



MERCURY EXPOSURE THROUGH FISH CONSUMPTION IN RIPARIAN POPULATIONS AT RESERVOIR GURI, USING NUCLEAR TECHNIQUES, BOLIVAR STATE, VENEZUELA

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Abstract

*In the reservoir Guri located at the south of Venezuela in Bolivar State has occurred the bioaccumulation process. Several studies have demonstrated it. In samples of 42 specimens of carnivorous trophic level, the average value of total mercury was 1.90 mg/g with a maximum of 6.04 mg/g. As first job it was necessary to identify and classify the infrastructures of each town according to their use due to the lack of updated demographic information. In this investigation is described the home characteristics with relation to its residence conditions and work status of home bosses through the design and application of a survey by home in two communities nearby reservoir Guri: "La Paragua" and "El Manteco". It was also designed and applied a simple questionnaire where was asked to home bosses the weekly frequency of consumption of fish, especially those of carnivorous habits as well as the quantity in grams consumed per week. Homes were better structured at "La Paragua" than at "El Manteco" but in the latest the monthly income by home was bigger nevertheless, it does not meet the requirements of the basic basket in Venezuela of US \$ 323 for a four people family. The overall consume of fish per week was twice higher at "El Manteco" (1,485 kg) than at "La Paragua" (678 kg). The fish specie consumed as first priority at "La Paragua" was *Prochilodus rubrotaeniatus* ("Coporo") which is of detritivorous alimentary habits while the second more consumed was *Cichla ocellaris* ("Pavon") of carnivorous alimentary habits. On the opposite side, at "El Manteco" the first priority of fish was *Cichla ocellaris* ("Pavon") while the second one was for *Prochilodus rubrotaeniatus* ("Coporo"). Next step will be the organic mercury analysis in hair samples and the nutritional profile in individuals from the selected homes: 36 at "La Paragua" and 50 at "El Manteco" towns.*

1. INTRODUCTION

The reservoir Guri located at the south of Venezuela in Bolivar State arose from damming the Caroni river and its main tributary, the Paragua river. It was built between the years 1963 and 1986 by the company "Electrificación del Caroní C.A". ("EDELCA"), which is a governmental hydroelectric company, branch of the "Corporación Venezolana de Guayana" ("CVG"). The first flood occurred in 1968, covering an area of 800 Km². In 1986 the dam flooded an additional surface of 3,119 Km². The reservoir has a total surface of 3,919 Km², a useful volume of 84,720.4 x 10⁶ m³ with an altitude of 271 m.a.s.l. for a power generation of 9,957 MW [1].

The reservoir Guri, the same as some reservoirs from other countries has shown what has been called "dam effect", term used to designate the occurrence of bioaccumulation process in

reservoirs due to the high mercury levels found mainly in piscivorous fish species which are the most preferred by fish consumers. Several studies have demonstrated the presence of this phenomenon at reservoir Guri. In samples of 42 specimens of carnivorous trophic level, the average value of total mercury in dorsal muscle was 1.90 $\mu\text{g/g}$ with a maximum of 6.04 $\mu\text{g/g}$ [2].

The information that we will get related to the neurological disorders, which may be found in the nearby population of reservoir Guri due to chronic mercury exposure present in fish would be of great relevance because it constitutes a sensitive point at regional level.

We are presenting here the results of some socioeconomic characteristics of two of the main populated centers in the nearby of reservoir Guri and the alimentary habits of fish consumption at “La Paragua” and “El Manteco” towns. The choice of these two places was not by chance. “La Paragua” is located close to the Paragua river just below the mouth of the reservoir and people usually consumes river fish, for the opposite “El Manteco” is located close to the reservoir, toward its northeast side, and people from this location usually consume fish coming from the reservoir itself. This situation will permit to make a very interesting comparisons related to mercury levels in both populations.

After the present project started we promote several meeting in order to design an intercalibration program among different laboratories for metal analysis. Actually, these labs are filling in a simple questionnaire to harmonize the program. This activity has had the acceptance of the Pan-American Sanitary Office, Regional Office of the World Health Organization in Venezuela.

2. METHODS

2.1. Sample size

In view of the fact of not having updated demographic information of the populations nearby reservoir Guri, it was necessary to identify and classify the infrastructures of each town according to their usefulness by using a map of scale 1:10,000.

2.2. Socioeconomic study

The investigation began by the determination of home characteristics with relation to its residence conditions and work status of home bosses through the design and application of a survey by home, and sampling two communities nearby reservoir Guri: “La Paragua” and “El Manteco”. From the demographic point of view, these two populated centers are the most important at the nearby of reservoir Guri. The main populated centers around the reservoir Guri are shown in figure 1, there can also be seen the sectors how “EDELCA” has divided the whole area of the reservoir: “GURI”, “EL MANTECO”, “LA PARAGUA” and “EL PLOMO”.

In the context of this research it is understood for home that formed by a person or group of two or more people, with or without family bounds that cohabit in oneself housing and share the same services, staying an economic dependence exclusively through a common expense to eat [3].

2.3. Fish consumption

It was designed and applied a simple questionnaire where it was asked to the home bosses the weekly frequency of consumption of fish, especially those of carnivorous habits coming from the reservoir Guri or from the rivers “Paragua”, “Caroní”, “Chiwao” and “Aza”, as well as the quantity in grams consumed per week.

A database was elaborated to manage all the information gathered during the field work. It was selected those homes where its members usually eat at least 500 grams weekly, do not eat fish coming from the sea, and have at least one year of permanency in each place. To reduce dispersion will be considered four groups of age between 15 and 55 years. The body mass index will be also taking into account.

In the next field work will be determined in those chosen individuals, the organic mercury levels in hair and the nutritional profile. Finally, these persons will be explored from the medical point of view to identify signs and symptoms of neurotoxicity. The exposed group will be compared to a non exposed group for establishing differences.

3. RESULTS AND DISCUSSION

The survey allowed us to establish the housing conditions and home characteristics, and to know the socio-demographic information and the fish consuming homes at “La Paragua” and “El Manteco”. A total of 678 houses were identified at “La Paragua”, on the average we found 5 people by house for a projection toward the total population of 3,390 inhabitants. Following the same procedure, the total population at “El Manteco” was around 5,230 inhabitants based on 1,046 houses with an average of 5 people in each.

From the binomial variable associated to the study we are dealing with, the sample size was determined in both “La Paragua” and “El Manteco” towns with a significance level of 0.05.

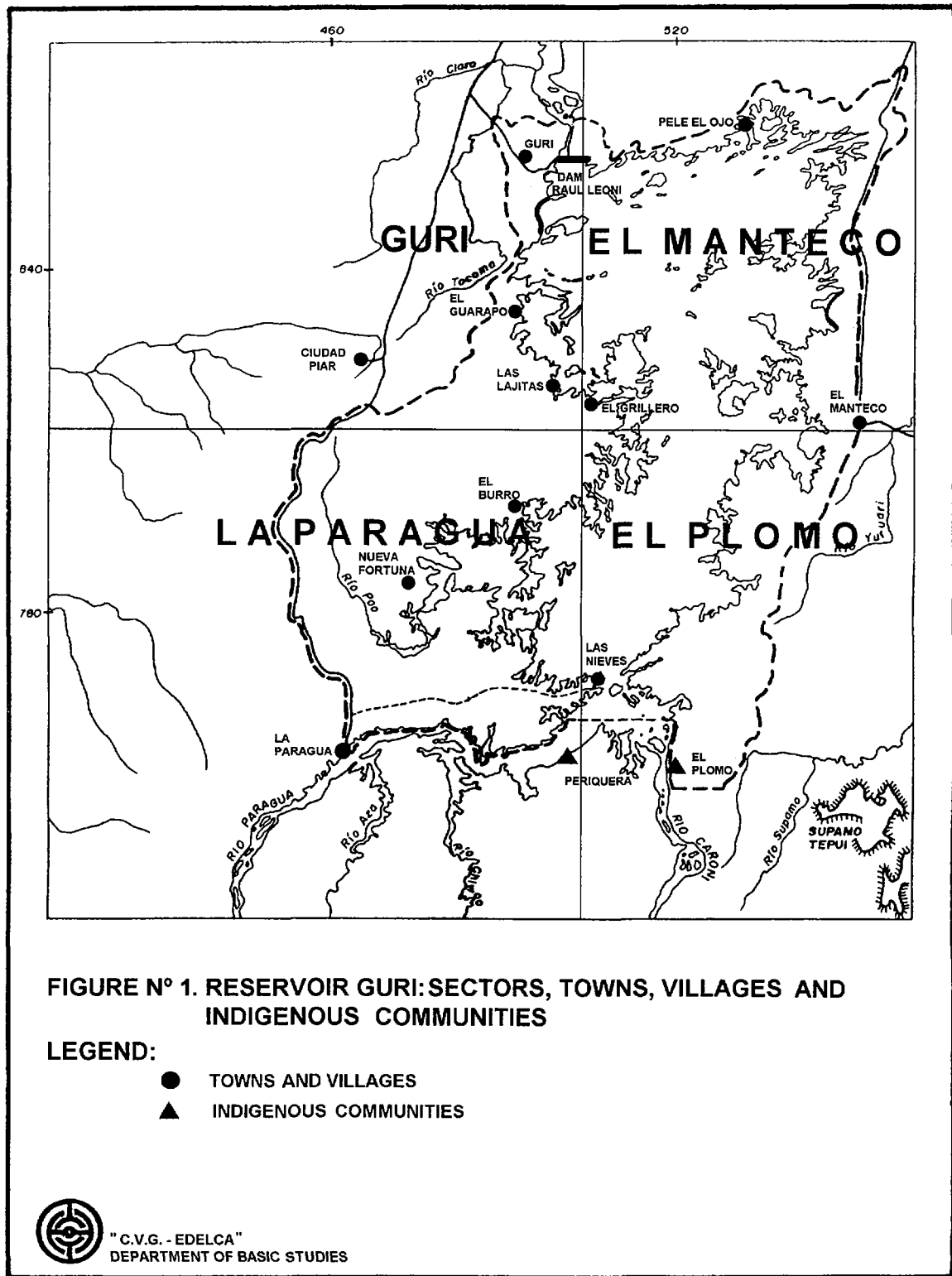


FIG 1: Reservoir Guri: sectors, towns, villages and indigenous communities

A total of 252 and 290 houses were selected at “La Paragua” and “El Manteco”, respectively.

3.1. “La Paragua” town

3.1.1. Home characteristics

The homes are well structured: 73.6 % are directed by a couple in marital life. From this percentage 68.6 % of the couples live as concubines and 31.3 % under marriage. The remaining percentage is represented by home bosses that do not have couple, here are included widows, singles and divorced.

Most of the time the home leader is a man (79.1 %) while in the remaining, this position is occupied by a woman alone.

The heaping index of dwelling houses is 5 inhabitants by house, and families have on the average 4 children.

3.1.2. Socioeconomic situation

The monthly income by home, including wages or profits coming from the work of other family members, is about US \$ 279. This income is not enough comparing to the basic basket cost in Venezuela, which is approximately US \$ 323 for a family of four people. It indicates that the income for the average family at “La Paragua” should be US \$ 404 approximately; in consequence it represents a deficit of 31 %, approximately. This situation is compensated performing subsistence activities such as fishing and harvesting.

3.1.3. Main jobs and the occupation index

The sector of more occupation is that of services. Approximately 37.36 % of the home bosses are in this sector. The main employment is represented by the commerce of any item. The government’s officials, farmers, and small gold and diamond miners have equal proportion: 8%.

The occupation index is low (74.72 %), while the unemployed index is 25.27 %. The later is bigger than the average of both Bolivar State and Venezuela (15 %, approximately) [3].

3.1.4. Educational level of family’s bosses

The 40.65 % of family’s bosses do not have any educational level (including illiterate and functional illiterate), 45.16 % with basic level (high school) and 5.49 % with university studies.

3.1.5. Fish consumption

We identify 36 homes where people eat fish in amounts equal or bigger than 500 g per week. From these 36 homes we choose the individuals that fulfilled with the others inclusion criteria already mentioned.

On the average, the fish consumption by home is 1.055 kg per week and the overall fish consumption at “La Paragua” was 715 kg per week. Nevertheless, we have to consider that fish are available depending on the season of the year.

The three fish species more consumed by week are: *Prochilodus rubrotaeniatus* (“Coporo”) (19.42 kg/w); *Cichla ocellaris* (“Pavon”) (8.79 kg/w); y *Plagioscion squamosissimus* (“Curvinata”) (2.10 kg/w) (Figure N° 2). *P. rubrotaeniatus* is of detritivorous habits, its reproduction time is from the middle of april through june and the best fish caught starts in september and finishes in november, in this lapse begins to go down the water level; *C. ocellaris* is of carnivorous habits, its reproduction time is all the year but the best fish caught is at the end of the rainy season (November); and *P. squamosissimus* is of carnivorous habits and the best fish caught is between July and September which is in accord with the period of high waters. In addition, *Hoplias macrophtalmus* (Aimara) carnivorous specie was consumed in an amount of 1.88 kg per week.

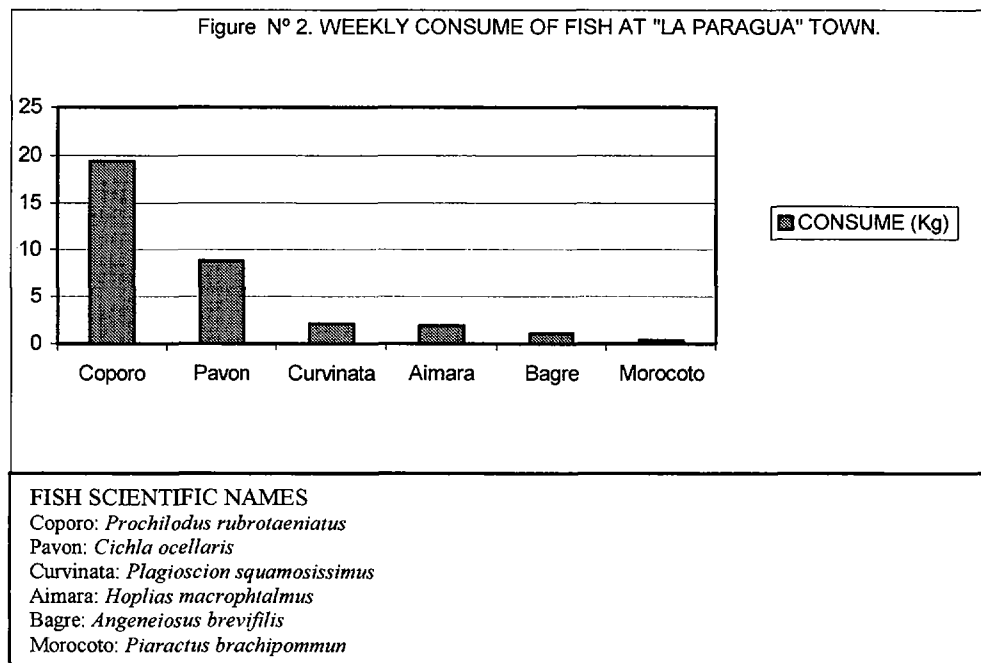


FIG 2: Weekly consume of fish at “La Paragua” town

3.2. “El Manteco” town

3.2.1. Home Characteristics

A man in 62.98 % of the cases, which acts as family boss, addresses homes. However, a woman is in charge of the family at some homes although she lives in couple (37.02 %). From this situation we can say that a couple resides in 86.25 % of the homes, which are addressed, but it does not matter who is the leader. From total couples 24,04 % is married and 75.96 % lives as concubines

The heaping index of dwelling houses is 5 inhabitants for house, and families have on average 3 children.

3.2.2. Socioeconomic situation

The monthly income by home, including wages or profits coming from the work of other family members is about US \$ 311. Inasmuch as this income is close to the basic basket cost in Venezuela (US \$ 323), it is not enough for a five-people family (US \$ 404), however, there

is a deficit of 23 %. The same as “La Paragua” town, this situation is compensated performing subsistence activities such as fishing and harvesting.

3.2.3. *Main jobs and the occupation index*

The sectors of more occupation are those of commerce and services. Approximately 29 % of the home bosses are in these sectors. The others home bosses' work sources are the following: 11.83 % mining, 8.01 % government's officials, 6.87 % manufactures and 4.96 % cattle rising.

The occupation index is low (70.99 %), while the unemployed index is 29.01 %. The later is bigger than the average of both Bolivar State and Venezuela (15 %, approximately) [3].

3.2.4. *Educational level of family's bosses*

The 28.62 % of family's bosses do not have any education level (including illiterate and functional illiterate), 66.41 % with basic level (high school) and 4.96 % with university studies

3.2.5. *Fish consumption*

We identify 50 homes where people eat fish in amounts equal or bigger than 500 grams per week. From these 50 homes we choose the individuals that fulfilled with the others inclusion criteria already mentioned.

On the average, the fish consumption by home is 1.42 kg per week with an overall fish consumption per week of 1,485 kilograms.

The three species of fish more consumed by week are: *Cichla ocellaris* (“Pavon”) (43.64 kg/w), *Prochilodus rubrotaeniatus* (“Coporo”) (13.96 kg/w) y *Plagioscion squamosissimus* (“Curvinata”) (8.16 kg/w) (Figure N° 3). The same as “La Paragua”, the reproduction time and the best fish caught also apply to “El Manteco”.

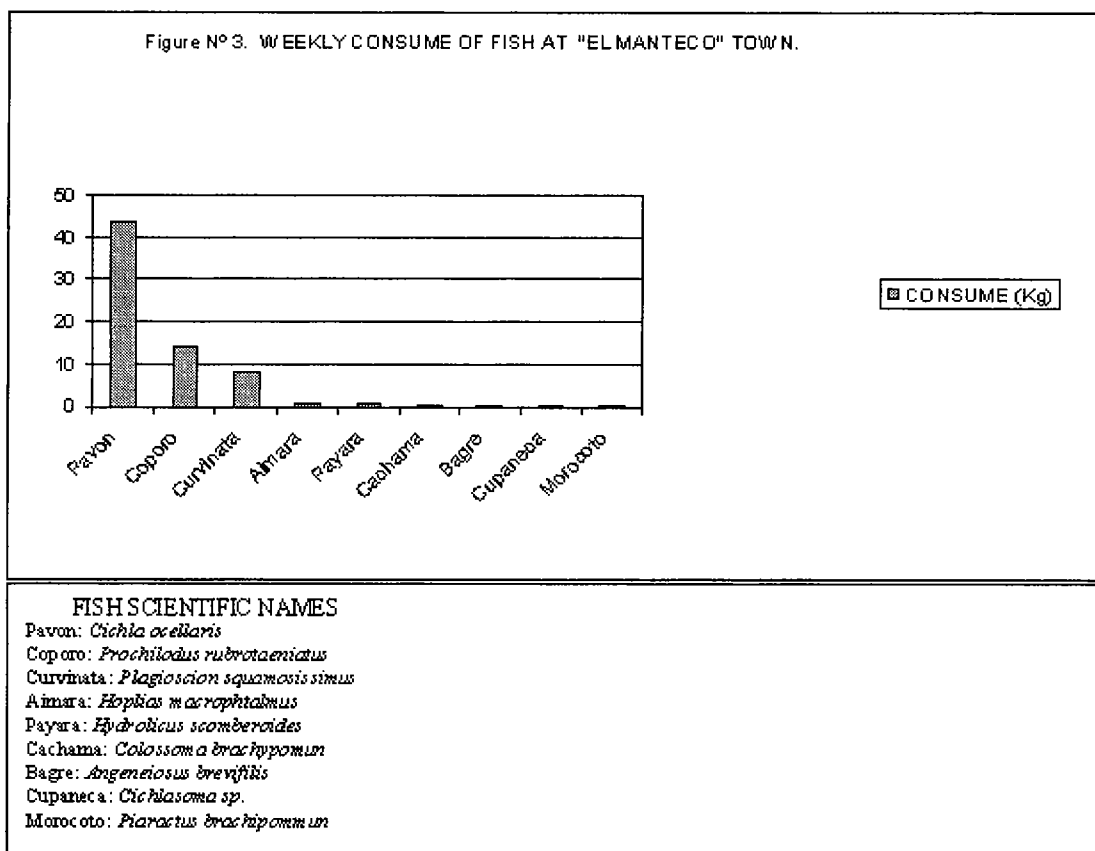


FIG 3: Weekly consume of fish at "El Manteco" town

4. CONCLUSIONS

A total of 678 houses were identified at "La Paragua". There are on the average 5 people by house so the projection toward the total population would be around 3,390 inhabitants. Following the same procedure, the total population at "El Manteco" was around 5,230 inhabitants based on 1,046 houses with an average of 5 people in each.

Homes were better structured at "La Paragua" than at "El Manteco".

At "El Manteco", the monthly income by home was bigger than at "La Paragua", but in both cases were not meeting the requirements for a five-people family (US \$ 404).

The sector of more occupation in both "La Paragua" and "El Manteco" was that of services and the unemployed index was higher than the average, which locally and nationally is about 15 percent.

The fish consuming per week was twice higher at "El Manteco" (1,485 kg) than at "La Paragua" (715 kg), it may keep relation to the bigger population in the former.

The fish specie consumed as first priority at "La Paragua" was *Prochilodus rubrotaeniatus* ("Coporo"), which is of detritivorous alimentary habits while the second more consumed was *Cichla ocellaris* ("Pavon") of carnivorous alimentary habits.

At “El Manteco” the first priority of fish was *Cichla ocellaris* (“Pavon”) while the second one was for *Prochilodus rubrotaeniatus* (“Coporo”).

There were selected 36 homes at “La Paragua” and 50 at “El Manteco” towns from which will be chosen the individuals for performing organic mercury in hair samples and the nutritional profile study.

5. PLANS FOR FUTURE WORK

First of all we have to continuous the previous work plan: determination of mercury fluxes downstream from reservoir Guri by monitoring mercury levels in fish and in the water column; mercury biotransformation and bioaccumulation studies using radioactive tracers; and mercury exposure studies of the nearby population using biological indicators and medical examinations.

It is necessary to continue the survey of the nearby population at reservoir Guri to identify those fish consumers in order to complete one of the project objectives. As could be seen this activity has been hard because of the lack of information related to demography.

It is necessary to determine the mercury levels in fish at the “Paragua” river and its tributaries “Aza” and “Chiwao”, close to “La Paragua” town, inasmuch as the population consumes fish from these rivers and there is not information related to this issue at all.

We learned that the social issue is quite important in this type of research so we will consider it in the future. At the present time it becomes of vital interest in view of the fact that we do not have any available information related to demography at the reservoir Guri vicinity and the 2001 census is just starting.

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