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ORIGINAL RESEARCH ARTICLE

Identification of active pesticide compounds used in two fishing areas in Burkina Faso

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Abstract: Persistent organic pollutants (POPs) are non-degradable pollutants that pose a growing threat to the sustainable management of natural resources, particularly aquatic resources. This study aims to support the better management of aquatic resources in Burkina Faso by identifying the pesticides used and assessing their potential to contaminate surrounding aquatic environments. A field survey was conducted by interviewing 20 pesticide sellers and 80 agricultural producers to identify the types of pesticides sold and used near rice-farming plains. The identified pesticides were then compared against the Sahelian Pesticides Committee and the Rotterdam Convention lists to determine their registration status, bans, and hazard classifications. The half-lives (DT_{50}), organic carbon partition coefficients (Koc), and groundwater ubiquity scores of these pesticides were calculated. The survey revealed 52 commercial products from sellers (35 herbicides, 14 insecticides, 1 fungicide, and 1 acaricide) and 29 products used by farmers (17 herbicides, 10 insecticides, 1 fungicide, and 1 acaricide). These pesticides contain 30 active compounds, 11 of which were found to be persistent in the environment due to their high DT_{50}. All the active compounds were approved by the Rotterdam Convention and classified by the World Health Organization as follows: 17 moderately dangerous (Class II), six slightly dangerous (Class III), two very dangerous (Class Ib), and one extremely dangerous. In addition, some compounds also showed high leaching potential, indicating a high risk of surface water contamination.

Keywords: Burkina Faso; Contamination; Half-life; Fisheries; Pesticides; Persistent organic pollutants

1. Introduction

Fisheries around the world, particularly in Burkina Faso, play an important role in the economy.[1] They contribute to food and nutritional security, as well as to the well-being of the population, through job creation and diversification of income sources.[2] However, fisheries are increasingly threatened by human activities such as industry, agriculture, and gold mining, which contribute to environmental pollution.[3] Among the various pollutants, pesticides are frequently encountered around fishing sites.[4] Agriculture, the main economic activity in Burkina Faso, faces various threats such as pests (e.g., insects) and diseases (e.g., bacterial wilt).[5] To prevent or alleviate these threats, farmers commonly rely on synthetic chemical pesticides.[6] However, their knowledge of the active compounds, appropriate dosages, frequency of application, and the potential impacts on human health and the environment is often limited.[7]

Some chemical pesticides are registered by the Sahelian Pesticides Committee (SPC), whereas others are strictly prohibited due to their high toxicity, persistence, and environmental remanence, as outlined by the Rotterdam and Stockholm Conventions, as well as the SPC.[8] In particular, pesticides belonging to the organochlorine family, known as persistent organic pollutants (POPs), fall under this group. According to the Stockholm Convention, POPs include DDT, aldrin, dieldrin, endrin, chlordane, heptachlor, mirex, toxaphene, and hexachlorobenzene.[9] Despite their ban, these unapproved pesticides are still commonly available on the market, and some are even stored in farmers' homes.[10] These substances are known for their high toxicity and persistence, exhibiting slow degradation similar to that of POPs.[11] Their lipophilic nature facilitates bioaccumulation in the tissues of aquatic organisms, further compounding the risk they pose to human and environmental health.[12] Although their direct health impact may be low, their environmental risk remains high.[13]

Previous studies have highlighted the types of pesticides and their active compounds in several water bodies.[14-17] The presence of these pesticides in the tissues of certain fish species, such as *Oreochromis niloticus* and *Clarias* spp., has also been reported.[18] However, prior research often lacked consideration of key parameters, such as half-life (DT_{50}) and the organic carbon adsorption coefficient (Koc), which are essential for evaluating POPs. Given the ever-increasing threats caused by pesticides to aquatic resources, research into POPs is necessary for the sustainable management of fishery resources. This study aimed to inventory the pesticides used by sellers and farmers and to assess their potential risk to the aquatic ecosystems in fishing zones across Burkina Faso.

2. Materials and methods

2.1. Study sites

The study was conducted in the Hauts-Bassins region of Burkina Faso, specifically at the sites of Bama, Banzon, and Bobo-Dioulasso (Figure 1). These sites are characterized by semi-intensive agriculture with the permanent use of pesticides.[17] Bama is located at 1°32'01'' West and 12°21'56'' North, whereas Banzon lies at 04°48'45'' West and 11°18'45'' North. Both the Bama and Banzon are rice-growing areas located around fisheries, where pesticide use is high.[19,20] These sites were chosen because they have been monitored and classified as potentially polluted by the Regional Department of Agriculture, Hauts-Bassins. All the study sites are located within the Sudano-Sahelian climatic zones[21,22] (POPs).

2.2. Sampling

The types of pesticides in use were determined through individual and semi-structured interviews conducted at the Bama, Banzon, and Bobo Dioulasso sites. The socioprofessional groups involved in the study included pesticide sellers and agricultural producers (primarily rice farmers). The sample size was determined based on the total population of producers around the fisheries in Bama and Banzon, and pesticide sellers in Bobo Dioulasso town. A total of 100 stakeholders were randomly selected for the survey: 10 pesticide sellers in Bobo-Dioulasso, 10 pesticide sellers in Bama and Banzon, and 80 farmers from the agricultural areas of Bama and Banzon.

2.3. Data collection

Data collected from pesticide sellers and agricultural producers focused on the types of pesticides used (insecticide, herbicide, fungicide, acaricide, etc.) and their registration status. A complete list of pesticides was compiled based on the responses obtained from the surveys.

2.4. Pesticides registration

The Rotterdam Convention and the SPC regulate the approval and banning of pesticides based on their environmental and human health risks. The World Health Organization (WHO) classified pesticides into five categories according to their level of hazard: Class Ia for extremely hazardous; Class Ib for very hazardous; Class II for moderately hazardous; Class III for slightly hazardous; Class U for unlikely to present acute hazard.[23]

In this study, pesticides identified through interviews with sellers and producers were assessed for their registration status under the Rotterdam Convention and SPC listings. The SPC database includes multiple

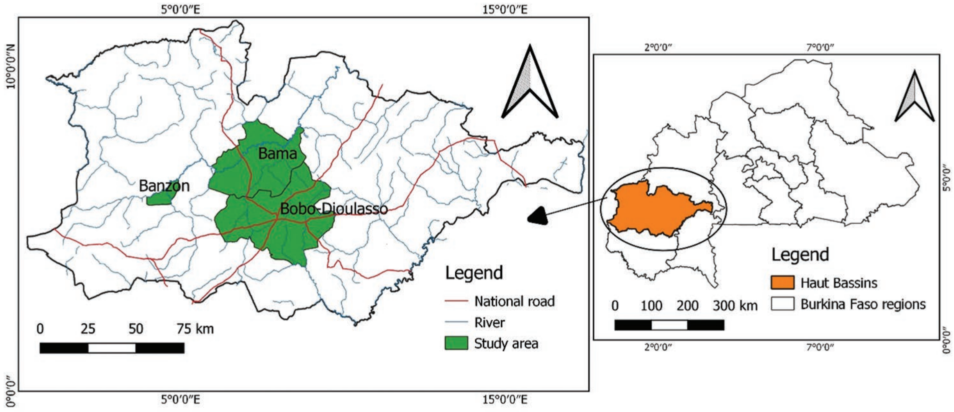

Figure 1. Map of the study site. Figure created by authors.

commercial formulations that may share the same active compounds. Pesticides were classified according to the WHO hazard scale.

2.5. Classification criteria for POPs

Pesticides reported by respondents were assessed for persistence characteristics to determine if they qualified as POPs. The classification was based on the DT_{50} of the active compounds, which represents the time taken for 50% of the substance to degrade in the field.[24] Information on DT_{50} was extracted from the University of Hertfordshire's Pesticide Properties Database (PPDB; http://sitem.herts.ac.uk/aeru/ppdb/en/atoz.htm). Pesticides were classified as follows: Persistent: DT_{50} is >100 days; moderately persistent: DT_{50} is between 30 and 100 days; non-persistent: DT_{50} is <30 days.

2.2.5. Contamination index of surface water

The potential for pesticides leaching from soil into water bodies was determined using the groundwater ubiquity score (GUS) index. This index combines the half-life (DT_{50}) and the soil organic carbon adsorption coefficient (Koc) to assess the mobility of pesticides. GUS index was calculated using the following formula:[25,26] $\log(DT_{50}) \times (4 - \log(Koc))$. Both DT_{50} and Koc values were obtained from the PPDB database. Based on the calculated GUS values, leaching potential was classified as: Low: GUS <1.8; Average: 1.8≤ GUS <2.8; High: GUS ≥2.8.

2.6. Data analysis

All data were analyzed using Microsoft Excel (version 16). This software was used to generate tables and to calculate the pesticide water contamination indices.

3. Results

3.1. Identification of pesticides from sellers

Table 1 lists the pesticides sold and their registration status. A total of 52 commercial pesticide products were identified. Among these, there were 35 herbicides, 14 insecticides, two acaricides, and one fungicide. Cross-referencing with the SPC database revealed that these 52 pesticides corresponded to 25 distinct active compounds. Of the 52 pesticides found on the market, 36 were registered by the SPC, representing 69.23%. It is important to note that a single active compound can be marketed under multiple commercial names. For instance, glyphosate was marketed under the following names: Aduwmastra 480 SL, Bibana 480 SL, Bibebana 480 SL, Bin'fla 360 SL, Deal 480 SL, Glycel 410 SL, Glycomais 360 SL, Glyphader 360 SL, Glyphodaf 360 SL, Kabatex 400 EC, Killer 360 SL, Killer 360 SL, Prodax 360 SL, Sunphosate 360 SL, and Tete Rouge 360 SL (Table 1).

3.2. Identification of pesticides from producers

Table 2 summarizes the pesticides used by farmers living near fishing sites. A total of 29 commercial names for pesticides were identified, including 17 herbicides, 10 insecticides, one fungicide, and one acaricide. These corresponded to 13 herbicidal, 10 insecticidal, one fungicidal, and one acaricidal active compounds, totaling 23 distinct active ingredients used by farmers. Of the 29 pesticides reported, 24 were registered in the SPC database as of October 2022, representing 82.75% of the products used.

3.3. Classification of pesticides by international organizations

The classification of active compounds by the three international regulatory organizations is summarized in

Table 1. List of pesticides sold by sellers and their SPC registration status

No	Types	Commercial name	Active compounds (Concentration)	Registered by SPC
1	Herbicide	Aduwmastra 480 SL	Glyphosate (480 g/L)	Yes
2		Akafissa 108 EC	Haloxyfop-R methyl (108 g/L)	Yes
3		Baraka 432 SC	Propanil (360g/L)+triclopyr (72 g/L)	Yes
4		Bibana 480 SL	Glyphosate (480 g/L)	No
5		Bibebana 480 SL	Glyphosate (480 g/L)	Yes
6		Bin'fla 360 SL	Glyphosate (360 g/L)	No
7		Cepropre 100 SC	Bispyribac-sodium (100 g/L)	Yes
8		Deal 480 SL	Glyphosate (480 g/L)	No
9		Glycel 410 SL	Glyphosate (410 g/L)	Yes
10		Glycomais 360 SL	Glyphosate (360 g/L)	No
11		Glyphader 360 SL	Glyphosate (360 g/L)	Yes
12		Glyphodaf 360 SL	Glyphosate (360 g/L)	Yes
13		Gramoxone 250 SL	Paraquat (250 g/L)	No
14		Halodaf 108 EC	Haloxyfop-R methyl (108 g/L)	Yes
15		Herbimais 240 OF	Dicamba (200 g/L)+nicosulfuron (40 g/L)	Yes
16		Kababin 40 SC	Dimethoate (40 g/L)	Yes
17		Kabatex 400 EC	Glyphosate (480 g/L)	No
18		Killer 360 SL	Glyphosate (360 g/L)	Yes
19		Lamachette 360 SL		
20		Ladaba 360 SL	Glyphosate (360 g/L)	Yes
21		Mega Super 400	Bispyribac-sodium (400 g/L)	Yes
22		Meprodaf 510 EC	Metolachlore (380 g/L)+prometryne (130 g/L)	Yes
23		Metonyx	S-metolachlore (960 g/L)	Yes
24		Oxatop 50 GR	Oxamyl (50 g/kg)	No
25		Paraforce 200 SL	Paraquat (200 g/L)	No
26		Pendaf 500 EC	Pendimethaline (500 g/L)	Yes
27		Pendistar 400 EC	Pendimethaline (400 g/L)	Yes
28		Prodax 360 SL	Glyphosate (360 g/L)	Yes
29		Rice Lord	Cyhalofop-butyl (150 g/L)+bispyribac-sodium (80 g/L)	No
30		Segaibaana 40 SC	Nicosulfuron (40 g/L)	Yes
31		Solution 50 GR	Glyphosate (360 g/L)	No
32		Sunfuron 40 EC	Nicosulfuron (40 g/L)	Yes
33		Sunphosate 360 SL	Glyphosate (360 g/L)	Yes
34		Topextra 720 SL	2.4-D (720 g/L)	Yes
35		Tete Rouge 360 SL	Glyphosate (360 g/L)	Yes
36	Insecticide	Acarius	Abamectin (18 g/L)	Yes
37		Bastion Super 50 GR	Oxamyl (50 g/kg)	No
38		Bomec 18 EC	Abamectin (18 g/L)	Yes
39		Caïman Rouge	Permethrin (25 g/kg)+thirame (250 g/kg)	Yes
40		Emacot 50 WG	Emamectin benzoate (50 g/kg)	Yes

(Cont'd...)

Table 1. ***(Continued)***

No	Types	Commercial name	Active compounds (Concentration)	Registered by SPC
41		Floca 50 WG	Flonicamid (50 g/L)	No
42		K Optimal	Acetamiprid (20 g/L)+lambda-cyhalothrin (15 g/L)	Yes
43		Kapass	Emamectin benzoate (20 g/L)+abamectin (20 g/L)+acetamiprid (40 g/L)	No
44		Lambda 25 EC	Lambda-cyhalothrin (25 g/L)	Yes
45		Lambda Plus 25 EC	Lambda-cyhalothrin (25 g/L)	Yes
46		Pyrimax	Cypermethrin (25 g/L)	No
47		Savahale	Methomyl (250 g/kg)	Yes
48		Titan 25 EC	Acetamiprid (25 g/L)	Yes
49		Typhon 50 EC	Acetamiprid (20 g/L)+indoxacarb (30 g/L)	Yes
50	Acaricide	Acarius	Abamectin (18 g/L)	Yes
51		Bomec 18 EC	Abamectin (18 g/L)	Yes
52	Fungicide	Caïman Rouge	Perméthrin (25 g/kg) or thirame (250g/kg)	Yes

Note: SPC: Sahelian Pesticides Committee (2022 list of approved pesticides).

Table 3. Results show that all pesticides were registered under the Rotterdam Convention. Among them, only paraquat was banned by the SPC; the remaining pesticides were not subject to SPC bans. According to the WHO hazard classification, the pesticides were categorized as follows: Four were classified as unlikely to present acute hazards (Class U), 17 as moderately hazardous (Class II), six as slightly hazardous (Class III), three as very hazardous (Class Ib), and one as extremely hazardous (Class Ia).

3.4. Classification of pesticides based on DT_{50}

Table 4 presents the classification of pesticides based on their DT_{50}. Among the 31 pesticides, 20 were classified as non-persistent, six as moderately persistent, and five as persistent.

3.5. Surface water contamination indices

The contamination indices of pesticides in surface water are presented in Table 5. Based on DT_{50} values, eight pesticides—including deltamethrin, emamectin benzoate, lambda-cyhalothrin, paraquat, cypermethrin, S-metolachlor, and indoxacarb—were classified as persistent in soil. However, pesticides such as flonicamid and triclopyr were classified as not persistent in soil and exhibited a high potential for leaching, indicating a high risk of surface water contamination. GUS analysis revealed that 23 pesticides had low leaching potential, four had medium leaching potential, and three had high leaching potential. Certain active compounds, such as deltamethrin, emamectin benzoate, and lambda-cyhalothrin, exhibited very high Koc values but were characterized by low leaching potential (Table 5).

4. Discussion

This study showed a diversity of pesticides sold by vendors and used by producers, many of which are likely to contaminate aquatic ecosystems in Burkina Faso. The identified pesticides were classified into four types based on their modes of action: herbicides, insecticides, fungicides, and acaricides. These types of pesticides are commonly encountered in Sahelian zones.[17,18,27] Among them, herbicides were the most widely sold and used, indicating a preference among farmers for chemical weed control over manual weeding. In terms of distribution, sellers reported 52 commercial pesticide names, which is higher than the 29 used by farmers located around the rice-farming plains (aquatic ecosystems). Glyphosate, for example, was marketed under multiple trade names, including Aduwmastra 480 SL, Bibana 480 SL, Bibebana 480 SL, Bin'fla 360 SL, Deal 480 SL, Glycel 410 SL, Glycomais 360 SL, Glyphader 360 SL, Glyphodaf 360 SL, Kabatex 400 EC, Killer 360 SL, Killer 360 SL, Prodax 360 SL, Sunphosate 360 SL, and Tete Rouge 360 SL. This widespread variation in product names likely reflects the limited technical knowledge in pesticide management and high rates of illiteracy among the farming population in West Africa.[27] In addition, some

Table 2. List of pesticides used by farmers

No.	Type	Commercial names	Active compounds (Concentration)	Registered by SPC
1	Herbicide	Cepropre 100 SC	Bispyribac-sodium (100 g/L)	Yes
2		Cotonet 500 EC	Metolachlore (333 g/L)+terbutryne (167 g/L)	Yes
3		Douma Woro	Glyphosate (480 g/L)	Yes
4		Glycel 410 SL	Glyphosate (410 g/L)	Yes
5		Glyphader 360 SL	Glyphosate (360 g/L)	Yes
6		Gramoxone 250 SL	Paraquat (250 g/L)	No
7		Herbextra 720 SL	2,4-D dimethylamin salt (720 g/L)	Yes
8		Lamachette 360 SL	Glyphosate (360 g/L)	Yes
9		Ladaba 360 SL	Glyphosate (360 g/L)	Yes
10		Mega Super	Bispyribac-sodium (400 g/L)	Yes
11		Meprodaf 510 EC	Metolachlore (380 g/L)+prometryn (130 g/L)	Yes
12		Nicomaïs 40 SC	Nicosulfuron (40 g/L)	No
13		Rubis 100 SC	Bispyribac-sodium (100 g/L)	Yes
14		Roundup 360 XL	Glyphosate acid (360 g/L)	Yes
15		Samory	Bensulfuron-méthyle (100 g/kg)	Yes
16		Tete Rouge 360 SL	Glyphosate (460 g/L)	Yes
17		Topextra 720 SL	2,4-D (720 g/L)	Yes
18	Insecticide	Bomec 18 EC	Abamectin (18 g/L)	Yes
19		Caïman Rouge	Permethrin (25 g/kg)+thirame (250 bg/kg)	Yes
20		Savahale	Methomyl (250 g/kg)	Yes
21		Decis 25 EC	Deltamethrin (25 g/L)	Yes
22		Emapyr	Emamectin benzoate (20 g/L)+pyriproxyfen (60 g/L)	Yes
23		K Optimal	Acetamiprid (20 g/L)+lambda-cyhalothrin (15 g/L)	Yes
24		Lambda 25 EC	Lambda-cyhalothrin (25 g/L)	Yes
25		Magnum 28 EC	Lambda-cyhalothrin (28 g/L)	Yes
26		Emacot 50 WG	Emamectin benzoate (19 g/L)	Yes
27		Pocket	Emamectin benzoate (20 g/L)	No
28	Fungicide	Caïman Rouge	Permethrin (25 g/kg)+thirame (250 g/kg)	Yes
29	Acaricide	Bomec 18 EC	Abamectin (18 g/L)	Yes

Note: SPC: Sahelian pesticides committee (2022 list of approved pesticides).

of the pesticides not used by rice farmers may be used by others, such as market gardeners or those cultivating cotton, millet, maize, and other crops. Although the number of pesticides identified in this study is lower than the 288 reported for vegetable and rice production in Mali,[10] the number of unique active compounds (25) remains substantial, indicating a broad range of chemical substances entering aquatic systems near farmlands. Most of the active compounds identified in this study were registered by the SPC. This diversity likely reflects the wide range of agricultural uses for pesticides, as well as farmers' tendencies to select the most effective, affordable, and accessible products to maximize yields.[8]

International conventions play an important role in regulating pesticides to ensure environmental and public health safety. Our study revealed that paraquat is the only active compound banned by the SPC. The presence of non-registered or banned pesticides such as paraquat (250 g/L) on the market can be explained by the lack of enforcement of pesticide regulations, fraud, and limited awareness due to illiteracy.[28,29] Other studies conducted in Burkina Faso have also indicated that paraquat is

Table 3. Classification of active pesticide compounds according to international regulatory frameworks

No.	Types	Pesticides (active compound)	Prohibited under the Convention of Rotterdam	Prohibited by SPC	WHO hazard class
1	Herbicides	Glyphosate	No	No	III
2		Haloxyfop-R methyl	No	No	II
3		Propanil	No	No	II
4		Triclopyr	No	No	II
5		Bispyribac-sodium	No	No	III
6		Paraquat	No	Yes	II
7		Dicamba	No	No	II
8		Nicosulfuron	No	No	U
9		Dimethoate	No	No	II
10		Metolachlor	No	No	III
11		Prometryn	No	No	III
12		S-metolachlor	No	No	III
13		Oxamyl	No	No	Ia
14		Pendimethalin	No	No	II
15		Cyhalofop-butyl	No	No	U
16		Bensulfuron-methyl	No	No	U
17		Terbutryne	No	No	III
18		2,4-D	No	No	II
19	Insecticide	Abamectin	No	No	Ib
20		Permethrin	No	No	II
21		Deltamethrin	No	No	II
22		Methomyl	No	No	Ib
23		Pyriproxyfen	No	No	U
24		Emamectin benzoate	No	No	II
25		Flonicamid	No	No	II
26		Acetamiprid	No	No	II
27		Lambda-cyhalothrin	No	No	II
28		Cypermethrin	No	No	II
29		Indoxacarb	No	No	II
30	Fungicide	Thirame	No	No	II
31	Acaricide	Abamectin	No	No	Ib

Note: SPC: Sahelian Pesticide Committee. World Health Organization (WHO) hazard classification system: Ia: Extremely hazardous; Ib: Highly hazardous; II: Moderately hazardous; III: Slightly hazardous; U: Unlikely to present acute hazard under normal use.

the most dominant active compound.[15,30] These studies revealed paraquat's risks to human and environmental health, which likely prompted its ban by the SPC. Other unregistered or banned pesticides include nicosulfuron (40 g/L) and emamectin benzoate (20 g/L). Their continued use can be explained by illegal supply chains, low cost, and high efficacy in controlling crop pests.[8] In addition, this study found that some pesticides in use—such as abamectin and methomyl—are classified by the WHO as Class Ib, meaning they are very dangerous. The use of these products should be strictly prohibited for farmers who have received no training, those lacking appropriate personal protective equipment, and those who tend to overlook the dangers associated with the pesticides.[31] Farmers lacking these safeguards should only use pesticides from lower WHO hazard classes (II, III, and U), and even then, only under proper guidance.[5]

Table 4. Classification of active pesticide compounds based on DT_{50}

No.	Type	Active compound	Persistence		
			Short (DT_{50}<30 days)	Moderate (DT_{50}=30–100 days)	Long (DT_{50}>100 days)
1	Herbicides	Glyphosate	X		
2		Haloxyfop-R methyl	X		
3		Propanil	X		
4		Triclopyr	X		
5		Bispyribac-sodium	X		
6		Paraquat			X
7		Dicamba	X		
8		Nicosulfuron	X		
9		Dimethoate	X		
10		Metolachlor		X	
11		Prometryn		X	
12		S-metolachlor		X	
13		Oxamyl	X		
14		Pendimethalin			X
15		Cyhalofop-butyl	X		
16		Bensulfuron-methyl		X	
17		Terbutryne		X	
18		2,4-D	X		
19	Insecticide	Abamectin	X		
20		Permethrin	X		
21		Deltamethrin		X	
22		Methomyl	X		
23		Pyriproxyfen	X		
24		Emamectin benzoate			X
25		Flonicamid	X		
26		Acetamiprid	X		
27		Lambda-cyhalothrin			X
28		Cypermethrin	X		
29		Indoxacarb			X
30	Fungicide	Thirame	X		
31	Acaricide	Abamectin	X		

Notes: DT_{50}: half-life of the pesticide in soil; X indicates the active compound's persistence class: Short (DT_{50} < 30 days), Moderate (DT_{50} = 30–100 days), Long (DT_{50} > 100 days).

Regarding persistence, several pesticides were identified as moderately to highly persistent based on their DT_{50}. These included paraquat, pendimethalin, emamectin benzoate, lambda-cyhalothrin, and indoxacarb. Other moderately persistent compounds, such as metolachlor, prometryn, S-metolachlor, bensulfuron-methyl, terbutryn, and deltamethrin, have also been reported in previous studies.[32] POPs are defined by four major characteristics: Persistence, bioaccumulation, toxicity, and environmental mobility.[33] These findings are consistent with those of earlier studies in Mali, Côte d'Ivoire, and Burkina Faso.[13,29,34] For example, paraquat and emamectin benzoate were noted for their extreme persistence (≥300 days). The DT_{50} values of pesticides depend on factors such as soil composition, rainfall, and irrigation practices.[35] The study sites, characterized by clay soils, heavy rainfall during the wet season, and intensive irrigation

Table 5. Water contamination index of pesticide compounds

No.	Leaching potential	Active compounds	DT_{50} (days)	Koc (mL/g)	GUS
1	Low	Deltamethrin	58.20	10240000.00	−5.31
2		Emamectin benzoate	300.00	377000.00	−3.90
3		Lambda-cyhalothrin	175.00	283707.00	−3.26
4		Paraquat	365.00	1000.00	−2.56
5		Cypermethrin	23.00	288735.00	−1.99
6		Permethrin	13.00	100000.00	−1.11
7		Propanil	0.40	149.00	−0.73
8		Pendimethalin	182.30	17491.00	−0.55
9		Cyhalofop-butyl	0.20	5247.00	−0.20
10		Haloxyfop-R methyl	0.50	0.00	0.00
11		Bispyribac-sodium	13.00	0.00	0.00
12		Dicamba	9.62	0.00	0.00
13		Dimethoate	2.50	0.00	0.00
14		S-metolachlor	51.08	0.00	0.00
15		Bensulfuron-methyl	74.90	0.00	0.00
16		Abamectin	25.30	0.00	0.00
17		Pyriproxyfen	10.00	0.00	0.00
18		Thirame	4.89	0.00	0.00
19		Acetamiprid	1.60	200.00	0.35
20		Indoxacarb	113.20	4483.00	0.72
21		Glyphosate	17.30	1424.00	1.05
22		Terbutryne	74.00	2432.00	1.15
23		2,4-D	4.40	39.30	1.55
24	Average	Methomyl	7.00	72.00	1.81
25		Flonicamid	3.10	1.60	1.87
26		Oxamyl	5.30	14.91	2.05
27		Prometryn	41.00	400.00	2.25
28	High	Triclopyr	18.10	27.00	3.23
29		Nicosulfuron	29.50	40.00	3.52
30		Metolachlor	90.00	120.00	3.75

Note: DT_{50}: Half-life of compounds in soil; Koc: Organic carbon partition coefficient (adsorption); GUS: Groundwater ubiquity score.

during the dry season, likely influenced the persistence of these compounds. These pesticides are extremely toxic to humans and animals. Paraquat, for instance, is lethal even at small doses. Considering its toxic characteristics, its use has been restricted or banned in many countries.[36] Emamectin benzoate, a powerful pesticide widely used in agriculture, causes poisoning risks due to its toxic characteristics.[37] Consequently, POPs have become a major focus of scientific research due to their toxicity, persistence, potential for long-range transport, and tendency to bioaccumulate.[38] These persistent pesticides can pose very high risks to aquatic organisms, particularly fish. In this regard, Vroumsia *et al.*[39] demonstrated that pesticide exposure in fish can induce symptoms such as slow opercular movements, loss of balance, increased surface activity, loss of pigmentation, increased aggressiveness, and erratic swimming.

The movement of active compounds has significant implications for public health because surface water and well water are used daily for drinking and cooking. This study showed that water bodies are highly vulnerable to pesticides, as around seven active compounds exhibit a GUS ≥ 1.8. Among these, metolachlor is the most mobile pesticide, indicating a high potential to contaminate aquatic ecosystems. Such mobility is often linked to contamination, especially in areas where irrigation and soil management practices do not adequately limit pesticide transport. This was observed at the study site, which experiences high rainfall and frequent irrigation. Conversely, other pesticides—such as deltamethrin, emamectin benzoate, lambda-cyhalothrin, and paraquat—were found to be persistent but exhibited low mobility due to their hydrophobic nature and limited water solubility. The combined analysis of GUS and DT_{50} values highlights the complexity of assessing the contamination risk of aquatic ecosystems, as pesticides with low mobility but high persistence can remain in the environment for extended periods without moving in water, while more mobile but less persistent chemicals can quickly reach surface water following heavy rainfall and the effects of irrigation.[10,40] These pesticides accumulate in the tissues of aquatic organisms over several years, leading to disruption in the food chain from producers to final consumers.[41] This process contributes to a reduction in fish biodiversity and an imbalance in food competition among organisms.[42,43]

5. Conclusion

In Burkina Faso, phytosanitary products are widely used by agricultural producers around the fishing sites of Bama and Banzon. These producers purchase their pesticides from various sellers. The study identified four main types of pesticides sold and used in these areas: Herbicides, insecticides, fungicides, and acaricides. Among these, several pesticides are persistent organic compounds that can enter aquatic ecosystems through surface runoff and leaching following rainfall and irrigation events. Consequently, they pose a threat not only to aquatic resources but also to human health. Given the widespread use of these pollutants, it is essential to raise awareness among various stakeholders—particularly pesticide vendors and farmers—about the dangers of using pesticides. In addition, close monitoring of illegal pesticide distribution and stricter enforcement of regulations governing pesticide registration, marketing, and usage are essential. Future research should focus on determining the concentration levels of these active compounds across various levels of the aquatic trophic chain.

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Conflict of interest

The authors declare no competing interests.

Author contributions

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Availability of data

Data are available from the corresponding author upon reasonable request.

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