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Assessment of the impact of urban dynamics on aquaculture activities in the municipality of Daloa

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Abstract: This present thesis sets the problem of the impact of the evolution of the town of Daloa on the aquacultural activities. The objective of this study is to show the impact of urban dynamic on aquacultural activities in the town of Daloa. To reach this objective, the methodology used id based on three parts : documentary research, talks with people, inquiries through a list of question. First, the documentary research consisted in defining the scope of the subject to apprehend it. Then, the talks realised with the actors of the field of production, with the NGO and specialised institutions allowed us to collect of some information or facts. At last, basing on the non probabilist method, which consists in snowball-tree, we made investigation on thirty (30) pisciculturists or fish breeders in the town of Daloa. From these investigations, it emerges that the activity of aquaculture in the town of Daloa has every chance to succeed. We mean, natural and human potentialitis. Meanwhile this activity knows different steps in the development. Unfortunately, areas used for this activity are being affected by wild or uncontrolled urbanization. This gives birth to many environmental and sanitary problems on the pisciculture work. Pisciculturist are obliged to let down or abandon their places without any compensation throwing them out of work.

1. Introduction

Defined as all the techniques used to develop and exploit the natural animal and plant resources of water and the aquatic environment, aquaculture plays an important role in food production, economic development and food security in Africa (Troeml et *al*., 2023). In sub-Saharan Africa, it has great potential due to the fact that the African continent is endowed with gigantic water resources (FAO, 2014). However, water resources are under heavy pressure from anthropogenic activity (agriculture, industry, livestock, fishing, domestic, hospitals, etc.) (Adjagodo et *al*., 2016; El Abdouni et *al*., 2021). In addition, socio-economic anthropogenic activities coupled with that of natural processes (soil erosion, precipitation, evaporation, rainwater runoff) accelerate the degradation of surface water resources (Alla, 1991; Zerrouqi et *al*., 2013). Sub-Saharan Africa's growing urban population and booming economy have increased demand for fish and aquaculture, particularly in peri-urban areas (DPH, 2011; Adeleke et *al*., 2020; Ngarava et *al*., 2023). In Côte d'Ivoire, artisanal fishing plays an

important role, contributing almost 60% of national production (Belhabib et *al*., 2015). The main catches, small tunas, are of great economic value to local communities in Côte d'Ivoire. However, the country remains heavily dependent on imports to satisfy its domestic demand for fish products (DAP, 2014), leading to an imbalance in the balance of trade. As far as aquaculture is concerned, there is enormous potential for its development, given the country's considerable natural assets (150,000 ha of lagoons, 350,000 ha of lakes and numerous lowlands suitable for aquaculture farms, mangrove vegetation, rivers, water reservoirs).The commune of Daloa, which is our study area, offers all these assets for developing aquaculture activities to supply the country's other localities. However, this activity is being neglected in the face of the department's urban development. It is the undisputed reflection of unbridled urbanization, with a rate of 79.5% in 2014. The urban population rose from 60,837 in 1975 to 266,324 in 2014, and according to a projection by INS in 2019, it could reach 267,117 by 2020 (INS-RGPH, 2021). This demographic surge is reflected in the city's spatial expansion. Thus, from 393 ha in 1962, the city grew to 838 ha in 1975, then, 1,118.25 ha in 1980 and finally 9,650.75 ha in 2014 (Mairie Daloa, 2014). This acceleration in the urbanization process is particularly noticeable in forested areas. Indeed, because of their economic potential, several populations have flocked to them, and as a result they will be subject to several constraints (disproportionate population growth, uncontrolled spatial growth, proliferation of unorganized economic activities) linked to the degradation of their living environment, phagocytizing rural spaces intended for certain activities such as aquaculture (Cotton, 1968).

How does urbanisation impact aquaculture activities in the commune of Daloa?

From this fundamental question, the following secondary questions emerge:

- *How does aquaculture operate in the commune of Daloa?*
- *How has urbanisation occupied the spaces dedicated to fish farms?*
- *What are the impacts of urbanisation on aquaculture activities?*

To answer these questions, the aim of our study is to show the impact of urbanisation on aquaculture activities. More specifically, it will be a question of: studying the way in which aquaculture activity operates in the commune of Daloa; locating the areas dedicated to aquaculture under the influence of urbanisation in this locality and in order to show the impacts of urbanisation on aquaculture activities in the commune of Daloa.

2. Methodology

2.1 Methodological approach

The research methodology used in this research work consists of the research hypotheses, the description of the observation units, the analysis variables, the collection and processing of the data and the presentation of the difficulties encountered in the field.

2.1.1. Research hypotheses :

This task requires the formulation of answers to the various research questions in this work.

- General hypothesis: *Urbanisation has several impacts on aquaculture activity in Daloa.*

- Specific hypotheses :

- *The commune of Daloa has several assets for the development of aquaculture;*
- *The areas dedicated to aquaculture are influenced by urbanisation in Daloa;*
- *Urbanisation has an impact on the activity in the commune of Daloa at several levels.*

2.1.2. Observation units

The observation units consist of the commune of Daloa and its neighbourhoods, which constitute the geographical framework of the study.

2.1.2.1. Description of the geographical setting

Our study area is located in the Haut Sassandra region, in central-western Côte d'Ivoire, in a mesophilic forest environment, between 6° and 7° north latitude and 7° and 8° west longitude. It is bordered to the north by the departments of Vavoua and Zuénoula, to the south by Issia and Sinfra, to the west by Duékoué and Bangolo and to the east by Bouaflé. Daloa is 141 km from Yamoussoukro, the political capital, and 410 km from Abidjan, the economic capital. The country's third largest city, Daloa is the capital of the Haut Sassandra administrative region. The urban perimeter has grown from 2,064.87 ha in 1998 to 3,300 ha (BNETD/CCT, 2007), reaching 9,650.75 ha in 2014, with an estimated population of 266,324, representing a growth rate of 7.9% between 1998 and 2014 (INS-RGPH, 2021). Seven (07) villages are attached to it. These are Balouzon, Gbokora, Dérahouan, Gogoguhé, Sapia, Tagoura and Zaguiguia. These villages have become peri-urban neighbourhoods as a result of sprawl (**Figure 1**).

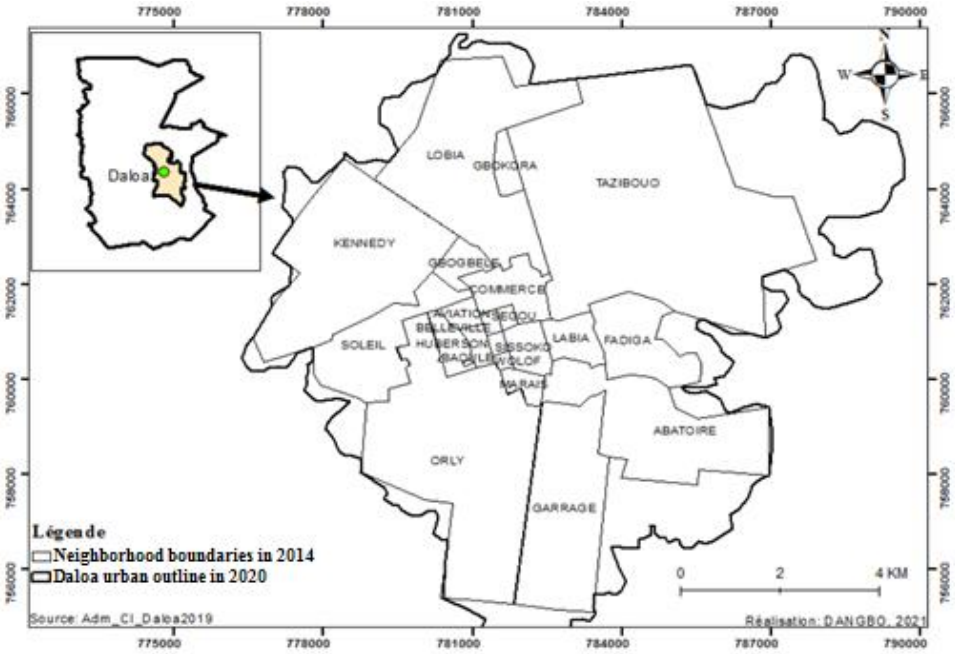

Figure 1: Map of the study area

2.1.2.2. Sampling sites

The study was carried out on fish farms in and around the town of Daloa. In all, the study involved thirty (30) fish farms

2.1.3. Analysis variables

These variables (quantitative and qualitative) were used to identify the various functions of the households surveyed, their levels of education and their origins in order to obtain information about the commune of Daloa. On the other hand, they make it possible to highlight the economic activities, the mode of installation and the impact of aquaculture activities in the commune of Daloa. These variables are made up of socio-demographic variables and variables relating to aquaculture activities and the impact of urbanisation in the town of Daloa (**Table 1**).

Table 1: Socio-demographic variables

Quantitative variables	Qualitative variables
▪ Number of children ▪ Age ▪ Age range	▪ Gender ▪ Marital status ▪ Origin ▪ Profession ▪ Level of education

Table 2 : Variables relating to aquaculture activities in the town of Daloa

Quantitative variables	Qualitative variables
▪ Number of years practised for an activity ▪ Profitability of the activity ▪ Length of residence in the commune ▪ Number of years practised ▪ Number of facilities ▪ Number of neighbourhoods	▪ Type of activity ▪ Production system ▪ Working method ▪ Obtaining land ▪ Installation method ▪ Reason for setting up ▪ Marketing of products ▪ Food impact of activity ▪ Types of disease ▪ Effects on spatial configuration ▪ Main species reared ▪ Most commonly consumed species ▪ Growing methods ▪ Difficulties encountered ▪ Outside help

2.1.3. Data collection and processing

Data collection was based on both documentary research and, above all, a field survey. The documentary research enabled us to summarize and cross-check the various documents that form part of our study. In order to obtain information in the field, we used a pre-survey, direct observation, an interview survey and a questionnaire survey. For this study we opted for the non-probabilistic method determined by network. This method consists of choosing a few people who correspond to the desired benefit and asking them for the names of similar people (Christine et *al*., 2012). Data was collected in the field by means of a survey of fish farmers on the various fish farms studied, with a total of 30 fish farmers surveyed (**Table 1**). Thus, to achieve the research objectives, we crossed data collection based on documentary research with that of the field survey. To show the impact of urbanization on aquaculture activity, we used Karl Pearson's chi-square test (Khi2) (Bernard, 1978). This test is of vital importance, as it shows the independence (no influence) or dependence (influence) between two observed variables. It is a statistical test that allows us to confirm or deny whether urbanization has an impact on aquaculture activities.

Table 3 : Liste des pisciculteurs enquêtés de notre zone d'étude par quartier

Name of district	Number of fish farmers surveyed
Abattoir 2	5
Abattaoir 2 Extension	1
Abattoir Sud	4
Bribo	1
Ermanconon	2
Evêché	1
Institut Pastorale	2
Lobia 2	1
Millionnaire	1
Orly Extension 3	1
Orly Plateau	4
Savonnerie	2
Suisse	1
Tazibo 1	2
Tazibo université	2
Total General	**30**

The hypotheses to be put forward in a statistical inference test are as follows:

- ***Null hypothesis (H0)* :** *This is the hypothesis that there is no link between the variables.*
- ***Alternative hypothesis* (H1) :** The hypothesis that there is a link between the variables.
- ***Theoretical numbers* :** To calculate the theoretical numbers, the following formula was applied:

$$Theoretical\ headcount\ = \frac{Total\ Line \times Total\ Column}{Grand\ Total} \quad \textbf{Eqn. 1}$$

Let's calculate the Chi-square: It is obtained from the following formula :

$$Khi2\ = \frac{(Observed\ headcount - Theoretical\ headcount)^2}{Theoretical\ headcount} \quad \textbf{Eqn. 2}$$

Degrees of freedom (DDL): For Pearson's Chi2 test, the number of degrees of freedom 1 in our table is equal to

$$DDL = (number\ of\ lines\ -\ 1)\ \times\ (number\ of\ columns\ -\ 1) \quad \textbf{Eqn. 3}$$

- The Chi-square of the tables is found from the significance level. For this study, we take 5% as the margin of error, so the confidence level is 95%. So, by matching the degree of freedom 1 with the margin of error of 5%, we obtain the Chi-square of the tables in the order of 3.8415.

- The Chi2 calculated is greater than the Chi2 of the tables (3.84), so there is a dependency between the two variables. As these two variables are qualitative variables, the use of the Chi2 test enabled us to assess the link between these different variables. However, to determine the strength of this link, we calculated Cramer's V (0 > V > 1). Harald Cramer (1946) measures the strength of the link between 2 qualitative variables using the formula :

$$V = \sqrt{\frac{X^2}{{X^2}_{max}}} = \sqrt{\frac{X^2}{n \times [\min(Line, Column) - 1]}} \quad \textbf{Eqn. 4}$$

Cramer's V is the square root of X^2 divided by ${X^2}_{max}$. This theoretical ${X^2}_{max}$ is equal to the number of employees multiplied by the smallest side of the table (number of rows or columns) minus 1.

Table 4 : The interpretation is made through the table of variation of the association measure

Cramer's V value	Intensity of the relationship between the variables
$< 0{,}10$	No or very weak relationship
$\geq 0{,}10\ et\ < 0{,}20$	Weak relationship
$\geq 0{,}20\ et\ < 0{,}30$	Medium relationship
$\geq 0{,}30$	Strong relationship

The two tests (Pearson's **Chi-square** and **Cramer's V**) will make it possible to verify the link between the impact of business activity and urbanisation.

2.1.4. Data processing

The information collected was processed using IT tools. First, the data was grouped according to theme. Geographical coordinates were taken using *OSMTracker* software and maps were produced using *Arc-View* software. Statistical processing, tables, diagrams and figures were produced using Excel.

3. Results et Discussion

3.1 Characteristics of aquaculture in the commune of Daloa

3.1.1. Natural assets favourable to the development of the activity in the commune of Daloa

The commune of Daloa boasts a number of natural and technical assets for the development of various activities, particularly aquaculture. Daloa has a humid tropical climate, with rainfall ranging from 1,200 to 1,600 millimetres per year (SODEXAM, 2010). Rainfall is spread throughout the year, with a maximum in June and July and a minimum from December to March. A humid zone par excellence, humidity is high, with a homogeneous average annual temperature of 26°C (SODEXAM, 2010). Hydrographically, the region is influenced by the Sassandra River and its tributaries (the Lobo and Davo). In addition, numerous seasonal streams such as the Dé, Bahoré and Boty irrigate the region, giving rise to a large number of cultivable lowlands. These rivers have a transitional tropical regime, with low water from January to May and high water in September and October. Hydrogeologically, the study region is part of the crystalline basement. The latter contains water reserves that develop in aquifers, the size of which depends on the degree of alteration and fracturing of the parent rock, enabling water to be kept in the ponds during dry periods. The vegetation in our study area is characterized by rainforest.

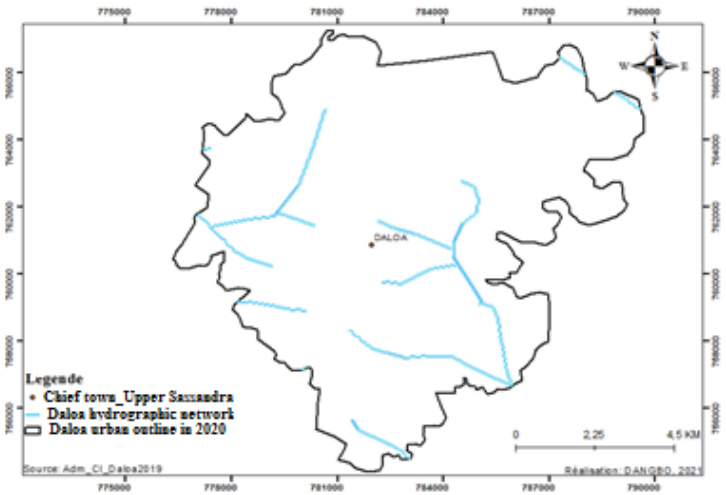

Figure 2 : Map of the hydrographic network in the commune of Daloa

3.1.2. Actors and techniques used by fish farmers to develop the activity in the commune

3.1.2.1. Players

Producers come from different social strata and different origins. The population of the commune of Daloa is made up of several ethnic groups, namely the Bété, Gouro, Niamboua, Ehotilé, Baoulé, Malinké, etc., as well as foreign communities including Malians, Burkinabés, Senegalese, etc. However, in the majority of cases, it is the farmers themselves who are responsible for the production of fish. In most cases, however, it is the traders who take up fish farming as a second source of income.

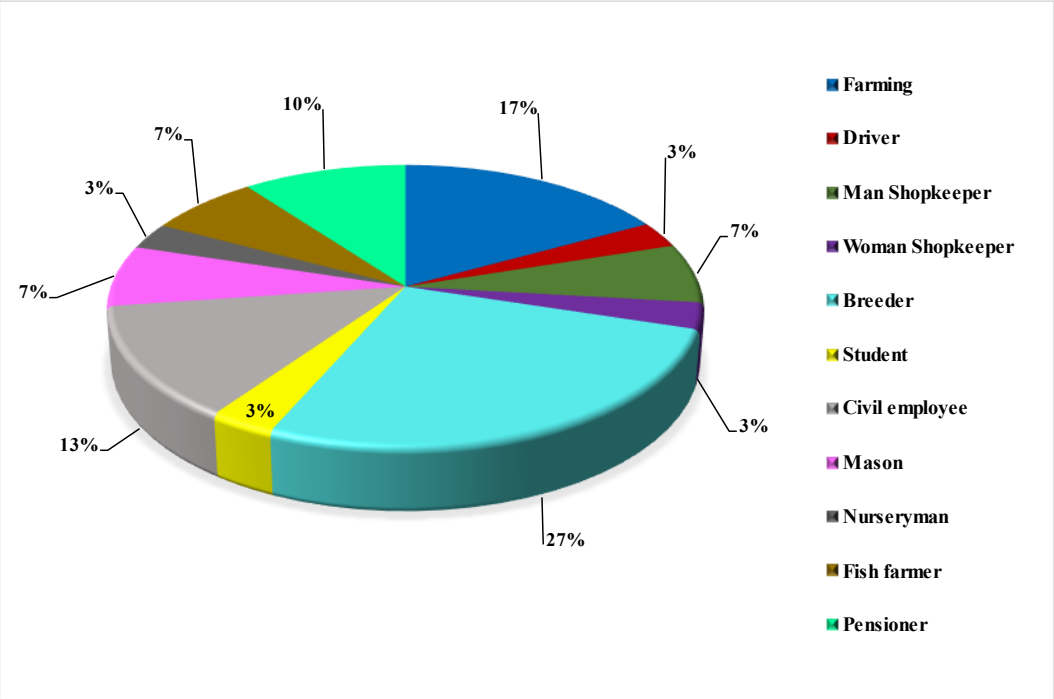

Figure 3 : Socio-professional activity of fish farmers

We found that 7% of the farms visited were under the responsibility of a manager, while 93% were run by their owner. This lack of management is due to the fact that their monthly income is low because of the lack of production. Men are more interested in fish farming than women. In fact, only 14% of the farms visited were owned by women. This is justified by the fairly high cost of investment, given that men generally have more financial resources than women, and that this activity also often requires physical effort. The owner generally has no access to credit.

3.1.2.2. Techniques used

There are different sources of financing for the creation of a fish farm: the fish farmers' own funds (93%); and their own funds and external donations (7%). External donations are mostly family assistance or a loan from a friend. Farmers say that bank loans are almost impossible due to high interest rates. The land they farm has been acquired in a variety of ways, including leasing, purchase, inheritance and illegal settlement. But most of the time the land belongs to the owner of the farm (46.66%). As a result, land problems are avoided and the fish farmer generally has the opportunity to invest freely without being troubled by land conflicts, unlike farms set up illegally or as a result of leasing, where the fish farmer runs the risk of losing the land and therefore the realisations. The techniques used by fish farmers to develop the activity in the area The techniques used by fish farmers are varied, depending on the production systems on the different farms and the types of fish ponds.

- **Production systems and types of ponds**

Fish farmers in the commune of Daloa practise two types of fish farming activity: intensive fish farming (84%) and semi-intensive fish farming (17%) **Figure 4a**.

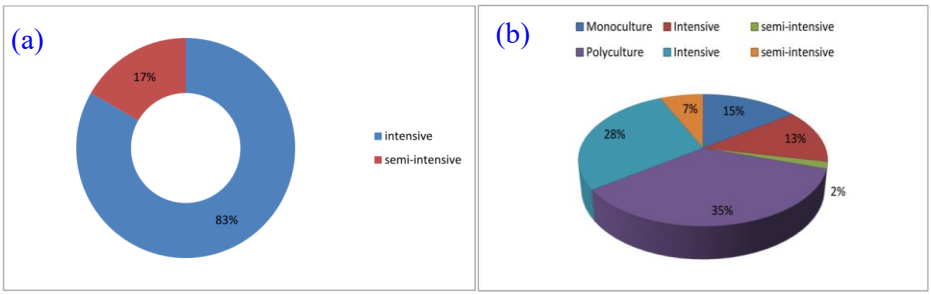

Figure 4 : Socio-professional activity of fish farmers

In ***intensive fish farming***, inputs are high and ponds contain a maximum number of fish. Supplementary feed is used, and natural feed production plays a secondary role. In this system, complex management problems can arise, linked to the high density of fish stock in the ponds (increased vulnerability to disease and dissolved oxygen deficiency) (Anonyme, 2000).

In ***semi-intensive fish farming***, inputs are moderate and fish production is increased by using additional fertilisers and/or feed. This involves higher labour and feed costs, but these are normally more than offset by the increased yields. The fish farms we visited have only one type of pond, the bypass pond, which is used by 100% of fish farmers.

Figure 5 : Picture of a diversion pond in the pastoral institute district

Diversion ponds are ponds through which some, but not all, of the water from a source passes. The water entering and leaving the pond is controlled. Part of the watercourse is therefore diverted into a feeder canal that brings the water to the ponds. The water intake on the watercourse is usually built in front of a small diversion dam. This dam ensures a constant water level in the feeder canal. Any surplus water that is not needed passes through the weir of the dam. Basins fed by a bypass canal can be built in parallel or in series.

Tilapia (*Oreochromis niloticus*), Cameroon (*Hétérotis niloticus*) and Catfish (*Heterobranchus longifilis*) are the species reared most in ***Monoculture*** (26.67%) and ***Polyculture*** (73.33%). The fry used on the farms are purchased from private individuals. The majority of farms visited practise the fry rearing cycle plus pre-fattening and fattening. The price of fry varies from 25 FCFA to 500 FCFA depending on the species. On all the farms surveyed, the fish are given feed. No farmer makes his own feed. Eighty-seven percent (87%) use agricultural by-products from the mills (low-grade rice and/or maize flour), compared with 13% who use industrial feed two or three times a day. Overall, fish farmers are finding it difficult to feed their fish properly because of regular supply disruptions. Surveys of fish farmers and officials from MIRAH (Ministry of Animal and Fisheries Resources) and APDRACI

(Association pisciculture et développement rural en Afrique tropicale humide Cote d'Ivoire) revealed that there is no data on annual fish farming production in the commune of Daloa. The commune of Daloa has a number of characteristics that are conducive to the development of aquaculture, and this sector has a variety of techniques for its development. Hypothesis 1, according to which the fish farming sector has several characteristics (natural and human) for its development, is verified.

3.2. Development and location of areas most affected by urbanisation

3.2.1. Development of fish farming in the commune of Daloa

Fish farming has gone through three (03) phases in the commune of Daloa as shown in **Figure 6** below, namely the period from 1980 to 1990, from 1990 to 2010 and from 2010 to 2020.

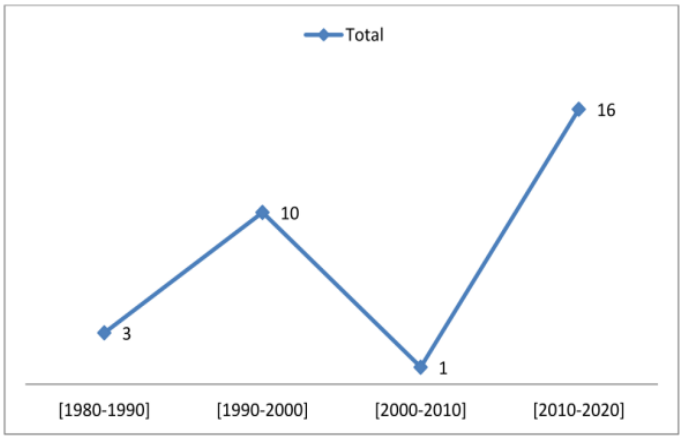

Figure 6 : Development of fish farms in the commune of Daloa

The period from 1980 to 2000 was marked by an effective presence of fish farms due to the good political climate and various projects such as the PPCO (*Projet Piscicole du Centre Ouest* = **Central West Fish Project**) initiated by the leaders of this new state (**Figure 7**). Indeed, after gaining independence in 1960, Côte d'Ivoire continued to promote aquaculture, which had been initiated by the colonists. However, the activity has encountered difficulties due to the country's socio-economic and political situation.

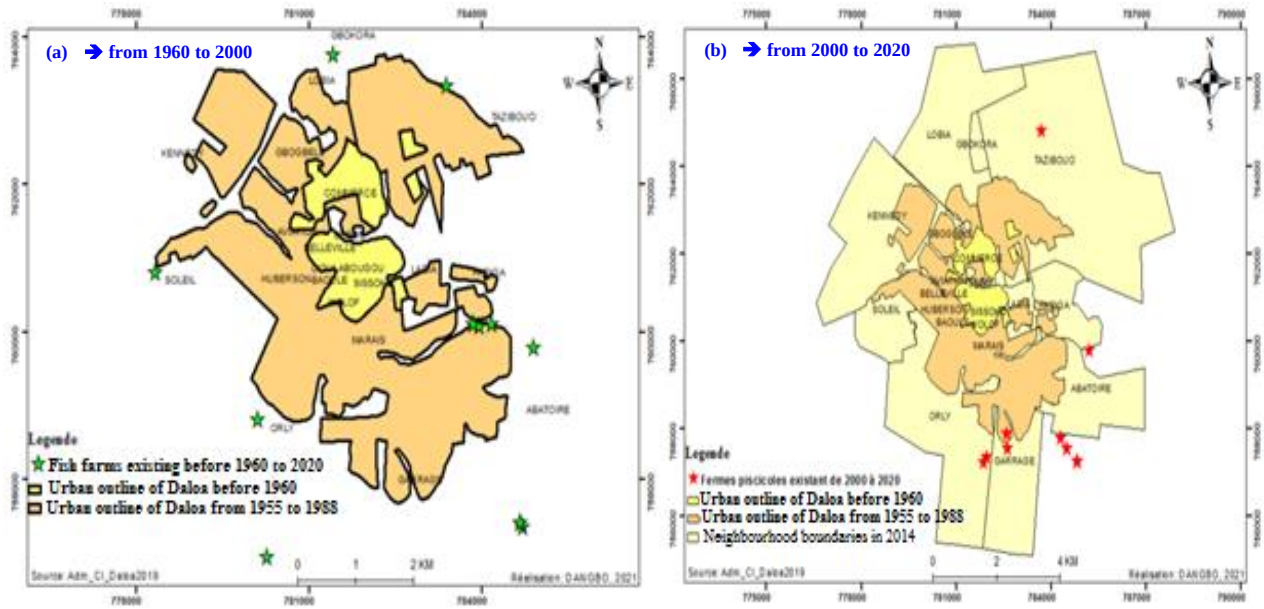

Figure 7 (a, b) : a-Map of existing fish farms from 1960 to 2000 **(a)** et and 2000 to 2020 **(b)**

In addition, farming techniques were not sufficiently well developed and farmer support was no longer as efficient (Assi-Kaudjhis, 2005). For the period 2000 to 2020, aquaculture activities declined between 2000 and 2010, due to a number of factors, including the various crises that the country has experienced, and the lack of funding, supervision and monitoring of projects by state structures, with 17% attributable to the various crises and 83% to other factors. Between 2010 and 2020, there has been an upturn in activity thanks to the various initiatives taken at national level with the aim of relaunching aquaculture activities.

3.2.2. Distribution of fish farms in the town of Daloa

The town of Daloa has 30 districts and 08 villages. Of these districts, only 14 have 29 farms, compared with one fish farm in the rural area of Bribuo, i.e. an occupancy rate of 40%. The distribution of fish farms in the commune is linked to the choices made by operators (**Figure 8**). They prefer to set up in localities that are better endowed with resources conducive to this activity. Thus, the more an area gathers together enormous factors useful for aquaculture, the more it attracts breeders, as is the case with the various farms encountered during our surveys. However, in the face of anthropic pressure, the various farms are being abandoned.

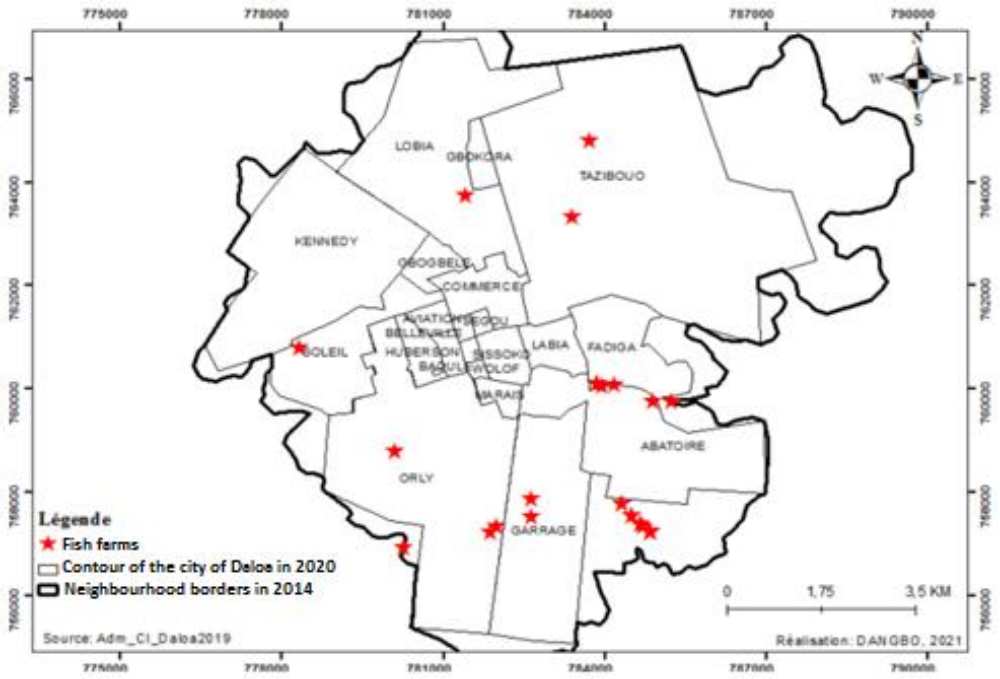

Figure 8 : Map showing the distribution of farms in the commune of Daloa

3.2.3. Location of areas most affected by urban development

The areas most affected by urban development are the southern part of the municipality. As the **Figure 9** shows, most of the fish farms under the influence of urbanisation have been abandoned. This neglect of the various farms is partly due to the growth of the commune of Daloa, which has resulted in the occupation of low-lying areas for housing purposes. The fish farming sector in the commune of Daloa has gone through several phases in its development, but the areas dedicated to this activity in the commune are being invaded by uncontrolled urbanisation. Thus, the hypothesis according to which: the areas dedicated to aquaculture are influenced by urbanisation in the locality of Daloa is verified.

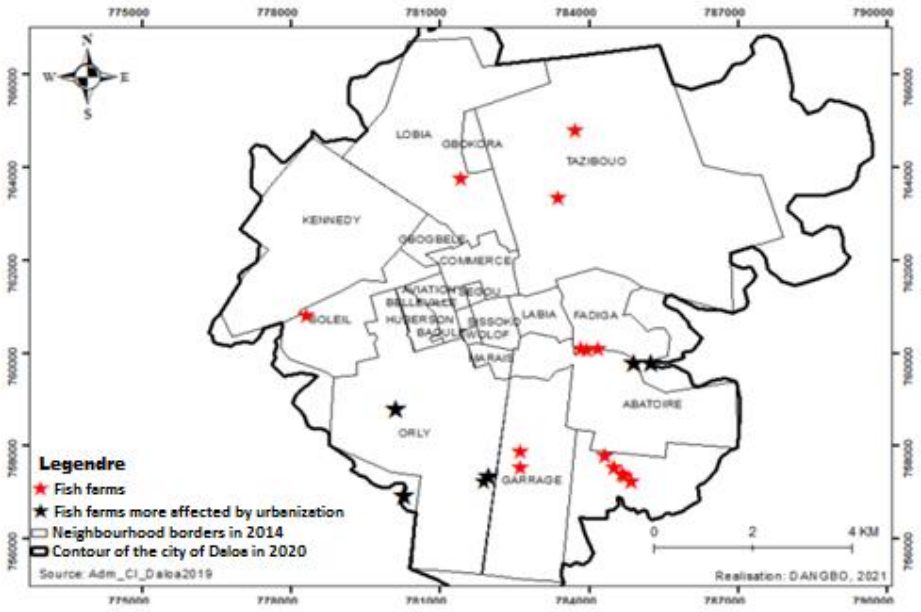

Figure 9 : Map of areas most affected by urbanisation

3.3. Impact of urbanisation on fish farms

3.3.1. Environmental impact of urbanisation on fish farming activities

The results of the survey showed that 75% of fish farmers are experiencing environmental problems. What is the link with urbanisation? The Karl Pearson Chi-square test was used to demonstrate the link between urbanisation and the environmental problems encountered by fish farmers in the commune of Daloa. This test is of the utmost importance, as it shows the independence (no influence) or dependence (influence) between two observed variables. It is a statistical test that allows us to confirm or deny the impact of urbanisation on environmental activity. The results of the survey recorded in the table show the data obtained in the field on the impact of urbanisation on aquaculture activity.

Table 5 : Impact of urbanisation on aquaculture activity

		Activity		Total
		Yes	No	
Urbanisation	**Yes**	23	2	**25**
	No	1	4	**5**
Total		**24**	**6**	**30**

Practical cases : $\frac{(24\times25)}{30} = 20$; $\frac{(24\times5)}{30} = 4$; $\frac{(6\times25)}{30} = 5$; $\frac{(6\times5)}{30} = 1$

We obtain the following table :

Table 6 : Theoretical values for the impact of urbanisation on aquaculture activity

		Activity		Total
		yes	No	
Urbanisation	**Yes**	20	5	**25**
	No	4	1	**5**
Total		**24**	**6**	**30**

The results recorded in the table above show the theoretical data obtained by calculation relating to the impact of urbanisation on aquaculture activity. These data will enable us to calculate the Kih2 shown in **Table 7** below.

Calculate the *Chi2* : $\frac{(23-20)^2}{20} = 0.45$; $\frac{(1-4)^2}{4} = 2.25$; $\frac{(2-5)^2}{5} = 1.8$; $\frac{(1-4)^2}{1} = 9$

We obtain the following table :

Table 7 : *Chi2* values

		Activity		Total
		Yes	No	
Urbanisation	**Yes**	0.45	1.8	2.25
	No	2.25	9.0	11.25
Total		2.7	10.8	13.50

The calculated Chi2 (13.5) is greater than the Chi2 from the tables (3.84), so there is a dependency between the two variables. Urbanisation is linked to the environmental problems encountered by fish farmers in the commune. Cramer's V is 0.67; we therefore observe a strong relationship between the two variables. The fish farmers surveyed encounter difficulties due to urbanisation. At the environmental level, this can be explained by the pollution of the ponds with run-off water from the various households due to the lack of water infiltration into the soil.

3.3.2. Socio-economic and health impacts of the activity

3.3.2.1. Direct job creation

To carry out this activity, fish farmers rely on family labour (90%) or outside labour (10%) to supervise the farm (**Figure 10**).

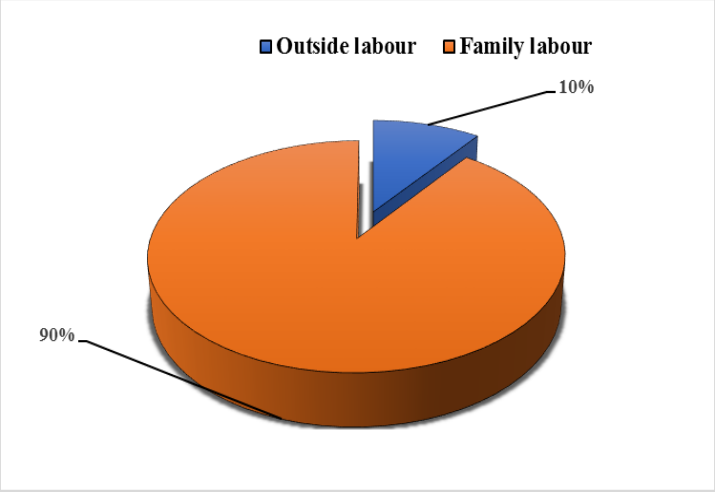

Figure 10 : Working methods of fish farmers

This sector can therefore be seen as providing employment. However, on most of the farms visited, the workforce was family-based, which is due to the fact that fish farming is not the farmers' main activity. The farmers surveyed in the commune of Daloa have a variety of activities, with only 7% of the population surveyed practising this activity full-time.

3.3.2.2. Creation of secondary jobs

According to our surveys, fish farmers believe that fish farming creates secondary jobs.

Table 8 : Secondary job type

	Type of job				
	None	**Commerce**	**Restaurants**	**Transport**	**General Total**
Number of types of job	6	14	4	6	30

What is the link between aquaculture activity and secondary job creation?

To demonstrate the link between aquaculture activity and secondary job creation, the Karl Pearson Chi-square test is used. The results recorded in **Table 9** show the data obtained in the field. This table highlights the job creation resulting from the aquaculture activity. The following **Table 10** is obtained.

Table 9 :

		Creation of secondary jobs		Total
		Yes	No	
Activity	**Yes**	14.00	5.00	**19.00**
	No	8.00	3.00	**11.00**
Total		**22.00**	**8.00**	**30.00**

Table 10 :

		Creation of secondary jobs		Total
		Yes	No	
Activity	**Yes**	5.00	6.00	11.00
	No	8.00	11.00	19.00
Total		13.00	17.00	30.00

The results in the table above show the theoretical data obtained by calculation. These data allowed us to calculate the Chi2.The calculation of the Chi2 gives **Table 11** below :

Table 11 :

		Creation of secondary jobs		Total
		Yes	No	
Activity	**Yes**	1.80	1.50	3.30
	No	1.12	0.81	1.93
Total		2.92	2.31	5.23

The Chi2 is therefore equal to 5.23. By matching the degree of freedom 1 with the margin of error of 5%, we obtain the Chi-square of the tables in the order of 3.8415. The calculated Chi2 (5.23) is greater than the Chi2 from the tables (3.84), so there is a dependency between the two variables. Aquaculture activity is linked to the creation of secondary employment in the commune of Daloa. Moreover, 80% of fish farmers believe that the activity creates secondary employment. According to the results, Cramer's V is 0.41. We therefore observe a strong intensity relationship between our two variables.

3.3.2.3. In terms of health

According to our surveys, fish farmers say that fish farming has an impact on their health. What is the link between fish farming and the health of fish farmers? The Chi-square test is used to highlight this relationship **Table 12**.

Table 12 : Fish farming activity and the health of fish farmers

		Health of fish farmers		Total
		Yes	No	
Fish farming activity	Yes	15.00	4.00	19.00
	No	10.00	1.00	11.00
Total		25.00	5.00	30.00

After calculating the theoretical number of employees, we obtain the following **Table** :

Table 13 :

		Health of fish farmers		Total
		Yes	No	
Fish farming activity	Yes	5.00	6.00	11.00
	No	9.00	10.00	19.00
Total		14.00	13.00	30.00

Calculation of Chi2 gives the following **Table**:

Tableau 14 :

		Health of fish farmers		Total
		Yes	No	
Fish farming activity	Yes	5.00	4.16	9.16
	No	2.77	3.16	6.37
Total		7.77	7.76	15.53

The Chi2 is therefore equal to 15.53. By matching the degree of freedom 1 with the margin of error of 5%, we obtain the Chi-square of the tables in the order of 3.8415. The calculated Chi2 (15.53) is greater than the Chi2 from the tables (3.84), so there is a dependency between the two variables. According to the results, Cramer's V is 0.71. There is a strong relationship between the two variables. Fish farming has an impact on the health of fish farmers.

Conclusion

At the end of our analysis, we can say that the commune of Daloa has a number of characteristics that enable this area to develop various activities offering its population a good diet. Aquaculture in the commune of Daloa has several assets for its development. However, the areas dedicated to this activity are under the influence of uncontrolled urbanization, which leads to pollution of the ponds by run-off water. The areas dedicated to aquaculture are influenced by uncontrolled urbanization in the commune of Daloa. Urban development is causing environmental problems due to run-off water polluting the ponds. However, there are inherent difficulties in fish farming in the locality. However, efforts will be made to eliminate or alleviate them, as fish farmers, large and small, and the public authorities work much more closely together to eliminate the constraints associated with a lack of knowledge..

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