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Local Perceptions of the Socio-Economic and Environmental Impacts of *Typha domingensis* (Pers.) in the Sahelian Agro-Systems of Niger

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Abstract

The uncontrolled proliferation of *Typha domingensis* in the wetlands of Niger poses a major challenge. It disrupts the habits of local communities by altering their way of life and causes damage to their environment. Therefore, this study was conducted with the aim of contributing to providing some answers regarding the real impact of this species on the life of communities and on the environment on the one hand, and on the other hand, of clearly determining the opportunities it offers. It covered two sites more than 1000 km apart along the country's Sahelian agro-ecological zone and 392 vegetable and/or rice farmers out of a total of 1009 producers. The methodological approach adopted was based on individual surveys combined with village general assemblies and interviews with agents from state technical services. The results show that *Typha domingensis* was first observed in the 1970s in southeastern Niger (Zinder region), while in the west of the country, it only appeared in the 1980s. The majority of respondents (73.2%) attributed its appearance to natural causes, while others

(26%) favored supernatural ones. The remaining 0.8% believed it was introduced by humans. All respondents agree that the presence of *Typha domingensis* has significant negative impacts on agricultural production, fishing, and livestock farming. In addition to these drawbacks, the results also show that *Typha domingensis* is used in "construction and housing development" (88.1%), "human and animal food" (78.81%), "crafts" (7.3%), and "health" (0.3%). Regarding control techniques used to contain and/or eradicate *Typha domingensis* from wetland ecosystems, weed cutting remains the primary method. Although utilizing Typha as a source of biomass or biomaterials for construction or crafts is not in itself a method of species control, it can nevertheless contribute to its management by reducing the cost of certain operations and generating additional income.

Keywords: Local perception, Impacts, *Typha domingensis*, Sahelian agro-ecosystems, Niger

Introduction

Wetlands are of great environmental and economic importance (Smets, 2002) due to their numerous environmental benefits (Abdullahi et al., 2019). They contribute to groundwater recharge, mitigate the effects of flooding, purify water, and retain sediment (Barbier et al., 1997), and also serve as stopover and resting places for migratory and resident species, as well as refuges (Lameed, 2011). According to Zare (2015), they also provide a wide range of ecosystem services such as water supply, timber production, food production, etc. Following the droughts that occurred throughout the Sahel in the 1970s and 1980s, the reduced rainfall resulted in an overall decrease in runoff. The transition to this drought was all the more abrupt as it directly followed the wettest period of the century (Paturel et al., 1998). This led to problems of siltation (Ambouta et al., 2018), salinization (Barbiero & Valles, 1992), and the drying up of watercourses (Wang et al., 2016), but also, and above all, the invasion of water bodies by invasive macrophytes (Djima Idrissou, 2013) that establish themselves and potentially become dominant (Wilcox, 2012). Invasive aquatic vegetation that establishes itself in these wetland ecosystems, such as *Typha domingensis* (*T. domingensis*), leads to their general dysfunction (Pimentel et al., 2001) and a loss of local biodiversity (Boers et al., 2007; Magnnon et al., 2007) through competition, predation, and hybridization. The species produces numerous, fertile offspring and has a strong potential for expansion over large areas (Heger & Trepl, 2003). The only species of its genus present in Niger (Bansal et al., 2019), it tolerates large variations in water level (Wilcox & Xie, 2008) and preferentially occupies eutrophic environments (Woo & Zedler, 2002). In Niger, the invasion of water bodies by this species was highlighted by the work of Amani & Barmo (2010), who showed that T. domingensis had invaded numerous bodies of water (Tabalak, Madarounfa, and Komadougou), ponds (Dallol, Maggia, Tarka, and Korama), and oases. Ali et al. (2020) also reported the colonization of the "Diaspora Valley," located west of the capital (Niamey), by this species. According to a study by PGIPAP (2009) cited in Amani & Barmo (2010) of 24 ponds in Niger, 70.7% of the total area is invaded by T. domingensis. Its reproductive method, based on seeds and vegetative propagation (Diagne et al., 2010), makes its spread rapid and difficult to control. This leads to a wide range of socioeconomic, ecological and health impacts (Kane & Akpo, 2015). In the Nigerien context, the socioeconomic and environmental impacts of its presence have not yet been formally established by scientific evidence. Therefore, this study was conducted to contribute to providing some answers, with the objectives of (i) examining the harms associated with the presence of *T. domingensis* and (ii) clearly identifying the opportunities it presents.

2. Methodological approach

2.1. Study area

This study took place in the Sahelian agro-ecological zone of Niger. With a tropical climate and a single rainy season, this zone is characterized by a so-called cool season (November to February) with average temperatures of 10°C; a hot dry season (March to June) with average temperatures of around 45°C; and a rainy season (July to September) with an average temperature of 33°C. Rainfall there is characterized by an annual rainfall ranging between 300-600 mm (Van Vyve, 2006). Among the six soil types that dominate the territory of Niger (FAO, 2000), vertisols and hydromorphic soils are the most common in areas invaded by T. domingensis (Adamou Moumouni et al., 2025), the rest being dominated by sandy texture soils. Along the area, two sites were identified and selected for surveys. The choice of these sites took into account the presence of the species and the existence of rice cultivation and/or market gardening, on the one hand, and the accessibility of the site, on the other. The sites in question are the Toula Hydro-Agricultural Development (urban commune of Tillabéri), located on the banks of the Niger River between 14°11’22’’ North latitude and 01°27’47’’ East longitude, and the market gardening sites near the Wacha pond (rural commune of Wacha), located between 13°21’56’’ North latitude and 09°16’59’’ East longitude (Figure 1). At the first site, rice production is the main activity of the farmers, while around the Wacha pond, market gardening remains the primary activity.

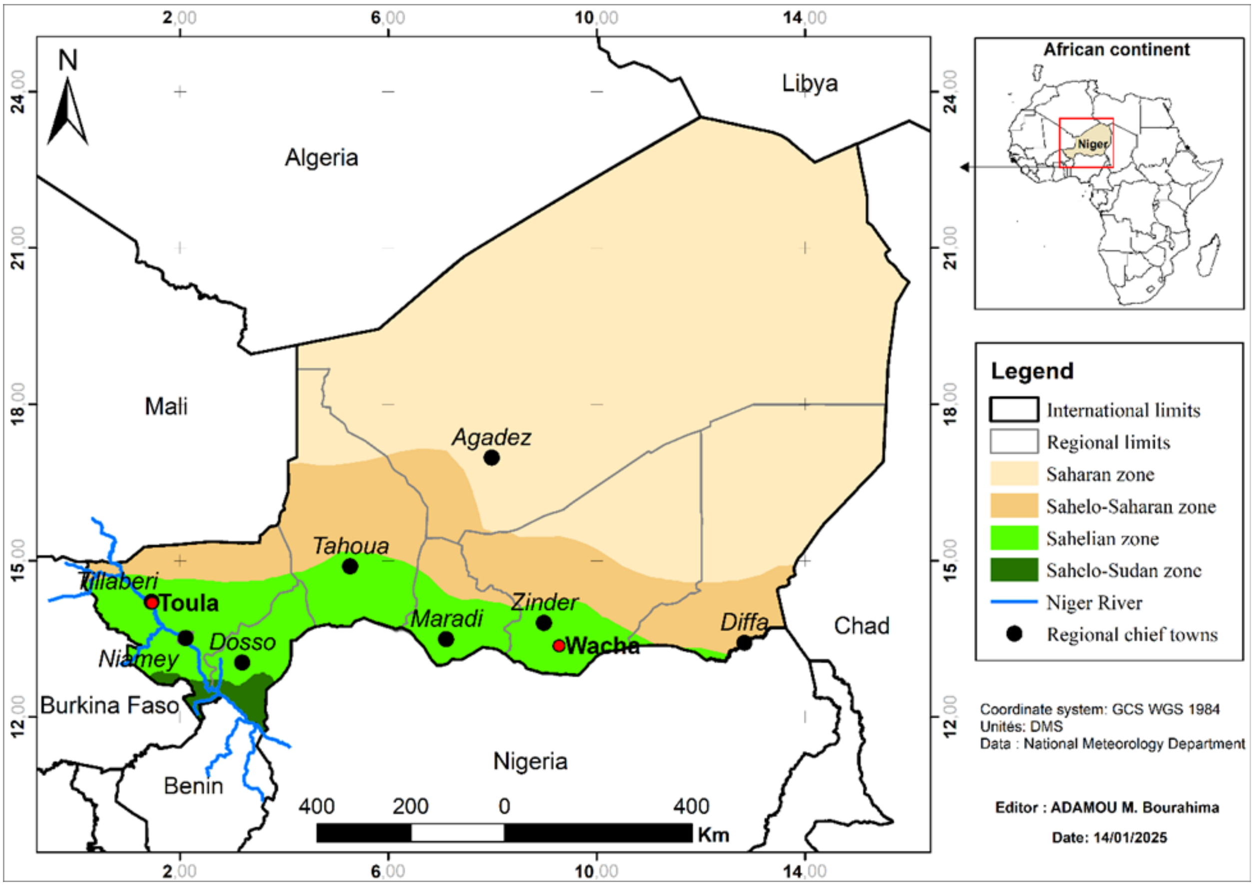

Figure 1 : Map showing the location of the study area

2.2. Sampling and conducting the survey

The farm, as the presumed unit of production and management, was chosen as the unit of investigation and analysis. The total number of producers in the Toula Hydro-Agricultural Development area is 809, all belonging to the same cooperative (Toula Cooperative). In Wacha, there are 200 producers distributed among five groups (Niya: 64 members, Kalawyi: 21 members, Maïtoumaki: 59 members, Maïdiré: 28 members, and Maja: 28 members). The number of producers surveyed at each site was determined using the formula of Giezendanner (2012). Thus, 260 and 132 producers were surveyed in Toula and Wacha, respectively.

$$n = \frac{t^2 N}{t^2 + I^2(N-1)}$$

With: **n** being the sample size ; **N** the number of operators ; **I** the range of uncertainty (**I** = 2e) ; **e** the margin of error (between 0 and 10%; **e** = 5%) ; **t** the margin coefficient deduced from the degree of confidence (1 α) that we want (**α** the level of statistical significance = 5%, i.e. a degree of confidence of 95% and **t** associated = 1.96).

The survey process began with a general assembly of producers. Subsequently, the producers to be surveyed (the sample) were selected randomly using a sampling method. Questionnaires developed using Sphinx Plus2, version 5 software, covering topics such as their socioeconomic situation; their knowledge of invasive aquatic plants; the impact of *T. domingensis* on their socioeconomic activities and on invaded wetland ecosystems; the socioeconomic uses of *T. domingensis*; and control practices and/or techniques, were administered. Interviews were also conducted with technical services, such as the Municipal Director of Agriculture (CDA) of Wacha and the Director of Hydro-Agricultural Development of Tillabéri, to supplement the information gathered.

2.3. Data processing and analysis

The collected data were processed and entered into IBM SPSS Statistics, version 26. Descriptive and inferential statistical analyses, such as frequency analyses, cross-tabulations, and correlation tests (chi-square test), were performed. Excel and IBM SPSS Statistics, version 26, were used to organize some results into tables and generate graphs, respectively. The results of these analyses are presented in the Results section.

3. Results

3.1. Characteristics of the producers surveyed

The sample surveyed is predominantly male (99.2%) and dominated by the 45-49 age group in Toula (33.3%) compared to the over-50 age group in Wacha (29.5%). Among them, there are more married men (98%) than single men (1.8%). The average household size is significantly higher than the national average (7 people), at 10 people. Regarding education, the majority of those surveyed have studied the Quran (51.3%). In Toula, this category is followed by those with no formal education (33.7%), while in Wacha, it is followed by those with only a primary school education (20.5%). The main areas of activity in Wacha are agriculture (market gardening and rainfed farming) (99.2%) and education (0.8%), while in Toula, small-scale trade (3%) and livestock farming are added to agriculture and education. Table 1 presents the characteristics of the people surveyed at the two sites.

Table 1 : Characteristics of the producers surveyed at the Toula and Wacha sites

Indicators		Proportion (%)		
		Toula	Wacha	Total
Sex	Man	100	2.3	99.2
	Women	-	97.7	0.8
Age	Under 19 years old	-	3	1
	20 to 24 years old	2.6	10.6	5.4
	25 to 29 years old	1.5	5.3	2.8
	30 to 34 years old	7.9	6.8	7.4
	35 to 39 years old	3.7	11.4	6.4
	40 to 44 years old	19.5	19.7	19.4
	45 to 49 years old	33.3	13.6	26.8
	Over 50 years	31.5	29.5	30.9
Marital status	Married	99.3	94.7	98
	Singles	0.7	4.5	1.8
	Widower	-	0.8	0.2
Average household size	-	9	11	10
Education level	Primary	17.6	20.5	18.9
	College	2.2	11.4	5.1
	lyceum	0.4	1.5	0.8
	University	1.1	-	0.8
	Vocational training	0.4	-	0.3
	Quranic school	44.6	64.4	51.3
	Nothing	33.7	2.3	23
Main activity	Agriculture	96.3	99.2	97.4
	Small business	1.9	-	1.3
	Exodus	1.1	-	0.5
	Teaching	0.7	0.8	0.8

3.2. Knowledge of invasive aquatic plants

All the producers surveyed have a good knowledge of invasive aquatic plant species. The results of the chi-2 test show that this knowledge of invasive aquatic macrophytes varies only according to the sites with P>0.000 (the other socio-demographic variables of the respondents having no influence on this knowledge). Overall, thirteen (13) species were recorded from producers at the Toula site, compared to twelve (12) species from those at the Wacha site (Figure 2). Among these species, *Typha domingensis* and *Eichhornia crassipes* were the most frequently recorded (100%) at Toula, while at Wacha, *Typha domingensis* and *Cyperus articulatus* were the most frequently cited species (100%). These species were followed by *Echinochloa colona* (98.1%) and *Oryza longistaminata* (96.2%) at Toula, compared to *Phragmites australis* (97.7%) and *Nymphea micrantha* (93.2%) at the Wacha site.

Furthermore, to identify the most threatening invasive aquatic plants present on the sites, a question limiting the maximum number of species to be cited to three (3) was asked. The results revealed that of the 13 species known to the producers in Toula, only five (5) were cited, compared to six (6) species in Wacha. Thus, *Typha domingensis* (100%), *Echinochloa colona* (97.7%), and *Oryza longistaminata* (73.5%) were the most frequently cited species at the Toula site, while at the Wacha site, the most frequently cited species remained *Typha domingensis* (99.2%), *Phragmites australis* (94.7%), and *Cyperus articulatus* (84.8%). These species, apart from *T. domingensis*, also pose potential threats to household livelihoods and the area's wetland ecosystems. Regarding the degree of harm caused by these species, more than half of the respondents (50.8%) stated that they severely disrupt their economic activities, while nearly half of the remaining respondents (46.4%) said that these species have a high degree of harm.

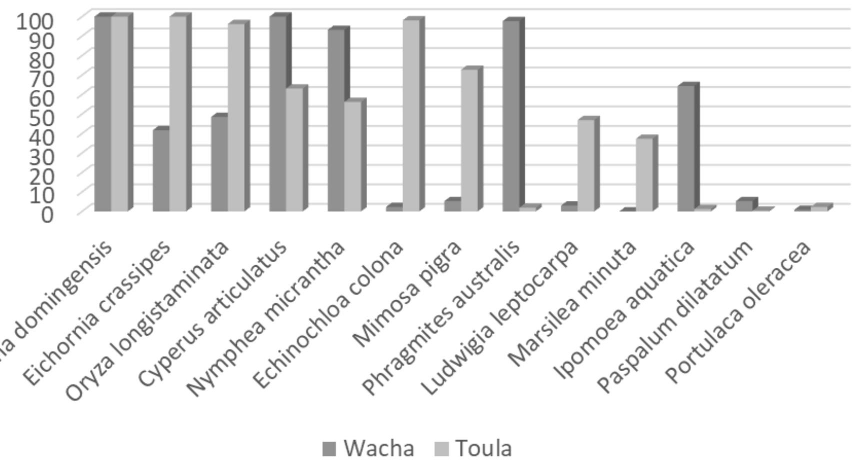

Figure 2 : Invasive aquatic macrophytes known to producers of Toula and Wacha

3.3. Presence of *Typha domingensis* in the area

The majority of respondents at the Wacha site (40.2%) maintain that the species was first noticed in the 1970s, compared to 34.1% who believe it appeared in the 1980s. Unlike Wacha, almost all producers at the Toula site (93.1%) state that Typha appeared in the 1980s, while the rest of the sample (6.9%) maintain that it appeared in the 1990s. For the vast majority of respondents (73.2%), its appearance is attributed to natural causes, such as the dispersal of seeds by wind and the presence of water sources and/or moisture. Some (0.8%) believe it was introduced by humans, while others (26%) lean towards supernatural causes, asserting that it is the work of God (Figure 3). Furthermore, all agree that its proliferation is significant, with an exponential increase in its occupation of wetland ecosystems.

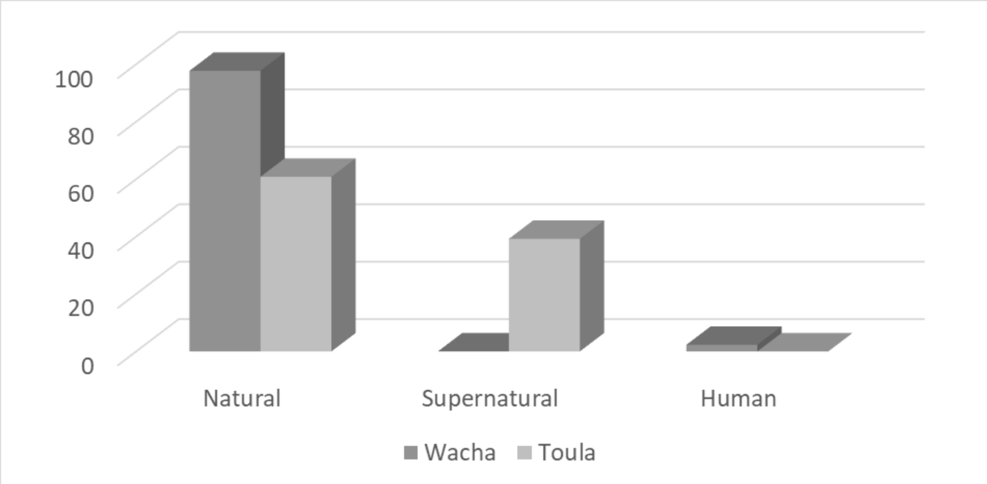

Figure 3: Causes of the appearance of *T. domingensis* according to the surveys in Toula and Wacha

3.4. Disadvantages related to the presence of *Typha domingensis*

All respondents agree that the presence of *T. domingensis* has significant negative impacts on agricultural production, fishing, and livestock farming (Table 2). For agricultural production, "occupation of production areas" and "abandonment of production plots" are the leading problems (77.9%), with an average loss of 1.33 ha for the entire sample. This figure varies, however, between sites, with an average loss of 0.29 ha in Toula compared to 1.41 ha in Wacha. Furthermore, "limited access to irrigation water" (57.9%) and "habitat for harmful insects and granivorous birds" (37.9%) also constitute significant challenges. All these problems lead to an overall average yield loss of 90.51%, of which 46.6% is at the Toula site compared to 92.25% at the Wacha site. Regarding fishing, the main problem is "the scarcity of fish" (100%), followed by "the obstacle to canoe navigation" (62.5%) and "the reduction of navigable waterways" (12.5%). Indeed, all respondents maintain that there were more fish to catch before the invasive species. For livestock farming, the presence of Typha poses a real threat to the species favored by animals (80.2%) and also leads to difficulties in accessing drinking water (57.3%).

Table 2 : Main difficulties related to the presence of *T. domingensis* in Toula and Wacha

Activity	**Disadvantages**	**Proportion (%)**		
		Toula	**Wacha**	**Total**
Market gardening	Occupancy of production areas	75	78	77.9
	Limited access to irrigation water	50	58.3	57.9
	Habitat for harmful insects and seed-eating birds	87.5	34.8	37.9
	Abandonment of production plots	87.5	77.3	77.9

Fishing	Reduction of the navigable surface	33.3	20	25
	Obstacle to canoe navigation	100	40	62.5
	Fish scarcity	100	100	100
Livestock farming	Difficult access to drinking water	-	59.1	57.3
	Threat from palatable species	100	79.5	80.2
	Decline in reproduction	-	1.6	1.5
	Disease	-	8.7	8.4

3.5. Benefits derived from the presence of the species *Typha domingensis*

The continued occupation of wetland ecosystems by *T. domingensis* in the locality has raised the issue of its use in daily activities. The results of the study show that the species, regardless of the site, is used for various purposes (Figure 4). These include "construction and development of habitats" (88.1%), "human and animal food" (78.81%), "crafts" (7.3%) and "health" (0.3%). Indeed, most homes have products made from processed Typha (cattails) displayed on the roof or used as fencing. Resembling millet ears, the grains are eaten raw by children and even some elderly people. The young Typha shoots are consumed by animals during the hot, dry season (lean season). These animals are primarily cattle, and sometimes donkeys. Furthermore, Typha is also used as a biofertilizer in Wacha. Among the respondents (12.88% of the Wacha sample), 76.5% stated that they use its ash as fertilizer, while 17.6% use it as compost and 5.9% as mulch.

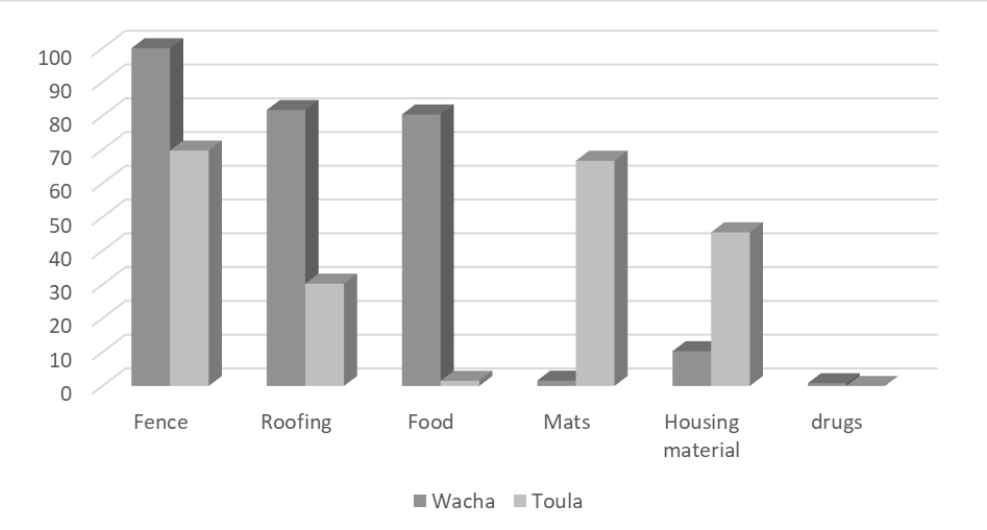

Figure 4 : Main uses of *T. domingensis* biomass in Toula and Wacha

3.6. Control methods used against *Typha domingensis*

All respondents (100%) at the Wacha site agreed that 2016 marked the beginning of efforts to combat the invasion of wetland ecosystems by *T. domingensis*. Of these respondents, only 3.8% stated that these control efforts were still ongoing at the time of the survey, with the support of a farmers' association. The remaining 96.2% reported that control efforts ceased with the discontinuation of the projects that funded these activities. In Toula, only 10.8% of the sample reported that control efforts began in 2014 with the support of the government and its partners (NGOs). According to respondents, these control efforts were no longer being carried out at the time of the survey. On the affected sites, weed cutting remains the primary control method used. Furthermore, for effective management of the species, respondents overwhelmingly favored chemical control (60.2%), followed by mechanical control using machinery (37%), and continued manual weed cutting (27%) (Figure 5). Very few mentioned the production of biofertilizers and livestock feed (agronomic valorization: 4.8%) or artisanal valorization (2%).

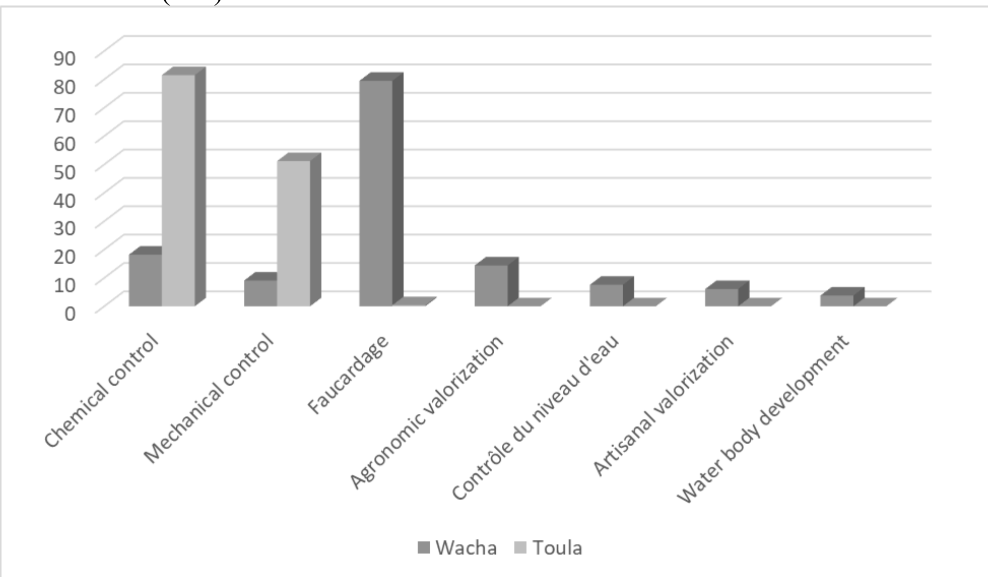

Figure 5 : Management proposals for *T. domingensis* by respondents from Toula and Wacha

4. Discussion

Considered an introduced species, *T. domingensis* has become invasive in Niger. It now occupies a significant place in wetland ecosystems, where it tends to supplant most local aquatic herbaceous species. A survey conducted among farmers revealed key information about its emergence. The results indicate that Typha was first observed in the 1970s in southeastern Niger (Zinder region), while in the west of the country, it only appeared in the 1980s. The introduction of the species into the country therefore seems to have begun in the southeast, before spreading westward. This finding is consistent with that of Aliero et al. (2022), who reported that *Typha angustifolia* was first observed in the Komadougou River basin in 1972. The same is likely true for *T. domingensis*. However, its presence has been reported in the Senegal delta since at least 1933 (Trochain, 1940 in Sarr, 2002). The reasons for its establishment are primarily natural, according to those interviewed, and attributed to the dispersal of seeds by wind and the presence of water sources and/or humidity. This finding is similar to that obtained by Sarr (2002) in Senegal. According to him, the intrinsic characteristics of Typha provide it, in a suitable environment, with both seeds and rhizomes for its reproduction and proliferation.

The results also show that agriculture, livestock farming, and fishing are the sectors most affected by the constraints linked to the presence of *T. domingensis* in the Nigerien context. Indeed, thanks to its strong vegetative reproduction capacity and high growth rate, Typha quickly outcompetes and dominates other species, which are eliminated, leading to a complete change in the ecosystem. This results not only in a significant loss of arable land and agricultural yields, but also in the impoverishment of flora and a decline in aquatic biodiversity. According to Calestreme (2002), the plant's dramatic spread in irrigation systems, estimated at approximately 10% per year, reduces the efficiency of hydraulic structures, leads to a significant drop in rice yields (from approximately 1 to 5 tons per hectare), and results in the abandonment of infested plots. The work of Sabo et al. (2016) showed a reduction (75%) or complete loss of certain crops, particularly irrigated crops such as maize, wheat, rice, and vegetables. These same authors noted a significant reduction in fish catches, although the fish caught were larger than before the emergence of Typha. Theuerkorn & Henning (2005) suggest that the development of T. domingensis can hinder canoe navigation and fishing by considerably reducing the surface area of open water. Although the issue of health was only briefly mentioned by producers, the results of Sarr's study (2002) showed that the proliferation of Typha and its high density in water bodies create conditions conducive to the development of schistosomiasis and malaria. All these constraints are likely to seriously jeopardize the food security of local communities.

In terms of the species' use, its degree of utility remains variable and depends on the main activity of the people interviewed. Generally speaking, "the construction and development of habitats" and "human and animal food" are the most frequently encountered uses. Although Typha has a short lifespan (1 to 2 years), it is considered a good insulator for the roofs of huts (Sarr, 2002). Its use in the manufacture of handicrafts and as a medicine to treat certain illnesses is, however, rarely documented. Furthermore, its use as an organic fertilizer by some producers highlights the low fertility of soils used in agricultural practices and therefore the need to fertilize these soils. Similar results were obtained by Malam Boukar (2019), who produced compost from fresh *T. domingensis* biomass, and Sarr (2002), who emphasized its use in making baskets, fences, and shelters. In traditional Turkish medicine, the female flowers are used for burns and wound healing (Yesilada, 2002 in Akkol et al., 2010). In China, the pollen is used to treat bleeding of various origins (Tao et al., 2009). According to Theuerkorn & Henning (2005), Typha is used in China, Australia, and America in the form of flour made from dried rhizomes. The same authors report that the young shoots are eaten fresh or boiled, and the young leaves are used as a condiment. Despite the species' harmful nature, these findings highlight its potential uses. However, given its uses in other countries, it goes without saying that further efforts are needed to develop its artisanal, medicinal, and especially agricultural applications in Niger.

Regarding control techniques used to contain and/or eradicate *T. domingensis* from wetland ecosystems, weed cutting remains the primary method to date. The results of underwater cutting (Faucardage) experiments reported in the literature are variable, but most are considered significant in terms of effectiveness (Hellsten et al., 1999; Wilcox et al., 2017). However, controlling Typha with eradication as the objective cannot be achieved through a single weed-cutting operation; the operation must be repeated several times, depending on the effectiveness of each pass (Castellanet et al., 2019). Theuerkorn & Henning (2005) consider the use of the plant as a resource to be one of the most promising approaches for controlling its proliferation.

Conclusion

The uncontrolled growth and spread of *T. domingensis* in Niger's wetland ecosystems poses a major challenge not only for those managing these environments but also, and especially, for the communities whose livelihoods depend on them. The responses provided by those interviewed helped establish a database detailing the species' establishment history, as well as the socioeconomic and environmental challenges and opportunities it presents. First observed between the 1970s and 1980s, *T. domingensis* is believed to have been introduced to the country through wind dispersal of seeds (anemochory) and the presence of water sources and/or moisture. Thanks to its rapid vegetative reproduction and high growth rate, Typha quickly outcompetes and dominates other species, which are eliminated, leading to a complete transformation of the ecosystem. This results not only in a significant loss of arable land and agricultural yields, but also in the impoverishment of flora and a decline in aquatic biodiversity. Despite the challenges posed by this species, it is used in habitat construction, human and animal food, crafts, health applications, and, to a lesser extent, compost production. Weed cutting remains the primary method used to control the species' spread. While utilizing Typha as a source of biomass or biomaterials for construction or crafts is not, in itself, a method of species control, it can contribute to its management by reducing the cost of certain operations and generating additional income.

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