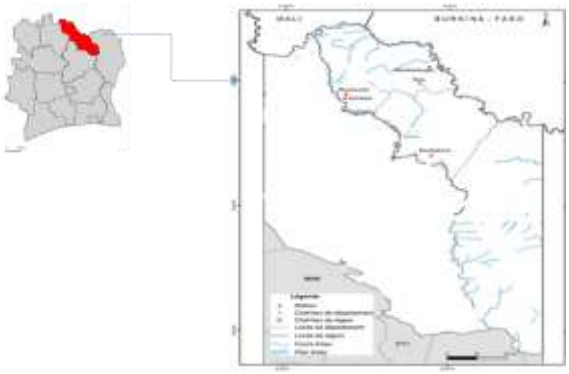

Fig. 1. Dams studied in the Tchologo region

Sampling of aquatic macroinvertebrates

The different sampling campaigns were carried out between June 2016 and June 2018. The data were collected in such a way as to obtain a representative sample of the stations located on the reservoirs studied. Samples of aquatic macroinvertebrates were collected in the littoral and sublittoral zones (Sanogo and Kabre, 2014) according to the multi-habitat approach (AFNOR, 2009) using a Van Veen grab and sieve. Samples were washed and fixed in 5% formalin in labelled jars. In the laboratory, organisms were sorted, identified to family level and counted.

Identifications were based on the work of Durand and Lévêque (1980); Dejoux *et al.* (1981); Moisan (2010); Tachet *et al.* (2010).

Data analysis

Chironomid index

The chironomid index, or percentage of chironomids, is the ratio of the abundance of chironomids to the total abundance of organisms present at a station (Rosa *et al.*, 2014). It is calculated using the following formula:

Chironomid Index (%)= {(Number of Chironomidae individuals)/(Total number of benthic macroinvertebrates)}×100

Mary (1999) proposes the following classification based on the relative abundance of Chironomidae:

% Chironomidae > 75% : Highly polluted water;
20 % < % Chironomidae ≤ 75 %: moderately polluted water;
5 % < % Chironomidae ≤ 20 % : slightly polluted water;
% Chironomidae ≤ 5%: very good water quality

Kruskal-Wallis test

The Kruskal-Wallis test is a non-parametric alternative. It is used to compare three or more samples from the same distribution or from distributions with the same median. The Kruskal-Wallis test is based on ranks rather than means (Siegel and Castellan, 1988). The significance of the results is assessed on the basis of the probability value *p*. If *p* is greater than 0.05, the parameter under investigation does not show significant variation. In this study, the non-parametric Kruskal-Wallis test was used to compare the variation of parameters between different stations.

RESULTS

Composition of the community of aquatic macroinvertebrates in the north of Ivory Coast. Analysis of the taxonomic composition of all the stations in the North revealed 35 families in 11 orders and 3 classes (Achaetes, Gastropoda, Insects) (Table 1).

Table 1. Composition and distribution of aquatic macroinvertebrates in reservoirs studied in northern Côte d'Ivoire from June 2016 to June 2018

Classes	Ordres	Familles	Tor	Kor	Mamb	Noum	Samb
Achaetes	Rhynchobdelliform	Erpobdellidae	+			+	
		Glossiphonidae					+
Gasteropoda	Basommatophora	Lymnaeidae	+			+	+
		Physidae				+	
		Viviparidae		+			
	Mesogasteropodes	Hydrobiidae	+		+	+	+
Insects	Coleoptera	Dytiscidae	+	+	+	+	+
		Elmidae			+		
		Gyrinidae					+
		Haliplidae				+	
		Hydrophilidae	+	+	+	+	+
	Diptera	Ceratopogonidae				+	+
		Chironomidae	+	+	+	+	+
		Culicidae			+		
		Syrphidae	+				
		Tabanidae		+	+		
	Ephemeroptera	Amelitidae		+			
		Caenidae			+		
		Baetidae	+				
		Siphlonuridae		+			
	Trichoptera	Ecnomidae					+
	Lepidoptera	Pyralidae			+		
	Planipennes	Sisyridae	+				
	Héteroptera	Belostomidae	+		+	+	+
		Corixidae	+	+			+
		Naucoridae			+		
		Nepidae	+		+	+	+
		Notonectidae		+			+
	Odonata	Aeshnidae	+			+	

		Calopterygidae					+
		Coenagriidae	+	+			
		cordulegasteridae	+	+	+		+
		Cordulidae		+			
		Gomphidae	+				
		Libellulidae			+	+	+
4 Class	11 Orders	35 Famillies	33	19	19	18	22

Tor: Torla; Kor: Korokara; Mamb: Mambiadougou; Noum: Noumousso; Samb: Sambakaha

Table 2. Mean chironomid index values and standard deviations calculated at the different sampling stations in the north zone from June 2016 to June 2018

Stations	Seasons	Chironomid index (%) ± Standard error
Torla	Dry season	0 ± 0,00
	Rainy season	34,48 ± 4,40
Korokara	Dry season	0 ± 0,00
	Rainy season	95,27 ± 6,70
Mambiadougou	Dry season	13,33 ± 0,60
	Rainy season	86,50 ± 7,04
Noumousso	Dry season	63,75 ± 5,14
	Rainy season	92,15 ± 4,70
Sambakaha	Dry season	38,88 ± 3,40
	Rainy season	87,63 ± 2,30

The Odonata are represented by 07 families. They are followed by the Diptera, represented by 06 families. The Coleoptera contain 05 families. Ephemeroptera and Heteroptera are represented by 04 families each.

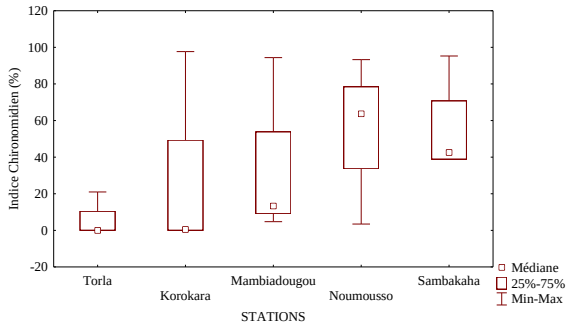

Fig. 2. Spatial variation of the chironomid index of aquatic macroinvertebrates at surveyed stations in northern Côte d'Ivoire from June 2016 to June 2018

Seasonal and spatial variation of the chironomid index at northern stations

Chironomidae were present only during the rainy season at the Torla (34.48%) and Korokara (95.27%) stations (Table 1). At Mambiadougou [dry season (13.33%); wet season (86.50%)], Noumousso [dry season (63.75%); wet season (92.15%)] and Sambakaha [dry season (38.88%); rainy season (87.63%)], the Chironomidae index values were higher in the rainy season than in the dry season (Table 2). The chironomid index is highest at the Korokara station and lowest at the Torla station. The values obtained at these stations are 97.67% and 0%, respectively (Fig. 2). Chironomidae are present only during the rainy season, with median values of 10.50% at Torla and 49.33% at Korokara. Spatial and seasonal differences between the stations were not significant (Kruskal-wallis test, *p*-value > 0.05).

DISCUSSION

The aim of the study was to determine the aquatic macroinvertebrate population of a number of reservoirs in northern France and to assess their water quality. The water quality of the reservoirs was assessed using the chironomid index. With the exception of Torla (Chironomid index = 0%) and Korokara (Chironomid index = 0.5%), the Chironomid index values were high at Mambiadougou (Chironomid index = 13.33%), Noumousso (Chironomid index = 63.74%) and Sambakaha (Chironomid index = 42.61%). The high values of the Chironomid Index indicate that human activities cause organic pollution resulting in the proliferation of Chironomidae. This result corroborates those of Abahi *et al.* (2020), who state that intense human activity in the Ouémé River has led to serious organic pollution, resulting in a proliferation of pollutant-resistant macroinvertebrates such as Chironomidae to the detriment of pollutant-sensitive ones.

The study of seasonal variation showed that the Chironomid index values are more or less identical in the dry and wet seasons at all stations studied. Furthermore, the Chironomid Index shows that pollution increases significantly from the dry season to the rainy season at the stations of Raviart, Allomambo,

Sambakaha, Mambiagou, Korokara and Torla. This finding is in line with the work of Onana *et al.* (2016), which states that domestic wastewater inputs and waste from anthropogenic activities degrade the quality of watercourses. At the Kongobo and Noumousso stations, the Chironomid index is higher in the dry season than in the wet season. These low levels of Chironomidae would mean that these stations are less affected by human activities in both seasons (Abahi *et al.*, 2020).

CONCLUSION

This study assessed the water quality of a series of dams in northern Côte d'Ivoire using aquatic macroinvertebrates. The population consists of 2628 individuals divided into 35 families, 11 orders and 3 classes. The Mambiadougou and Noumousso dams are heavily affected by human activities. The Korokara and Sambakaha dams are moderately affected by human activities. The Torla dam is only slightly affected by human activities. We recommend that decision-makers set up committees to raise awareness of the dangers associated with the degradation of the aquatic environment, control and regulate agricultural practices, and strengthen the construction of hydraulic pumps.

RECOMMENDATIONS

To protect both human health and the integrity of aquatic ecosystems, several actions are recommended. For the local population, it is essential to avoid swimming or engaging in recreational activities in waters of only average quality, as such environments may pose health risks. In addition, residents should ensure that agricultural and pastoral activities are kept at a safe distance from dams, in order to reduce pollution and limit the degradation of aquatic resources.

For decision-makers, it is recommended to establish local awareness committees dedicated to informing communities about the dangers linked to the deterioration of aquatic environments. Furthermore, authorities should work to control and regulate agricultural practices, ensuring that land use around water bodies follows environmental standards and contributes to the long-term preservation of water quality.

REFERENCES

Abahi KS, Gouissi MF, Akodogbo HH, Sanni Worogo SH, Adje ADD, Gnohossou PM. 2020. Assessment of the water quality of the upper reaches of the Ouémé River in Benin using benthic macroinvertebrate-based biotic indices. Journal of Water Science **4**, 433–444.

AFNOR. 2009. Ecological quality of aquatic environments and sampling of aquatic macroinvertebrates in shallow rivers. French Standardisation Association, Paris, 9p.

Aimé LS. 2017. Assessment of water quality in Taï National Park (PNT) based on aquatic macroinvertebrates. Master's thesis, Félix Houphouët-Boigny University, Abidjan, Ivory Coast, 51p.

Aka NM. 2003. Zooplankton in small dam lakes in northern and central Ivory Coast: communities, biomass, trophic relationships and the impact of predation by *Chaoborus* larvae and fish. Doctoral thesis, University of Abobo-Adjamé, Abidjan, Ivory Coast, 269 p.

Alhou B. 2007. Impact of waste from the city of Niamey (Niger) on the water quality of the Niger River. Doctoral thesis, Notre-Dame de la Paix University, Namur, Belgium, 199p.

Cecchi P, Gourdin F, Kone S, Corbin D, Jackie E, Casenave A. 2007. Small dams in Côte d'Ivoire. Latitudes Collection 23, IRD Publishing, Paris, 295p.

Dejoux C, Elouard JM, Forge P, Maslin JL. 1981. Iconographic catalogue of aquatic insects of Côte d'Ivoire. ORSTOM Report, 178p.

Goula BTA, Issiaka S, Brou K, Vamoryba F, Gnamien BK. 2006. Impact of climate variability on water resources in the N'Zo and N'Zi basins in Côte d'Ivoire (humid tropical Africa). VertigO. https://doi.org/10.4000/vertigo.2038

Labbo R, Ernould JC, Djibrilla A, Sidiki A, Chippaux JP. 2003. Transmission of *Schistosoma haematobium* in the city of Niamey, Niger. Bulletin of the Society of Exotic Pathology **96**(3), 178–182.

Mary N. 1999. Physicochemical and biological characterisation of watercourses in New Caledonia: proposal for a biotic index based on the study of benthic macroinvertebrates. Doctoral thesis, French University of the Pacific, Nouméa, New Caledonia, 182 p.

Micha JC, Noiset JL. 1982. Biological assessment of pollution in streams and rivers using aquatic invertebrates. Probio-Revue **5**(1), 143p.

Moisan J. 2010. Identification guide to the main freshwater benthic macroinvertebrates of Quebec. Ministry of Sustainable Development, Environment and Parks, Quebec, Canada, 82p.

Onana FM, Zébazé TSH, Koji E, Nyamsi TNL, Tchakonté S. 2016. Influence of municipal and industrial pollution on the diversity and structure of benthic macroinvertebrate communities in an urban river in Douala, Cameroon. Journal of Biodiversity and Environmental Sciences **8**, 120–133.

ONEP. 2008. Preliminary technical and environmental report. DRE, 20p.

Rosa BJFV, Rodrigues LFT, Da Gama Alves R, De Oliveira GS. 2014. Chironomidae and Oligochaeta for water quality evaluation in an urban river in southeastern Brazil. Environmental Monitoring and Assessment **186**, 7771–7779.

Sanogo S, Kabre TJA, Cecchi P. 2014. Inventory and spatio-temporal distribution of macroinvertebrate bioindicators in three water bodies in the Volta Basin in Burkina Faso. International Journal of Biological and Chemical Sciences **8**(3), 1005–1029.

Siegel S, Castellan JRNJ. 1988. Nonparametric statistics for the behavioral sciences. 2nd edition, McGraw-Hill, London, UK, 399p.

Tachet H, Richoux P, Bournaud M, Usseglio-Polatera P. 2010. Freshwater invertebrates: systematics, biology, ecology. CNRS Editions, Paris, France, 588p.

Warwick RM. 1986. A new method for detecting pollution effects on marine macrobenthic communities. Marine Biology **92**, 557–562.