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RESEARCH ARTICLE

ENVIRONMENTAL RISKS LINKED TO CULTURAL AND PASTORAL PRACTICES ON THE BANKS OF THE ZIGA DAM (BURKINA FASO)

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ABSTRACT

The practice of activities on the shores of the Ziga dam lake involves the use of products that may affect the quality of its water. The objective of this study is to assess the anthropic activities that may impact the quality of the water of the Ziga dam. In order to do so, surveys were conducted among market gardeners and breeders in order to know their working methods and their behaviour towards the resource. The results of the surveys showed that more than half of these two groups of users (78% of market gardeners and 54% of herders) have not attended school. With plots of land less than 50 m from the dam lake for 50% of the market gardeners, most of them (60%) use chemical fertilizers (NPK). Usually using moderately dangerous pesticides, 36% of them bury the leftovers in holes and 28% abandon them in the fields. As for packaging, 64% bury them in holes and 11% abandon them in the fields. The survey also revealed that 9% of market gardeners wash the application equipment at the dam and 30% wash it in the fields. As for livestock farmers, it was found that only 10% had received training in rangeland management methods. 90% of them have a mixed herd, while 10% have a herd consisting solely of cattle and 78% have livestock not exceeding 50 head. The survey notes that 42% of the farmers send their herds to the dam and 57% of them do so twice a day. It is concluded from this study that the activities of these two user groups are potential factors that could harm the biological health of this water body or even have consequences on human health. Consequently, the study recommends a physico-chemical diagnosis of this water body and the launching of an awareness campaign among these stakeholders.

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INTRODUCTION

Human control of water resources, understood as the ability of societies to mobilize and control (fresh) water across space and time, represents a formidable tool for sustainable socio-economic development (Grey and Sadoff, 2007). However, in sub-Saharan Africa, there is an imbalance between the locally available resource and the demand, due to climatic deterioration. Moreover, the considerable specific needs in crystalline basement areas cannot be met from groundwater (Cecchi et al., 2009). In order to meet water needs in large urban centres on a sustainable basis, states have resolutely turned to the creation of water reservoirs such as dam ponds.

The Ziga dam, located some 50 kilometres from the city of Ouagadougou in Burkina Faso, was created with this in mind in May 1998. The dam is dependent on surface water (GIRE, 2001) and is used for drinking water supply and also for the domestic activities of riparian populations (Ouattara et al., 2012). At the level of the dam, in addition to fishing, there is an increasing proliferation of market gardening and livestock farming activities on the banks of the water body by the riparian populations. These activities on the banks represent potential threats to the quality and quantity of the dam's water. Indeed, runoff water from activities around dams, carrying various wastes, arrives in the waters with a high pollution load (Kêdowidé et al., 2010). These users present themselves as potential polluters of this water body. As a prelude to an assessment of the water quality of the dam, this study was conducted among these direct users in order to establish the pollution risks related to their daily practice around the dam.

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METHODOLOGY

Study area: The study was conducted on the banks of the Ziga dam located in the Nakambé (White Volta) watershed and is situated between latitude 12°29'21.44"North and longitude 1°7'25.84"West. The dam is located in the rural commune of Nagréongo in the south-eastern part of the Oubritenga province, itself in the Central Plateau region (Map 1). The chief town of the commune is 18 km from Ziniaré and 38 km from Ouagadougou. The commune of Nagréongo is bordered to the north-east by the rural commune of Absouya, to the south-west by the commune of Koubri (Kadiogo province), to the east by the commune of Zam (Ganzourgou province), to the west by the commune of Saaba (Kadiogo province) and to the north-west by the commune of Ziniaré.

Characteristics and purpose of the Ziga Dam: With an area of 8,872.5 hectares, the Ziga dam mobilizes an estimated 208 million m³ of water during flood periods. The dyke has an average height of 18.80 m and is 3,154 m long. The length of the spillway is 120 m. All these characteristics give it a drinking water production capacity of 3,000 m³/h with the possibility of extension to 4,500 m³/h and 9,000 m³/h. The main purpose of the Ziga dam is to supply the city of Ouagadougou with drinking water. It has been in operation since 2004 and supplies 70% of the city and the communes of Ziniaré, Loumbila and Donsin with drinking water (ONEA, 2002).

Materials

The technical equipment for data collection consisted of a GPS (Geographic Positioning System) device that was used to take the geographical coordinates of the dam, a camera and survey sheets developed for the benefit of the producers.

Methods of data collection

Field surveys: The individual investigation was adopted and involved 50 market gardeners and 50 farmers. This approach makes it possible to know and evaluate the knowledge, attitudes, practices and perceptions of the target groups in relation to the questions asked (Dawson et al., 1993). In general, the survey focused on identifying members of each target group. For market gardeners, data were collected on cultivated plots, pesticides used, risk management and water use. For livestock farmers, the survey focused on herd characteristics, watering methods, the health status of the herds and the individual training of each respondent. The number of producers surveyed was chosen according to the time available for the study and the availability of actors. The choice of the producer to be surveyed was made on the banks of the dam for market gardeners; in the surrounding households and markets for herders in a pseudo-random way. The surveys were carried out mainly in four villages, namely : Kolokom, Nagréongo koudogo, Toghin-Bangré and Moackin (Map 2). These villages were chosen because of their immediate proximity to the lake.

Data Analysis

The comparison of survey data was done through histograms and pie charts produced using Microsoft Excel 2016 spreadsheet software.

RESULTS

Education level of respondents: It emerges that more than half of the respondents do not attend school, i.e. 78% of the market gardeners and 54% of the breeders (Figure 1).

Market gardening

Experience of market gardeners and characteristics of their farms: On the whole, they have little experience (30% have 0 to 4 years of experience while the most experienced represent only 12%). They are neither trained nor organized. Half of the exploited plots (50%) are located at a distance of less than 50 m from the dam. In general, these plots are large as 60% of them have a surface area of between 4000 and 6000 m² (Figure 2).

Pesticides used, method of managing residues and packaging

The various commercial formulations identified are grouped into 10 active ingredients (Table 1). More than half of the pesticides used (7) by market gardeners are Class II, therefore moderately toxic, according to the toxicity classification (SP - Sahelian Pesticides Committee, 2019). This classification presents five levels of dangerousness: Ia, Ib, II, III and U.

The survey found that only 8% of market gardeners reuse pesticides afterwards, 36% place them in holes and 28% leave them either in the fields or at home (Figure 3). As for packaging, more than half of the respondents (64%) bury them in the ground. The others either incinerate them (7%) or take them home (18%) or simply leave them in the fields (Figure 3). After applying the products, 9% of the market gardeners use the dam water to wash the equipment, 30% use it in the fields and 61% use it at home (Figure 3).

Inventory of fertilizers used by market gardeners: The survey revealed that most market gardeners (60%) use chemical fertilizers (NPK*) to enrich the soil (Figure 4). *: mixture of nitrogen, phosphate and potassium

Breeding

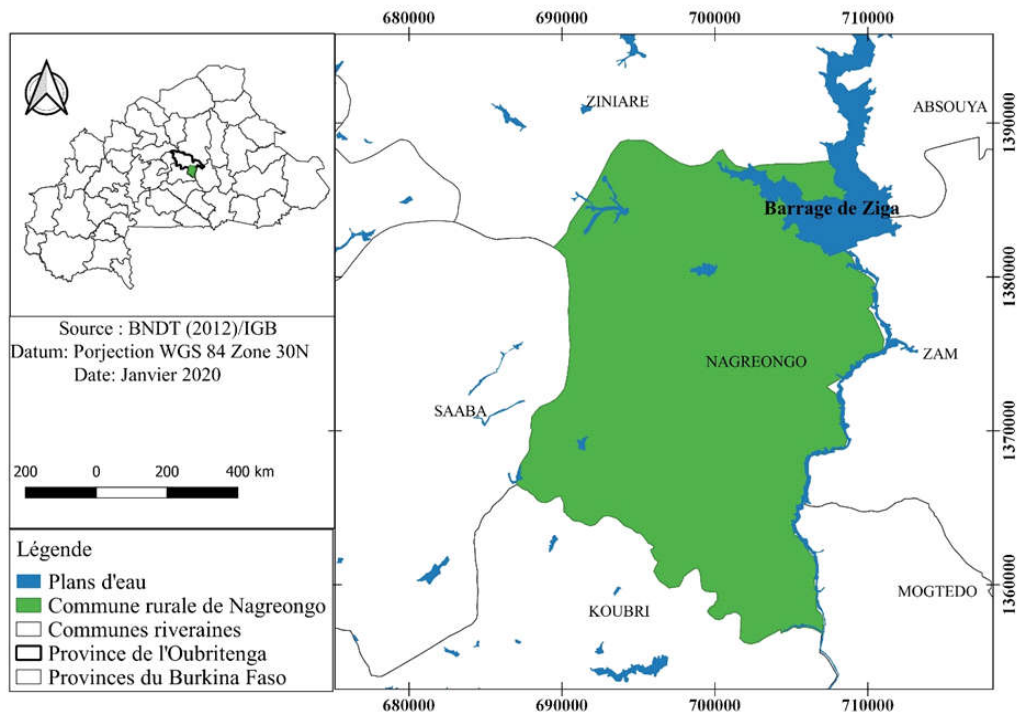
Breeder training and livestock sizing; Only 10% of the farmers around the dam have received training in intensive farming methods. The others are trying to adapt to the new ruralities that are imposed on them. The majority of the herders (78%) have a herd of no more than 50 animals, and 94% of the respondents have mixed herds (Figure 5).

Livestock watering place and frequency at dam level

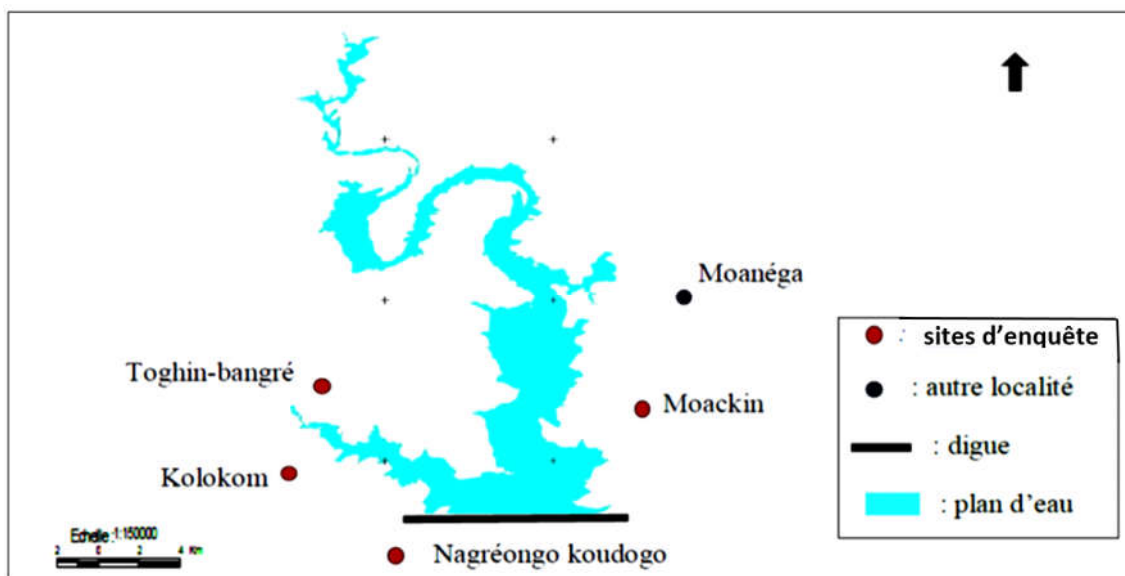
The survey found that 42% of farmers send their herd to the dam and 57% of them do so twice a day (Figure 6). All the animals drinking at the dam do so directly without any means of water drainage.

DISCUSSION

Characteristics of respondents: The educational level of the vast majority of market gardeners is very low. This can be attributed to the fact that this activity is carried out in an artisanal way without prior instruction. According to the farmers, market gardening is a means of coping with unemployment.



Map 1. Location of the Ziga Dam



Map 2. Location of survey sites

Table 1 : Active ingredients listed and their percentages

Active ingredients	WHO* Class	Chemical family
Abamectin	II	Avermectins
Acetamiprid	II	Neonicotinoid
Cypermethrin	II	Pyrethroids
Deltamethrin	II	Pyrethroids
Emamectin	II	Avermectin
Glyphosate	III	Phosphonoglycine
Lamda-cyhalothrin	II	Pyrethrinoids
Mancozeb	III	Carbamates
Methomyl	II	Carbamates
Permethrin	III	Pyrethroids

* : World Health Organization

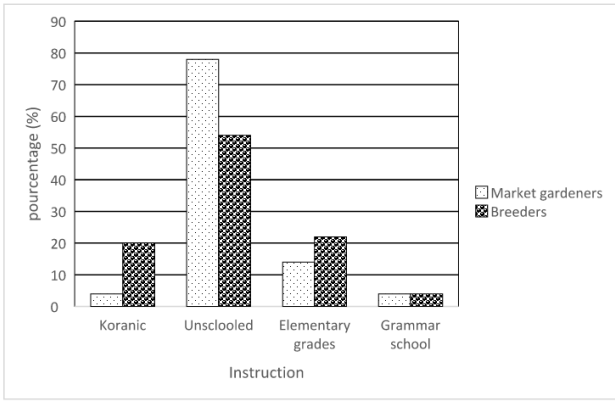


Figure 1 : Education level of respondents

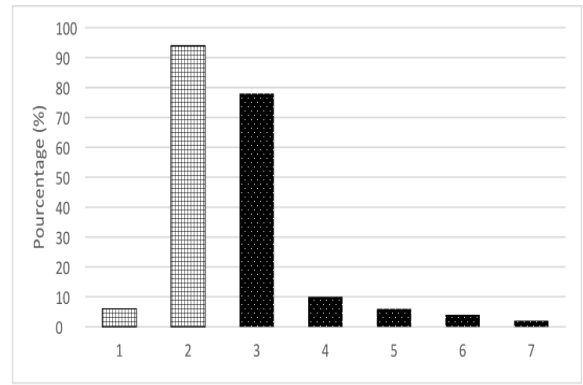


Figure 5: Types of herds and numbers of animals of the breeders around the Ziga dam

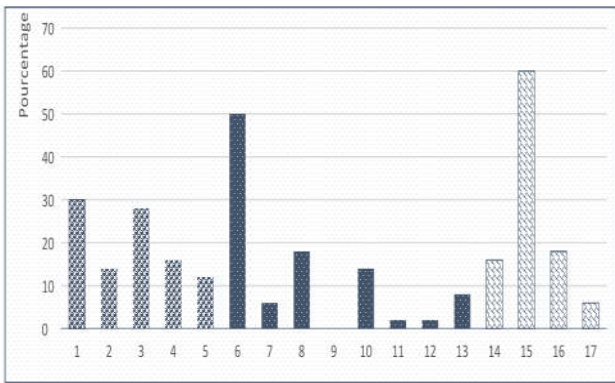


Figure 2 : Number of years of experience of market gardeners and characteristics of their farms

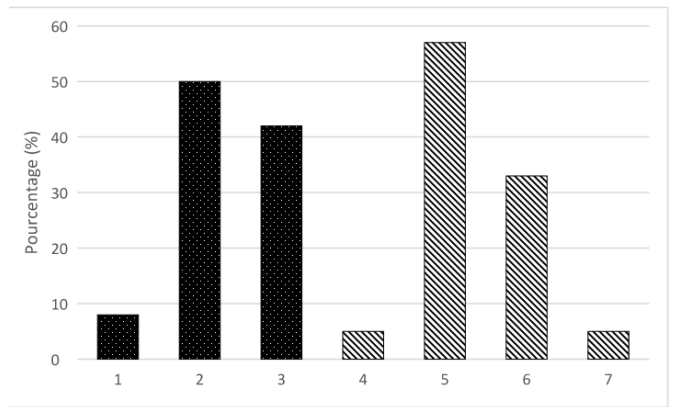


Figure 6: Livestock watering place and daily frequency at the Ziga Dam

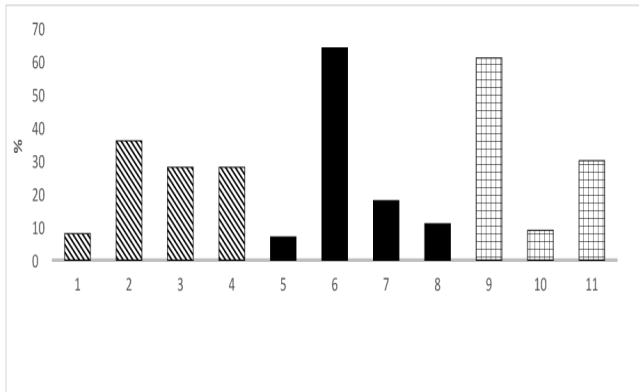


Figure 3: How leftover pesticide packaging is managed and where equipment is washed

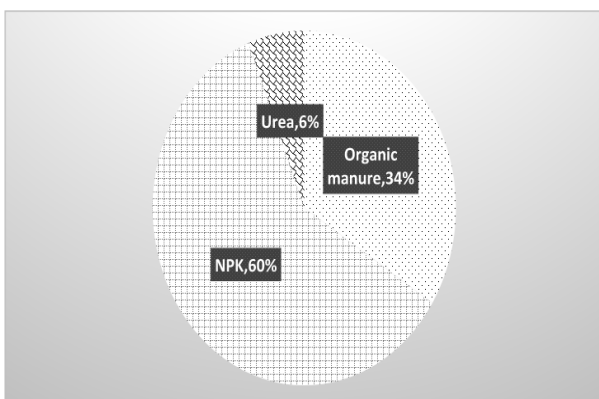


Figure 4: Fertilizers used by market gardeners around the Ziga dam

Our results corroborate with those of Ouédraogo (2016) who found that 78% of market gardeners working around the dams in Ouagadougou are not educated. These market gardeners are not very experienced for the most part. Indeed, many young, they inherit the land from their parents. Ouédraogo (2016) found similar results around the Ouagadougou dams. The lack of training of the latter was rather described by Ohui (2014) in a survey conducted in Nariarlé (Burkina Faso) where 85.25% of the market gardeners are not trained. This situation could be explained by the fact that these market gardeners are installed in an anarchic manner and also by the fact that they are not organized. As for the breeders, their level of schooling is very low. Indeed, this activity is carried out in an artisanal way without prior instruction. Our results are similar to those of the Ministry of Animal Resources (MRA) of Burkina Faso (2010), which showed that in Burkina Faso literate herders represent only 18% of those who practice this activity.

Risks to the water quality of the Ziga dam lake

Risks Associated with the Use and Management of Pesticides and their Packaging: The risks associated with pesticides depend on their characteristics, techniques for storing residues and disposing of empty packaging, and application conditions. The chemical families of pesticides identified are characterised by the predominance of pyrethroids. According to the majority of market gardeners, their choice is guided by the type of pest. Lambda cyhalothrine, Cypermethrin and Acetamiprid are the most common active ingredients. Similar results were found by Ohui (2014) in Koubri in Burkina Faso. However, according to

Calvet et al (2005), synthetic pyrethroids are stable in the environment and active at low doses. In the long term, their use can lead to their accumulation in the environment. However, being very poorly soluble in water as pointed out by Mamy et al. (2008), pyrethroids are quickly leached into the lake. The management of leftovers and packaging, which for the most part consists of burying them, would result from the high illiteracy rate and the lack of training and experience of the market gardeners of the said locality. This state of affairs constitutes a risk of contamination of the resource because the product can seep into the soil and be transported to the lake. Weather conditions and time of day are also important when applying pesticides, as they reduce the risk of transporting the product. To this end, Onil and Louis (2001) recommend a wind speed not exceeding 12 km/h and Zeba (2014) recommends applications in the evening. However, market gardeners in the study area take very little account of climatic factors and proceed in the morning. This can lead to contamination of the lake water, especially since half of the market gardeners surveyed are located less than 50 metres from the lake.

Risks related to the use and management of fertilizers: The type of fertilizers used, how and when they are applied and stored are risk factors for lake contamination. The vast majority of market gardeners use chemical fertilizers (NPK) to enrich the soil. This could change the chemical characteristics of the water if these products leach and are transported into the lake. Our results differ from those of Gongo (2016) who found that organic manure is the most widely used fertilizer in Banfora, Burkina Faso. The way in which fertilizers are applied influences the mobility of nutrients. In this regard, Huber and Schaub (2011) point out that anyone using fertilizers must apply them with a certain degree of precision, taking into account the needs of the crops. This prevents nutrient losses. However, the study showed that market gardeners do not take into account the real needs of the crops. This is said to be due to their low level of education, training and lack of appropriate working tools. As a result, they are all guided by the search for the highest possible yield. This leads them to increase fertilization considerably. When fertilizers are not fully used by the plants (cases of excess, climatic hazards and/or diseases), the nutrients can be leached out and washed into the lake water. The timing of fertilizer application also influences nutrient mobility. For this reason, Beaudin (2006) recommends a longer time between fertilization and the onset of rainfall so that nitrate and phosphorus are fixed by the crops. However, since producers have not been trained, they apply them at all times. This increases the risk of loss to the lake and contributes to its nutrient enrichment. Interim storage of manure in fields where there is no impervious liner is also a real risk factor for nutrient contamination of the lake water through runoff, especially since manure is highly soluble in water.

Risks related to animal husbandry: The direct watering of animals at Lake Ziga can be explained by the illiteracy of the herders and/or the absence or inadequacy of pasture and water points for pastoral purposes. This can lead to contamination of the water with animal waste (pathogens, antibiotics and hormones) (Steinfeld et al., 2006). During watering, lake water may also be contaminated by medicinal products, as many livestock farmers use market drugs to treat their animals for ailments. Few farmers use the services of veterinarians. According to them, this reluctance is due to several factors such as the distance of these services, their high cost and their

lack of professionalism. Inadequate animal health control reduces animal productivity. Hence the desire of farmers to have a large herd size. This explains the overgrazing and excessive trampling of the lake's banks by livestock, which is a risk factor for erosion and contamination of its water by excrement.

Conclusion

The construction of the Ziga dam had as its main objective the supply of drinking water to the city of Ouagadougou and the communes of Ziniaré, Loumbila and Donsin in the centre of the country. Nevertheless, the banks are today used by the local residents for several activities, including market gardening and livestock farming. The insufficient training and lack of experience of these actors lead them to practices likely to impact the quality of the dam's water. In fact, surveys have shown that more than half of these two groups of users have not attended school (78% of market gardeners and 54% of herders) and only 10% of herders have received training in rangeland management methods. With plots of land less than 50 m from the dam lake, most (60%) of the market gardeners use chemical fertilizers (NPK). Usually using moderately dangerous pesticides, 36% of them bury the leftovers in holes and 28% abandon them in the fields. As for packaging, 64% bury them in the ground and 11% abandon them in the fields. The survey also revealed that 9% of market gardeners wash the spreading material at the dam and 30% do so in the fields. The survey found that 42% of farmers send their herds to the dam and 57% do so twice a day. These different practices are potential factors that can affect the physical and chemical quality of this body of water and are also dangerous for human health.

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