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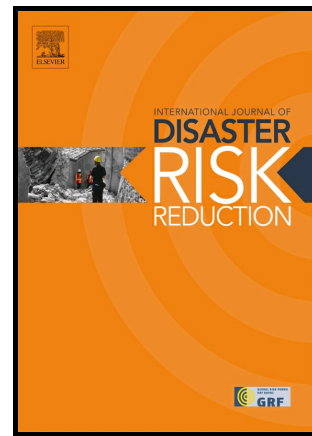
Urban Households' Attitude towards Flood Risk, and Waste Disposal: Evidence from Cotonou

Boris Odilon Kounagbè Lokonon

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Boris Odilon Kounagbè Lokonon
Université d'Abomey-Calavi, and Université de Parakou, Benin
odilonboris@gmail.com

Abstract

This study analyzes households' attitude towards flood risk, and the disposal of both dry and liquid wastes in Cotonou city. Multinomial probit model was used for the analysis of the attitude towards flood risk using a sample of 150 households from flood-prone zones of Cotonou, while the attitudes towards dry and liquid wastes disposal were analyzed by applying binary logistic regressions on the 2011 Benin Living Standards Measurement data. The findings show that 55.3% of the households were willing to leave flood-prone zones. Factors identified as household's flood risk taking behavior include duration of residence in the zone, number of children, perception on backfilling flood-prone zone with solid waste, and having residence in floodplains of Lake Nokoué/Lagoon of Cotonou. Pre-settlement information about the flood risk of the area, willingness to pay tax for settlement in the flood-prone area, and number of adults were found to decrease the flood risk taking. Household head age was found to have convex effect on flood risk aversion. The results suggest that the sex, age, education, and migration status of the household head were found to increase the odds of relying on vendors or making use of approved dump sites for waste disposal. Public policies should target among others, (i) building affordable housings outside Cotonou, as advocated in the urbanization plan of the country and propose to households that are living in flood-prone areas, (ii) reinforcing access to adequate education, and (iii) raising awareness on the harmful effects of improper management of waste.

Key words: Household attitude; floodplain; flood risk; waste disposal; Cotonou

1. Introduction

Climate change is one of the major environmental issues we face today [1]. The Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change [2] stated that climate change and variability is affecting many natural systems and has negative effects on economic activities. The occurrence of climate shocks and extreme climatic events such as floods, droughts, and hurricanes is widespread, although it is not easy to attribute them to a change in the climate [3].

Areas adjacent to rivers, streams, and swamps experience floods when the intensity of rainfall reaches a certain level [4]. With the increase in the intensity of rainfall, rivers and streams overflow and claim floodplains. In unoccupied floodplain areas, the impact of rivers and streams overflow on livelihoods remains minimal. However, what is customary is that people usually follow the residing of flood to make settlement and operate their livelihoods. This in turn makes the settles to be vulnerable to another round of flood events. Hence, in recent years flood became the most reported natural disaster events in many regions in terms of the damages it causes [5,6].

Cotonou is the economic capital city of Benin, located between the Atlantic Ocean and Lake Nokoué and is subject to increased urbanization and its challenges. The occupation of lowlands, and floodplains of the Lake Nokoué and Lagoon of Cotonou is detrimental to rainwater and overflow drainage. The city lacks relevant policies in terms of banning the occupation of floodplains and swampy areas.[1] Cotonou is characterized by a sub-equatorial climate, with two rainy seasons and two dry seasons. The rainfall is concentrated in the great rainy season (from March to July) with a peak in June (300 to 500 mm). Flood occurs during the overflow of Lake Nokoué, subsequent to water drainage from the North through the River Ouémé, and during the rainy seasons.

The analysis of historical annual rainfall records (1951-2010) revealed an alternation of water deficit and surplus periods.[2] The most significant deficits were observed during the 1977-1983 drought period, and the highest surpluses were recorded in 1988, 1997 and 2010 (Fig. 1). At seasonal scale, the situation is characterized by some abnormalities, particularly by a high concentration of rainfall over a short period (late on-set and early cessation).[3] Climate projections indicate that Southern Benin, where Cotonou is located, could experience in the coming decades high inter-annual rainfall variability, and by 2100 the same annual rainfall observed during 1971-2000 [7].

Many residents choose where to live, aware of the existence of flood risk, and this does not mean that they miscalculate the likelihood of occurrence and impacts of floods [8]. The choice of where to live depends, among others, on risk aversion.[4] Many residents resort to solid wastes to cope with floods, others stay in flooded environment with the risk of contracting water and vector-borne diseases. Many of the households who make use of solid wastes to backfill their dwellings to cope with floods, definitely contribute to water pollution. Some households leave the dwellings and stay a while with relatives when floods occur. This situation affects adversely their economic activities. The most significant floods, during the last thirty years occurred in 1985, 1991, 1997, 2004, 2006, and 2010.[5] Many dwellings are regularly affected and are invaded by dirty and muddy water, which carries everywhere all kinds of garbage. According to the Emergency Events Database (EM-DAT) of the Centre of Research on Epidemiology of Disasters in Brussels (CRED), the total damage of floods in Benin amounted to US\$ 61,000 and 46,000 in 1985 and 2010, respectively [10].

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[1] Mairie de Cotonou, Plan de développement de la ville de Cotonou. Direction de la Prospective et du Développement Municipal (DPDM), 2008.

[2] Ministère de l'Environnement, de l'Habitat et de l'Urbanisme (MEHU), Deuxième communication nationale de la république du Benin sur les changements climatiques. Direction Générale de l'Environnement. Benin, 2011.

[3] MEHU (2011)

[4] Risk aversion is generally measured by Arrow-Pratt measures [9]. Amihud [9] proposed a measure of attitude of individuals toward risk.
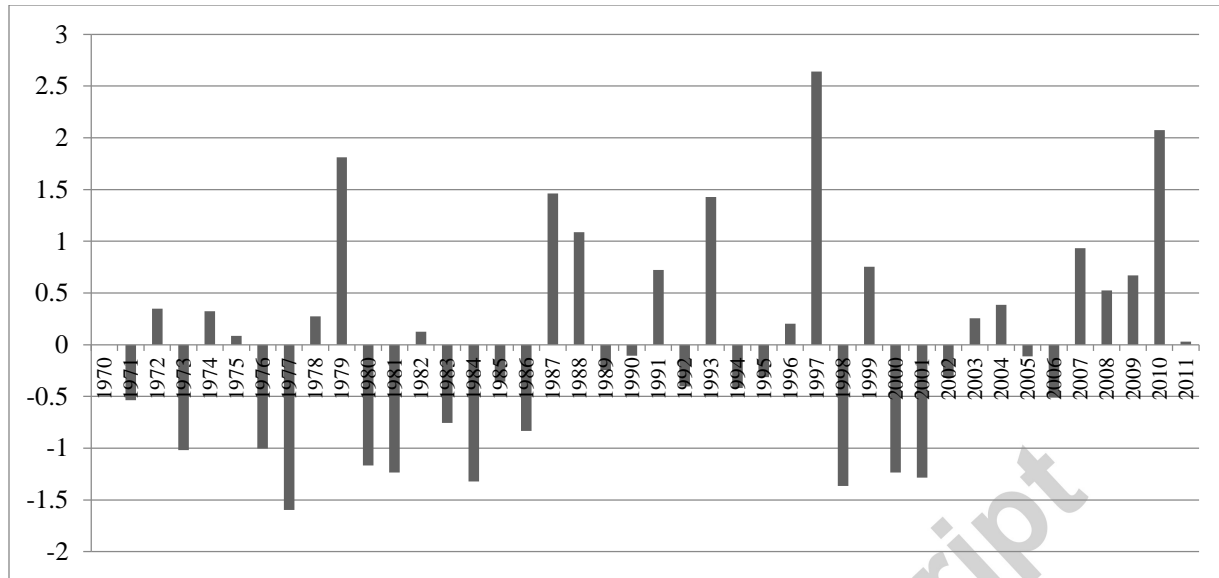
[5] MEHU (2011)

Fig. 1 Rainfall index[6] evolution in Cotonou

Flood risk is defined as a function of vulnerability and hazard. The hazard is related to the physical phenomenon of flooding and vulnerability, the presence of people or potential degree of damage to property and disruption. Fekete [11] argued that hazard is a natural event perceived as a threat by human beings, while vulnerability refers to the conditions of a phenomenon characterizing its disadvantages in the face of natural hazards. Vulnerability includes exposure, sensitivity, and capacities of individuals [2].

Cotonou is similar to a lakeside city when floods occur. Thus, it is urgent to develop a relevant flood risk management plan. The easiest solution is to ban the occupation of floodplains and swamps [4]. This solution is the zero-vulnerability approach and guarantees the best success in flood prevention. However, this easiest solution cannot be easily applied where human development exists or where population pressure encourages the recklessness of local authorities [4]. In the case where the occupation of floodplains and swamps is tolerated, flood risk can only be reduced by building infrastructures such as reservoirs, dams and drainage channels. However, without available sufficient space it is not possible to build these infrastructures. Therefore, it is necessary to move some people out of flood-prone areas.

Analyzing attitude towards risks is of paramount importance in planning risk management strategies [12]. There is a body of literature on households' preferences regarding flood risk management [e.g., 13,14,15,16 regarding flood insurance]. Moreover, Willis et al. [8] analyzed residents' perceptions of the probability and impact of flooding, in an urban area of Australia. In addition, Saqib et al. [12] examined the effects of socio-economic factors on risk attitudes of farmers in flood-prone area of Pakistan. However, to the best of our knowledge no study to date investigated the extent to which the households are willing to leave the flood-prone areas, especially in the context of West Africa. This study therefore aims to contribute in filling this gap. Thus, the objective of this study is to analyze households' attitude towards flood risk, and

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[6] $Rinfall\ index_t = \frac{Rainfall_t - Mean}{Standard\ deviation}$

waste disposal in Cotonou. The study is relevant in terms of providing insights on whether the households are willing or not to leave the flood-prone areas. The analysis of the attitude towards waste disposal is motivated by the way wastes are managed, which exacerbates urbanization issues related to floods (it worsens the situation when floods occur and blocks drainage channels). Indeed, many households make use of unapproved dump sites for solid and liquid waste disposal (e.g., street gutters, non-occupied places) instead of relying on vendors or approved sites for dumping.

The remainder of the paper is organized as follows. The next section presents the materials and methods. The results and discussion are presented in section 3, and the last section concludes the paper.

2. Materials and methods
2.1 Analytical framework

The analysis of households' attitude towards flood risk falls under the framework of utility and profit maximization under uncertainty. Following Gbetibouo [17], we consider a rational representative household whose aim is to maximize the net present value of expected utility over a given time horizon, and has to decide on among a set of j flood risk options. The rational household i decides to resort to option j if the household thinks that they will be better-off by choosing option j over the remaining options (e.g., k) depending on their risk aversion [18,17]:

$$U_{ij}(\beta_j' X_i + \varepsilon_j) > U_{ik}(\beta_k' X_i + \varepsilon_k), k \neq j \quad (1)$$

where U_{ij} and U_{ik} are the utility household i perceives from option j and k, respectively; X_i is a vector of explanatory variables that influence the choice of the options; β_j and β_k are vectors of parameters to be estimated; and ε_j and ε_k are white noises.

Under the revealed preference assumption that household chooses the option that generates the highest utility, the observable discrete choice of flood-risk options can be related to the unobservable (latent) continuous net benefit variable as $Y_{ij} = 1$ if $U_{ij} > 0$ and $Y_{ij} = 0$ if $U_{ij} < 0$ [17]. Y is a dichotomous dependent variable taking the value of 1 when the household chooses an option and 0 otherwise.

The probability that household i will choose flood-risk option j among the set of options could be defined as follows:

$$P(Y = 1/X_i) = P(U_{ij} > U_{ik}/X_i) \qquad (2)$$
$$= P(\beta_j' X_i + \varepsilon_j - \beta_k' X_i - \varepsilon_k > 0/X_i) \qquad (3)$$
$$= P[(\beta_j' - \beta_k')X_i + \varepsilon_j - \varepsilon_k > 0/X_i] \qquad (4)$$
$$= P(\beta^* X_i + \varepsilon^* > 0/X_i) = F(\beta^* X_i) \qquad (5)$$

where ε^* is an error term, β^* is a vector of unknown parameters that can be considered as the net influence of the vector of explanatory variables influencing the attitude towards flood risk, and $F(\beta^* X_i)$ is the cumulative distribution of ε^* evaluated at $\beta^* X_i$ [17]. Probability model is made operational by a particular choice of distribution for the disturbances and two models are usually considered; logit and probit [19]. As there are more than 2 options regarding households' attitude

towards flood risk, the appropriate econometric model should account for that (e.g., multinomial logit (MNL) and multinomial probit (MNP) regression model).

The same analytical framework applies to the households' attitudes towards solid and liquid wastes disposal. However, as there are two options regarding these attitudes, the appropriate econometric model should be either a binary logistic or a binary probit model.

2.2 Empirical models

The analytical framework described above serves as the basis of the empirical models. Indeed, the households have to decide on flood-risk, and garbage and waste water disposal options in regard to their socio-economic characteristics, to maximize their welfare.

2.2.1 Households' attitude towards flood risk
Dependent variable
The dependent variable is households' attitude towards flood risk. This variable has four modalities: *Yes, we will accept to leave this flood-prone zone for another if the authorities propose that to us* (which constitutes risk averse behavior)*; No, we will not leave because we are better-off here; No, due to the proximity of the activities; and No, the best way is to build infrastructures that will protect us against floods/because we are living in a family house*.

Independent variables
The independent variables included in the model are selected based on the literature. In addition, variables related to risk perception are included [12]. Furthermore, this paper controls for having residence in floodplains of Lake Nokoué and Lagoon of Cotonou. Finally, eleven independent variables are included in the regression. Their descriptive statistics and expected signs on the acceptance to leave flood-prone areas, as well as references are presented in Table 1.

Table 1 Variables hypothesized to affect households' attitude towards flood risk

Variables	Values	Mean	Standard Deviation	Minimum	Maximum	Expected sign (on acceptation)	References
Duration of household in flood-prone zone	Years	14.14	10.99	0	53	-	[14,15]
Number of children within the household	Continuous	2.37	1.83	0	9	-	[14]
Number of adults within the household	Continuous	3.23	2.25	1	20	+/-	
Household head age	Years	46.35	14.52	23	101	-	[20]
Square of household age	Continuous	2,358.15	1,517.63	529	10,201	+	[20]
Costs of damage due to floods	1 if high and 0 otherwise	0.67	0.47	0	1	+	[21,14,15]
Be informed about the characteristics of the area in terms of floods before deciding to settle	1 if yes and 0 if no	0.65	0.48	0	1	-	[15,8]
A person has the right to live wherever he wants, whatever the type of risk he will face	1 if agreed and 0 if no	0.75	0.43	0	1	-	[12]
People who build in flood-prone zones should pay a tax	1 if agreed and 0 if no	0.51	0.5	0	1	-/+	[12]
Perception on backfilling flood-prone areas with solid waste	1 if good and 0 if bad	0.27	0.45	0	1	-	[12]
Living in floodplain of Lake Nokoué/Lagoon of Cotonou	1 if yes and 0 if no	0.45	0.5	0	1	-	

2.2.2 Households' attitudes towards dry and liquid wastes disposal
Dependent variables
The dependent variables are households' attitudes towards dry and liquid wastes disposal. Each of the two variables has two modalities. Regarding dry waste disposal, the households have two options: (i) relying on vendors or making use of approved dump sites, or (ii) making use of unapproved dump sites. As for liquid waste disposal, they make use of either (i) gutter, pit or sewer, or (ii) unapproved dump sites. Households who rely on vendors or make use of approved dump sites for waste disposal are considered as risk averse households.

Independent variables
The independent variables included in the model are also selected based on the literature. In addition, variables related to the migration status of the household heads are included to capture the extent to which experiences from elsewhere influence the attitudes towards waste disposal.

Table 2 presents their descriptive statistics and expected signs on the odds of relying on vendors or making use of approved dumping sites as well as references.

Table 2 Variables hypothesized to affect households' attitudes towards waste disposal

Variables	Values	Mean	Standard Deviation	Maximum	Minimum	Expected signs	References
Household size	Continuous	4.07	2.35	20	1	-	[22,23,24]
Household head sex	1 if female and 0 if male	0.28	0.45	1	0	+/-	[24]
Household head age	Continuous	43	14.18	95	18	+	[23,24]
Education level of household head	Categorical (four modalities)						
None (Taken as reference)	1 if yes and 0 if no			1	0	-	[22,23,24]
Primary Education	1 if yes and 0 if no	0.32	0.47	1	0	+	
Secondary Education	I if yes and 0 if no	0.34	0.48	1	0	+	
Post-secondary Education	1 if yes and 0 if no	0.17	0.37	1	0	+	
Migration status	Categorical (three modalities)						
Non-migrant (Taken as reference)	1 if yes and 0 if no			1	0	+/-	
Returned migrant	1 if yes and 0 if no	0.11	0.32	1	0	+/-	
Other migrant	1 if yes and 0 if no	0.51	0.50	1	0	+/-	

2.3 Data

The data used in this study come from two sources. The data from the household survey, which was collected during March 2011 on one hundred and fifty randomly selected households, living in flood-prone areas of Cotonou (floodplains of Lake Nokoué/Lagoon of Cotonou, and swamp areas) is used to analyze households' attitude towards flood risk. The respondents were typically household heads, but in the case the head was not available, another adult household member was interviewed. A multi-stage sampling procedure was adopted. Cotonou was divided into three zones with respect to the geographical proximity of the districts. Four neighborhoods recognized of being affected by floods were randomly selected within each zone. At the end of the process, 46, 57, and 47 households were randomly selected in zone 1, 2, and 3, respectively. The allocation of the sample between zones and neighborhoods was done based on their demographic weights. The number of surveyed households (150) was purposively chosen due to financial constraints. The data from the Benin Living Standards Measurement Study (LSMS)[7] of 2011, collected by the National Institute of Statistics and Economic Analysis is used to analyze the attitudes towards dry and liquid wastes disposal. It is worth noting that it is the part of the data set relative to Cotonou that is used (1,890 households)[8]. The 2011 LSMS was on 18,000 households in the 77 communes by splitting the country into urban and rural areas. A two-stage sampling technique was followed to select surveyed households. First, 750 clusters were

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[7] The 2011 LSMS survey is the latest carried out in Benin.

[8] The total number of surveyed households in Cotonou was 2016, but there were missing observations in the data set.

randomly chosen. Second, random households were selected within the clusters. The questionnaires were administrated through direct interviews.

3. Results and discussion

3.1 Descriptive analyses

Among surveyed households in 2011, 72% were owners of their houses, and the remaining 28% were either tenants or were occupying the dwellings without paying any rent. Most of the owners (97.25%) lived permanently in the houses they have been surveyed. The time spent in the zone ranged from 0 to 53 years, and the average household size was about 6 persons. On average, there were more adult (57.60%) within the households than children. The youngest household head surveyed was 23 years old, whereas the oldest was 101. The average household head age was about 46 years. Female-headed households represented 14.7% of the sample. In terms of formal education, 19.3% of the household heads did not have any level, 42% had primary level, 28.7% had secondary level and 10% had university level.

Most of the households (93.3%) reported having experienced floods. Many households (80%) have suffered from damages due to floods such as damage to properties, evacuation of houses, health problems, and loss of personal belongings. In terms of damage floods have caused to them so far, 67.33% of surveyed households reported that the cost was so high, while 12.67% perceived that the cost was not high. About two-third (65.3%) of households were aware about the characteristics of the zone in terms of floods before deciding to settle. The households that were living the floodplains of Lake Nokoué/Lagoon of Cotonou were about 44.67% of the sample, while the remaining were from the swampy areas.

Many households (72.7%) perceived that backfilling floodplains with solid wastes is a bad behavior. Those who perceived it as a good behavior have given as main reason "it allows to better cope with floods". Thus, they thought that using solid waste helps canalizing sand and to quickly succeed in backfilling compared with using sand only. Therefore, it is necessary to raise their awareness on the harmful effects of solid waste on groundwater, as using wastes to cope with floods leads to water pollution. Regarding the perception on environmental quality, 56.7% believed that their environment is not good. Therefore, they were aware that an unhealthy environment is detrimental to their health. They said that they used to take up precautions to avoid contracting vector and water-borne diseases.

About 55.3% of the households were willing to leave the flood-prone areas. Among households that accepted to leave, 8.67%, 20%, 19.33%, and 7.33% had no formal education level, primary level, secondary level, and university level, respectively. As for being un-willing to leave, the distribution of the households with respect to formal education level is 10.67%, 22%, 9.33%, and 2.67%, respectively. The reasons motivating the un-willingness to leave the flood-prone zones are grouped into three categories: (i) we are better-off here (10.67%), (ii) due to the proximity of the activities (19.33%), and (iii) the best way is to build infrastructures that will protect us against floods or we are living in a family house (14.67%). Salaried-headed households seemed slightly to be more willing than the remaining households to leave the flood-prone areas (57.14%, 55.45%, and 55% of acceptance for salaried, non-salaried, and retired, respectively). Owners appeared to be more willing to leave than non-owners (55.96% against 53.66%).

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About 29.68% of the households made use of unapproved dump sites for solid waste disposal. They disposed of solid waste in the dwellings and/or other unapproved dump sites. As for liquid waste disposal, the situation was even worse, because only 19.68% of the households made use of approved dump sites (gutter, pit, and sewer).

3.2 Estimation results and discussion

The attitude toward flood risk is estimated using the MNP model, with the reference category being "Yes, we will accept to leave this flood-prone zone for another if the authorities propose that to us". The households that are willing to leave flood-prone areas are considered as risk averse households. The MNP model is a natural alternative to the MNL model that relaxes the independence restrictions built into the latter [19]. Table 3 reports the results of the attitude toward flood risk. The model is overall significant as $Prob > chi2 = 0.00$. The results show that the likelihood to be un-willing to leave than to be willing to leave, thinking being better-off in flood-prone zone decreases with household adult members. Adult household members are those that contribute to household income, and therefore the findings could be considered as the influence of income on flood risk aversion. The finding is in corroboration with earlier results that have reported a positive income effect on the probability of holding flood insurance [e.g., 14,25,26,27,28]. Households that had the information on the characteristics of the zone in terms of floods before deciding to settle have less odds of 'being un-willing to leave, thinking they are better-off in the current residencies' than to leave.

Table 3 Multinomial probit regression results of the attitude towards flood risk

	No, we will not leave because we are better-off here	No, due to the proximity of activities	No, the best way is to build infrastructures that will protect us against flood/because we are living in a family house
Duration of household in flood-prone zone	0.030 (0.020)	0.022 (0.020)	0.058*** (0.018)
Number of children within the household	-0.063 (0.143)	0.052 (0.104)	0.304*** (0.110)
Number of adults within the household	-0.678*** (0.199)	-0.043 (0.114)	-0.079 (0.107)
Household head age	0.001 (0.101)	0.156* (0.085)	-0.049 (0.067)
Square of household age	0.0003 (0.001)	-0.001* (0.001)	0.001 (0.001)
Costs of damage due to floods (1=high, and 0=otherwise)	-0.083 (0.527)	0.258 (0.434)	-0.140 (0.417)
Be informed about the characteristics of the area in terms of floods before deciding to settle (1=yes, and 0=no)	-1.255* (0.659)	0.257 (0.418)	0.020 (0.496)
A person has the right to live wherever he wants, whatever the type of risk he will face (1=agree, and 0=no)	0.887 (0.623)	0.680 (0.431)	0.591 (0.476)

People who build in flood-prone zone should pay a tax (1=agree, and 0=no)	-1.264*** (0.470)	-0.485 (0.362)	-0.141 (0.417)
Perception on backfilling flood-prone areas with solid waste (1=good, and 0=bad)	-0.674 (0.547)	0.671 (0.432)	0.877* (0.459)
Living in floodplains of Lake Nokoué/Lagoon of Cotonou (1=yes, and 0=no)	1.046* (0.575)	-0.145 (0.387)	-0.177 (0.456)
Constant	-0.360 (2.209)	-5.831*** (2.050)	-2.115 (1.919)

*, **, ***: Significant respectively at 1%, 5% and 10%. Robust standard errors are in parentheses.

Agreeing with the statement that people who build in flood-prone zone should pay a tax decreases the odds to be risk lover. Indeed, households who agreed with this statement are less likely to be un-willing to leave (because they think they are better-off in their current residencies) compared with being willing to leave. However, households that had their dwellings within the floodplains of Lake Nokoué/Lagoon of Cotonou are more likely than their counterparts that were in swamp areas to be un-willing to leave, because they think they are better-off in the current residencies compared with being willing to leave. This is due to the fact that a large part of the households living in these floodplains practiced fishery, and therefore they want to be close to the Lake/Lagoon to be able to continue fishing. Household head age has non-monotonic effect (convex effect on flood risk aversion) on the odds of being a risk lover, preferring to have residencies close to activities compare to accepting to leave. This result is consistent with the finding from the study by Picazo-Tadeo and Wall [20] who also reported a convex effect of age on risk aversion. The finding suggests that the awareness of the youngest household heads needs to be raised on the benefits of living in non-flood-prone zone. The households are more likely to be un-willing to leave, thinking that the best way is to construct infrastructures that will protect against floods or because the households are living in family houses compared with being willing to leave, with increasing duration in the zone, and number of children. Indeed, during the interviews some households said that changing residencies affects children who are obliged to change schools, and friends. Households who perceived backfilling flood-prone areas with solid waste as good have more odds of being un-willing to leave, thinking that 'the best way is to construct infrastructures that will protect against floods or because the household is living in a family house' than to accept to leave.

The results of the logistic regression models estimated to explain the odds of households to rely on vendors or make use of approved dump sites to dispose of dry and liquid wastes are presented in Table 4. Reliance on vendors or making use of approved dump sites for waste disposal is considered as risk averse behavior. The models pass all the diagnostic tests. For instance, the omnibus (overall) tests of the models coefficients show that the models are statistically significant. The overall percentage indicates that in 70.21%, and 80.74% of cases, the outcome variables (relying on vendors or making use of approved dump sites for dry and liquid wastes disposal) were correctly predicted. The findings show that the decision to rely on vendors or make use of approved dump sites for waste disposal is related to the sex, age, education level, and migration status of the household head. Female-headed households are 1.89 and 1.34 times more likely to rely on vendors or make use of approved dump sites to dispose of dry and liquid wastes, respectively compared with male-headed households. Thus, female-headed households

appear to be more risk averse compared with male-headed households. Indeed, Gbinlo [29] found that male-headed households were not willing to participate in a program aiming to improve garbage management in Cotonou.

Table 4 Logistic results of the attitudes towards waste disposal

	Dry waste	Liquid waste
	Odds ratio	Odds ratio
Household size	0.991	0.965
	(0.022)	(0.025)
Household head sex (male taken as reference)	1.891***	1.338**
	(0.246)	(0.194)
Household head age	1.017***	1.020***
	(0.004)	(0.004)
Education level of household head (none taken as reference)		
Primary education	1.253	1.092
	(0.196)	(0.233)
Secondary education	2.279***	1.785***
	(0.368)	(0.375)
Post-secondary education	5.797***	4.323***
	(1.256)	(0.979)
Migration status (Non-migrant taken as reference)		
Returned migrant	1.118	1.271
	(0.208)	(0.231)
Other migrant	1.046	0.753**
	(0.118)	(0.101)
Constant	0.551**	0.070***
	(0.134)	(0.022)
Observations	1890	1890
$Prob > chi2$	0.000	0.000

*, **, ***: Significant respectively at 1%, 5% and 10%. Robust standard errors are in parentheses.

The odds for reliance on vendors or make use of approved dump sites increase with the age of the household head, suggesting that awareness on waste management increases over time. Relying on vendors or making use of approved dump sites is related to the education level of the household head; the odds for relying on vendors or making use of approved sites for dumping increase with the level of formal education. Households whose heads had secondary education level are 2.23 and 1.79 times more likely to have their dry and liquid wastes disposed by vendors or make use of approved dump sites, respectively compared with those that did not have any formal education. For the households whose heads had post-secondary level, the odds of relying on vendors or making use of approved sites for dumping are increased 5.80 and 4.32 times relative to those with no education level for garbage and waste water, respectively. These findings suggest that education is important in acquiring knowledge on waste management, with risk aversion increasing with education. The findings also suggest that relying on vendors or making use of approved dump sites is in some extent associated with the migration status of the household head. Households headed by other migrants are 75.3% more likely to rely on vendors or make use of approved dump sites for liquid waste disposal compared with the non-migrants. This suggests that households headed by other migrants have experience from elsewhere on liquid waste management.

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4. Conclusion

This study analyzes households' attitude towards flood risk, dry and liquid wastes disposal in Cotonou. Multinomial probit model was used for the econometric analysis of the attitude towards flood risk. Binary logistic regression was used to estimate the models of households' attitudes towards dry and liquid wastes disposal. The results show that 55.3% of the households were willing to leave flood-prone zones; they were flood risk averse. Variables found to increase the odds to be flood risk lover include the duration in flood-prone zone, number of children, perception on backfilling of flood-prone zone with solid waste, and living in floodplains of Lake Nokoué/Lagoon of Cotonou. The number of adults, being informed about the characteristics of the area in terms of floods before deciding to settle, agreeing with the statement that people who build in flood-prone zone should pay a tax were found to decrease the odds to be flood risk lover. Household head age was found to have convex effect on flood risk aversion. The findings suggest that dry as well as liquid wastes management has to be improved. Variables found to increase the odds of relying on vendors or making use of approved dump sites for all forms of wastes disposal include the sex, age, education, and migration status of the household head.

Public policies should target the promotion of family planning measures, in order to control the number of children per household. A long-term policy should be implemented to reinforce access to adequate formal education. Therefore, by acquiring more formal education, the households could better understand the importance of family planning. Moreover, a well educated population perceives better the importance of clean environment. In addition, public awareness on the harmful effects of improper management of waste can be targeted at male and non-migrant headed households.

Public policies have to target building affordable housings outside Cotonou, as advocated in the urbanization plan of the country[9] and propose to households that are living in flood-prone areas. The country is committed to facilitate the population with access to a decent house at cheap cost, and thereby contribute to poverty reduction. These policies need to free places to build tanks, and drainage channels. They will allow recovering swamps that will serve as natural tanks, to play their main role. Future occupation of floodplains and swamps has also to be banned. This paper ignores flood insurance, which is a means to deal with inundation risk. Future research could focus on flood insurance in the context of Sub-Saharan African countries. Moreover, future research should focus on the preferences of population regarding affordable housings outside Cotonou that could be proposed to the population.

Conflict of Interest

The author declares that he has no conflict of interest.

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Acknowledgements

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