Assessing residents' attitude and practices of pesticide use in Aripo sub-catchment, Trinidad and Tobago

Katerina Hroudova

MSc thesis in Integrated Water Management

August 2012

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List of abbreviations

AMPA	Aminomethylphosphonic acid
CANARI	Caribbean Natural Resources Institute
CIESIN	Center for International Earth Science Information Network
CSO_a	Civil society organization
CSO_b	Central Statistical Office
CVM	Contingent valuation method
EMA	Environmental Management Authority
EPA	Environmental Protection Agency
NGO	Non-governmental organization
PEMSEA	Partnerships in Environmental Management for the Seas of East Asia
WASA	Water and Sewerage Authority

Abstract

With increasing modernization of agriculture pesticides became one of the biggest threats for local aquatic ecosystems in Trinidad. The Caroni presents a typical watershed exposed to pesticides. We studied in the Aripo sub-catchment the types of pesticides used and willingness of its inhabitants to limit or stop using pesticides. In general, farmers who have experience in farming with pesticides for dozens of years expressed lower awareness than non-farmers who are usually not in direct contact with these chemicals. The majority of both groups were open to contribute to a decrease in use of pesticides. Nevertheless, the majority of farmers refused the possibility of not using pesticides at all. This decision was based on the belief that farming would be impossible without using any pesticides. Farmers' WTA was expressed as "thousands of dollars" due to so many constraints they would have to face. Non-farmers' WTP was subsequently TT$ 100 and TT$ 200 which is nearly 2.3% or 4.6% of their mean income. It is necessary to advance the personal interests of both farmers and non-farmers by means of governmental incentives for increasing the awareness of pesticide issues.

1. Introduction

The water quality in Trinidad has been an important issue among scientists for decades. With the increasing modernization of agriculture, pesticides have become one of the biggest threats for local aquatic ecosystems. This study aims to explore the use of pesticides and the manner of environmental behavior of local residents living in the agricultural community located above the origin of the largest river of the island, the Caroni River. The Caroni River enters the Gulf of Paria at the west coast where Caroni Swamp is located. It is the biggest mangrove swamp on the island registered in the Ramsar Convention on Wetlands. Through focus on pesticide use in the Caroni's sub-catchment Aripo, the theory of environmentally significant behavior and the contingent valuation method are used. These are to be applied to the research done among farming and non-farming residents of the Aripo valley, the community in the upstream part of the Aripo sub-catchment. Through exploring the environmental behavior of local farmers and non-farmers, this study shows the potential of Aripo valley to sustain the quality of natural resources such as water and soil at a certain level. Knowing the local society perspective will help the decision makers to design appropriate development plans.

After the background, conceptual framework, research questions and methodology, the thesis continues with the results part which is subdivided in accordance with the topics farmers' and non-farmers' perception and pesticides used. My findings are interpreted in the discussion and contextualized in the theoretical framework after that. The last part of the report presents conclusion and recommendations.

1.1. CariWatNet project context

The thesis has been a part of the CariWatNet project in Trinidad and thereby contributes to the integrated water management of the Caroni river basin in Trinidad. The project aims to make "integrated watershed management plans contributing to sustainable use and governance of natural resources in the Caribbean Islands of Trinidad and Haiti that respect and enhance indigenous knowledge, protect the natural environment, increase livelihood security, restore biodiversity and reduce the communities' vulnerability to the effects of climate change and other natural disasters." (CariWatNet, 2009) The specific objectives of the project are as follows in table 1.

Table 1: Specific objectives of the CariWatNet project (Source: taken from CariWatNet, 2009)

Specific objectives of the CariWatNet project
Strengthen the Caribbean scientific community by assessing future research needs in the region **in relation to sustainable use and management of natural resources,** to train ACP scientific partners in proposal writing, capitalizing research results, and improving overall quality of research**.**
Construct vibrant **multi-stakeholder networks in the watersheds with members from the government, local authorities, NGOs, CSOs$_a$, scientists, farmers and forestry organizations, water boards, land users and land owners** to jointly identify stakeholder needs and potential approaches to improve current watershed conditions.
Monitor current land use and hydrological conditions in the watersheds using harmonized measurement methods and procedures, **quantifying and analyzing environmental risks like erosion, flooding, pollution and loss of biodiversity.**
Formulate Integrated Watershed Management Plans in collaboration with the multi-stakeholder networks and under guidance of the scientists participating in the CariWatNet proposal.
Communicate and disseminate achieved results to a wide range of national and international audiences, specifically policy makers and governmental institutions in the region, for further implementation and follow-up when making decisions on wider spatial scales.

These objectives correspond with the main priorities for watershed management in Trinidad determined by CariWatNet (2010): "**Better quality of water for farmers' use**; greater availability of water for farmers, especially in the dry season; more monitoring of water quality in water courses; **better utilization of water by farmers**". The first and the last priorities are covered in this thesis. The University of the West Indies, Trinidad and Tobago is responsible for the project related activities in Trinidad and Alterra, The Netherlands is the project coordinator.

1.2 Study area

1.2.1 Ecological characteristics

The Republic of Trinidad and Tobago is a country in the Southern Caribbean, 11 km north-east of Venezuela, consisting of two main islands Trinidad and Tobago (Ragbirsingh and Souza, 2005). Trinidad island covers an area of 4828 km^2 (Gibbes, 2006), with an estimated population of 1.3 million in 2010 (CSO_b, 2000).

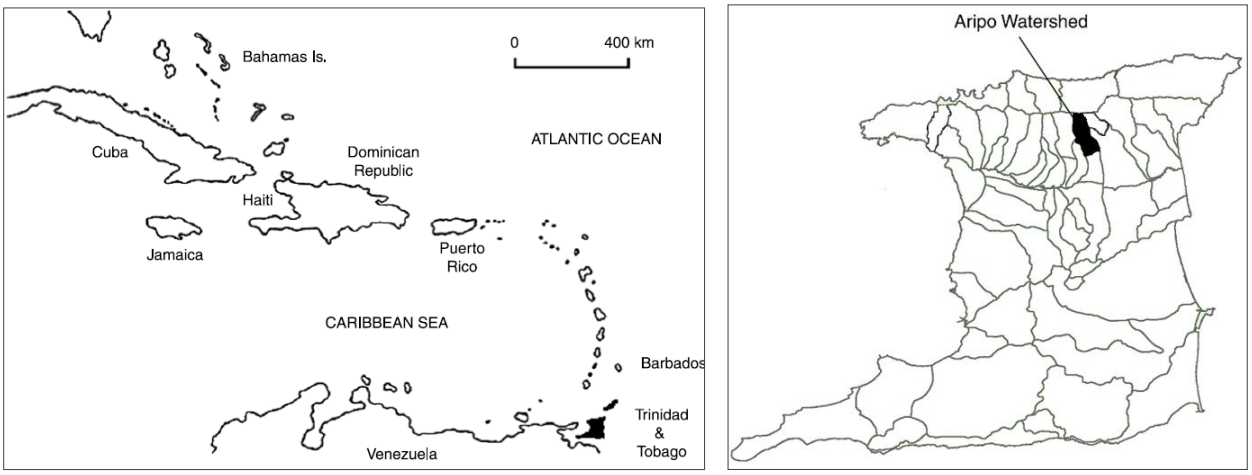

Fig. $1_{a,b}$: Location of Trinidad and Tobago in the Caribbean islands belt and location of the Aripo watershed in northern Trinidad (Source: taken from Phillip et al., 2008).

According to the Köppen climate classification, the state has a Tropical monsoon climate (Am). The wet season occurs from June to December, with the peak of precipitation from June to August and the dry season between January and May (Fig. 2).

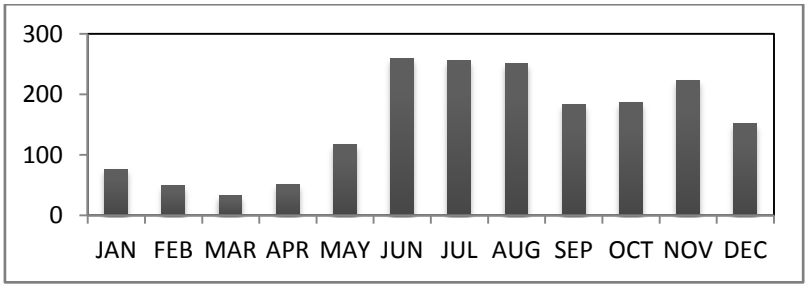

Fig. 2: Monthly precipitation over a year; mean calculated from 1946 to 2009 (Source: CariWatNet, 2009)

Biomes which can be found in Trinidad are tropical and subtropical moist broadleaf forests (92%), tropical and subtropical dry broadleaf forests (4%) and mangroves (4%) (CIESIN, 2010).The research site is the Aripo River catchment, a sub-catchment of the Caroni River Basin. The Caroni River is the largest river in Trinidad. It originates from the confluence of the rivers Aripo and Cumuto in the Northern Range and it runs for 40 km from its origin through the Caroni Plains to the Gulf of Paria at the Caroni Swamp (EMA, 2008; Pemberton, 2009). The Caroni River Basin makes 22% of Trinidad's land surface, which is an area of 883.4 km^2 (Pemberton, 2009). The topography of the Aripo sub-watershed comprises elevations up to 940 m at Cerro del Aripo (Day and Chenoweth, 2004) and as one of the tributaries of the Caroni River, the Aripo River drains a part of the most densely populated areas of Trinidad, the "East-West Corridor" (Pemberton, 2009).

1.2.2 Socioeconomic aspects

The Caroni River basin supplies potable water for approximately 40% of the population in Trinidad (EMA, 1998). Water demand in the Trinidad Island is increasing mainly due to the domestic use (Mahabir, 2004). However, water supply is uncertain and in a deficit on an annual basis due to severe dry seasons, when the water level is low and the turbidity is high (Mahabir, 2004 and Schneiderman& Reddock, 2004). According to WASA (2010; in Mycoo, 2011), in 2008 between only 18% and 21% of the population had an uninterrupted access to water for 24 hours, seven days a week. Mycoo (2011) also states that in comparison with the past, when it was safe to drink water from the tap, nowadays households with middle and higher income purchase only bottled water for drinking purposes and many households in rural and impoverished areas store water in barrels because of water shortages and therefore boil the water before drinking. During the fieldwork in the research area of Aripo valley many barrels for water were seen, which confirms Mycoo's findings.

Moreover, the Caroni River was identified as a major source of pollution for the Gulf of Paria (Mahabir, 2004), which is located along the west coast. Major threat for aquatic ecosystems is industrial, agricultural and domestic pollution as well as increased suspended load due to soil erosion (Pemberton, 2009). The pressure on land for housing and new industrial development contributes to deforestation and shifting of habitation to steeper slopes. The water pollution is considered to be related mainly to limited sewage treatment and non-point sources of pollution

(CANARI, 2002). Intense agriculture and disturbed natural ecosystems were found as a major polluter regarding heavy metals (Mahabir, 2004), due to their content in the pesticides used on agricultural fields. Moreover, the agricultural activity enhances the eutrophication process in wetlands due to the excessive use of fertilizers (Alkins-Koo et al., 2004).

Main crops which are grown in the Caroni river basin are cocoa, coffee, coconut, orange, banana, pineapple, mango, sugarcane, rice, cabbage, lettuce, hot peppers, pumpkin, tomatoes, and watermelon (citation). The subcatchment of the Aripo River comprises different types of landuse as a primary or secondary forest, agriculture and a village upstream, main road, the town of Valencia midstream and pastures and more dispersed housing development downstream, before the river enters the Caroni River (Appendix G). In the village of Heights of Aripo the farmers' fields are surrounded by the forest and the spring of the river comes from a cave above the village. Main crops grown in the agricultural community are mainly plantations of cocoa, vegetable (christophene, watercress) and ornamental plants, beside that two chicken farms are located in the valley. According to Surujdeo-Maharaj (2010), some of the agricultural fields are illegal, which has been confirmed by the local residents, who claimed about illegal marihuana farms and illegal logging on the slopes above the village Heights of Aripo.

The form of land property either is private property or state land being rented from the government.

The following groups are present in the village of Heights of Aripo:

Aripo Village Council	Aripo Youth Development Organization
Aripo Faith Centre Church	Aripo St. Jude Roman Catholic Church
Aripo Primary School	estate owners; land renters

Current institutional settings of land and water management are highly fragmented, as different pieces of legislation related to water and land management belong to different governmental institutions (CANARI, 2002).There is no overarching legislation which would clearly articulate water and land use policy, but in the same time there are many individual laws related to land and water issues (Mahabir, 2004). Besides that, there is an obvious conflict of interest between the governmental organizations, which are in charge of the environmental management in the country. The Environmental Management Authority (EMA)

aiming for the environmentally sustainable management of natural resources is placed under the Ministry of Planning and Development, which gains revenues from petroleum industry of Trinidad and Tobago and influences the housing and industry development and thus, as Mahabir (2004) states, the EMA lacks the power to manage the environment sustainability.

The main institutions involved in the land and water management in Trinidad are presented in the table 2.

Table 2: Institutions involved in water management in Trinidad and Tobago (Source: based on Pemberton, 2009)

Institutions involved in water management	
Water and Sewage Authority-public utilities	Mandated to manage, plan and regulate the multi sectoral use of water, development of sewage and water facilities, have to provide quality water and wastewater services.
Water resource agency	Deals with hydrological data and concessions for water withdrawal.
Ministry of Works and Transport	Charged with the construction and maintenance of physical infrastructure, drainage and flood control and river basin planning exercises.
Ministry of Planning and Development	Mandated to regulate land use.
The Environmental Management Authority (EMA)	Environmental, land and water pollution monitoring.
Ministry of Agriculture Land and Marine Resources (MALMR)	Management planning, land administration, land and water development and irrigation systems.

The government of Trinidad and Tobago is focused on, according to Mycoo (2011), supply water management rather than the demand management. Over five decades Trinidad has used flat rate charges based on the expected water consumption, but water taxes do not follow the increase of population nor the increasing income (Mycoo, 2011). The government treats water rather as a social good than an economic one, hence it excessively subsidizes water rates and encourage high water consumption levels and wastage.

Moreover, water rates used not to be paid by 20% of properties in 2002 (Mycoo, 2005) and recently in 2010, the minimum rate of TT $108 per quarter (US $17 for 90 days) of water usage was paid even by 60% of Trinidad's residents (Mycoo, 2011).

1.3 Pesticides

This study aims to inventory the locally most used pesticides and point to their persistency in the environment and their toxicity. To clarify the terms, FAO (2002) defines the term of pesticide as:

"any substance or mixture of substances intended for preventing, destroying or controlling any pest, including vectors of human or animal disease, unwanted species of plants or animals causing harm during or otherwise interfering with the production, processing, storage, transport or marketing of food, agricultural commodities, wood and wood products or animal feedstuffs, or substances which may be administered to animals for the control of insects, arachnids or other pests in or on their bodies. The term includes substances intended for use as a plant growth regulator, defoliant, desiccant or agent for thinning fruit or preventing the premature fall of fruit. Also used as substances applied to crops either before or after harvest to protect the commodity from deterioration during storage and transport."

Pesticides can be divided into following groups (tab. 3):

Table 3: Group of pesticides according to EPA (2011)

Group of pesticides	**Fields of action**
Algicides	Algae
Antimicrobials	Microorganisms
Attractants	Traps containing a pesticide and food to lure insects or rodents inside
Disinfectants and sanitizers	Disease producing microorganisms
Fumigants	Produce gas or vapor intended to destroy pests
Fungicides	Fungi (including blights, mildews, molds, and rusts)
Herbicides	Weeds
Insecticides	Insects and other arthropods
Miticides	Mites that feed on plants and animals.
Microbial pesticides	Microorganisms that kill or inhibit pests.
Molluscicides	Snails and slugs.
Nematicides	Nematodes
Pheromones	Biochemicals used to disrupt the mating behaviour of insects
Repellents	Repel pests, including insects and birds.
Rodenticides	Rodents

The main way in which pesticides can have any impact on the environment is a runoff of contaminants into water bodies (Ongley, 1996).

Depending on their persistence in the environment the pesticides can accumulate in soil, sediment and water or can be accumulated in organisms and subsequently join the whole food chain including humans (FAO, 2002). The persistency of pesticides is created in the ecosystem by bioconcentration or biomagnification.

Bioconcentration primarily means accumulation of a chemical in an organism. Regarding animals and humans, the main place for that presents fatty tissues in case of lipophilic pesticides (i.e. DDT). Some other can be metabolized (i.e. glyphosate) (Ongley, 1996). Biomagnification means that the pesticides enter the food chain and their concentration increases in top predators (Ongley, 1996).

Modern pesticides have a short half life time and a low risk to be accumulated. However, in Trinidad and many other developing countries, still persistent pesticides are applied which have a high risk of accumulation in the environment and often the exact effects are not known.

1.4 Problem definition

Caroni watershed is subject to rapid housing development and agricultural activities (Mahabir, 2004). The land use in Caroni watershed affects the river water quality negatively (Environmental Management Authority, 2005). The watershed is strongly influenced by deforestation and high uses of agrochemicals on agriculture sites which formerly were forestland (Pemberton, 2009). The Caroni watershed provides habitats for plenty of plant and animal species as well as water for human use and consumption, but in the same time, improper land management in combination with heavy rainfall causes runoff of the chemicals into the surface water (Ramlal and Baban, 2007). Among other agricultural chemicals, pesticides affect human health and soil and water ecosystems, often through unknown pathways. Current legislation regarding pesticide selling practices and utilization is insufficient (Pinto Pereira, 2007). The Aripo sub-catchment is the beginning of the Caroni River and as such, its anthropogenic activity is possible source of pollution of the Caroni River and Caroni Swamp.

1.5 Research objectives

The Aripo sub-catchment presents type of an agricultural area which is subject of development, including the modernization and intensification of its agriculture. It can be assumed that such a relatively pristine upstream part of the sub-catchment will be vulnerable to the ecosystem damage, among others also by the increased use of pesticides because of the increasing agricultural activity.

The first objective of the thesis is to assess the influence of pesticide use on the water quality of the Aripo River. Therefore, current practices of the farmers from the Aripo sub-catchment in pesticide use are examined and the mainly used pesticides in the area are identified.

The second objective of the thesis is to assess the extent to which the local residents are willing to conserve the ecosystem they are living in. Therefore the farmers' willingness to accept a compensation for a limited pesticide use or even non-pesticide use is examined along with the extent of their awareness of the possible undesirable effects of pesticides on human health and natural ecosystem.

The third objective of the thesis is to compare the farmers' willingness to accept compensation with the willingness of the non-farmers living in the Aripo sub-catchment to pay any environmental costs for maintaining good water quality in the Aripo River.

2. Concepts and methods

2.1 Conceptual framework

The conceptual framework of this study consists of two parts. First, the theory of environmentally significant behavior is presented. Subsequently, the concepts of “willingness to pay” and “willingness to accept” are described, as they are used to reflect the environmentally significant behavior of the interviewed community, which comprises local farmers and “non-farmers”. Non-farmers present the residents of the research area who do not practice any form of farming or gardening and thus do not use any agricultural chemicals.

Theory of environmentally significant behavior

The environmentally significant behavior is defined by Stern (2000) as „the extent to which it changes the availability of materials or energy from the environment or alters the structure and dynamics of ecosystems or the biosphere itself“.

According to Stern (2000) there are four basic types of environmentally significant behavior.

- Environmental activism means an active involvement in pro-environmental activities of different institutions. This type of behavior can affect the environment indirectly, as well as further kinds of behavior.
- Non-activist behaviors in the public sphere presents less active type of involvement then activism, but still deals either with joining, supporting or at least accepting of environmental activities, as a willingness to pay environmental costs for example.
- Private-sphere environmentalism can affect the environment directly with direct consequences (an excessive use of agricultural chemicals). The extent of environmental impact may be small regarding one person, but in case many people behave according to the same pattern, the impact will be more significant.
- Other environmentally significant behaviors are taken to mean a behavior of an individual, who influences the activities of the whole institution, either purposely or unconsciously.

The two types of environmentally significant behavior, non-activist behaviors in the public sphere and private-sphere environmentalism has been applied in this study.

The susceptibility of the research population to the non-activist behavior has been subject of the research through assessing of farmers' willingness to accept compensation for the reduction of the pesticide use and through assessing of non-farmers' willingness to pay for applying less pesticides on surrounded fields.

The extent of the private sphere environmentalism of farmers has been explored through assessing their approach to the pesticide use and practices. The scheme below shows the variables used. They are focused on the pesticide use and practices of the farmers of the Aripo valley. These are analyzed in order to assess the farmers' private sphere environmentalism.

The contingent valuation method and concepts of willingness

The contingent valuation method (CVM) is used in this study to assess the values, which the residents of the Aripo valley place on their ecosystem services as river water, crops, and disease control. In order to evaluate these values, the monetary values are assigned to them. These are supposed to be easier determined by the interviewees than other non-monetary types of values and moreover, placing monetary values on such non-market goods can be important tool for solid policy (Hanemann, 1994). This approach can be used to either derive interviewee's demand and/or the value they place on hypothetical goods and services that are not currently being offered; an environmental change (such as damage of aquatic ecosystem or increased exposure to pesticide pollution), or preserving the resource in its current state (PEMSEA, 2010).

The concepts of "willingness to accept" (WTA) or "willingness to pay" (WTP) have been used for this research within the framework of CVM as a tool to derive the demand for the ecosystem services. Since the ecosystem still provides drinking and service water, fertile soil, and recreational areas, it is supposed to be hard for the interviewee to determine the real value that he places on those services in order to preserve them. Nevertheless, by applying the concepts of "willingness", it is possible to assess the extent of stakeholders' awareness and concern for the environmental issues, to have an estimate of their willingness to keep the

services and through determinants of the willingness we can analyze the contingent behavior of the interviewees (Vanslembrouck et al., 2002). In the context of this study we can define "willingness to pay" as a minimum payment, that is a non-farmer willing to contribute to reduce using pesticides in his sub-catchment. The "willingness to accept" can be defined then as a minimum sum of money, that a farmer is willing to receive as a compensation for the limited ability to use pesticides on his estate.

If the monetary values stated by interviewees are supposed to be relatively easily and, more importantly, truthfully determined by them, the referendum format with close-ended questions should be used, as explained by NOAA panel (1993): "an open-ended request for willingness to pay or willingness to accept compensation invites strategic overstatement" and since respondents are rarely asked to put a monetary value on a public good, their confusion can cause "don't know" responses (Hanemann, 1994).

The monetary values, which are determined by interviewees, are then considered to be conscientiously decided by them and adult interviewees' willingness to accept compensation or to pay is considered to be relatively stable, since the human's values are shaped in a socialization process (Stern & Dietz, 1994). The research population as a whole is considered to be diverse in sense of different gender, age, ethnicity, religion, income, education etc. These kinds of socio-economic characteristics are traditionally used as an explanation of the variedness of individuals' WTP or WTA (Ojea and Loureiro, 2007), but more recently also ethical and moral motivations are mentioned to have an important effect on them (Kotchen and Reiling, 2000).

One of the objectives of this thesis is to assess the extent of interviewees' WTA or WTP and the awareness of pesticide issue. The following criteria have been chosen to be used for the contingent valuation analysis in order to compare them with interviewees' awareness and subsequently with their willingness: age, average annual income, and education. These have been chosen with regards to the occurrence of a similar analysis in literature and considering a highly sociological character of the other factors (gender, ethnicity, religion etc.), which would be beyond the framework of this research and therefore they are not covered in the study. Still, the knowledge of which factors do and do not influence interviewees' awareness and willingness can support one of the opinions on what causes the variedness of WTP/A as mentioned above.

The influence of income level to WTP has been described in many studies. In general, the expectation of a relationship between WTP and income is confirmed. For example a study of Turpie (2003) from South Africa says that a WTP is limited by income level; studies from Greece and United Kingdom (Togridou et al., 2005; Langford et al., 2001; Henson, 1996) say the WTP is influenced positively. Yet, a sophisticated research of Jacobsen and Hanley (2009) found no influence.

A similar trend can be found regarding the influence of education and age on the WTP/WTA. There is no clear tendency in literature saying which factors have unquestionable effect. For example the research done by Amigues et al. (2002) in France found the variable of education has no significant importance, but the variable of age was influencing the willingness positively in contrast to a study from India (Hadker et al., 1997), in which the results were contrary.

To describe illustratively the data analysis within the framework of the contingent valuation method and the entire theory of the environmentally significant behavior considering the non-activist behavior in the public sphere and the farmers' private sphere environmentalism, a scheme is presented (Fig. 3).

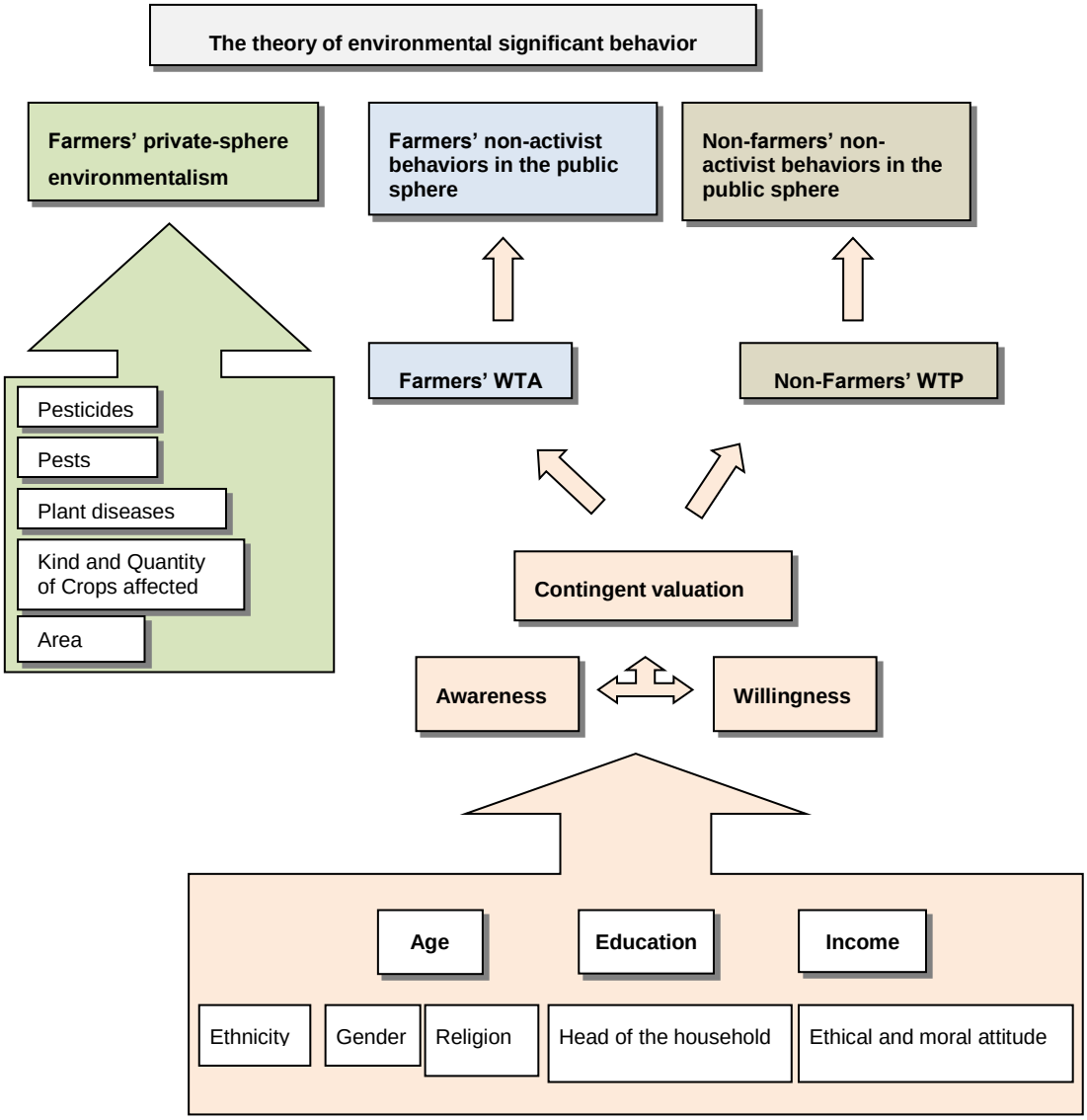

Fig. 3: A scheme of the data analysis using the conceptual framework.

2.2 Research questions

Q: Which pesticides do farmers use and how are residents of Aripo sub-watershed aware of risks of pesticide exposure and how are they open to make any mitigating effort?

SubQ1: How do the farmers in the Aripo sub-catchment use the pesticides and which pesticides are mainly used?

SubQ2: To what extent are the farmers willing to accept compensation and the non-farmers willing to pay for the environment-friendly pesticide use?

2.3 Methodology

2.3.1 Data collection

In order to collect the data for this study, a literature review and interviews have been performed. Pictures have been taken to have a visual image of the research area.

Literature review

The literature review has been conducted in order to get an overview of the research done in the past, related to Caroni watershed and the pesticide issue. The Alma Jordan Library of the University of the West Indies provided access to the national scientific journals and local unpublished studies. Furthermore, the concepts and theories relevant for this study were studied through scientific articles, textbooks, reports and internet sites.

Interviews

In order to gather all of the necessary information to answer the research questions, 59 interviewees were interviewed with 66 questionnaires in August and September 2011. The study has been focused on the agricultural community of Aripo sub-catchment, therefore the Aripo valley located upstream was chosen as all the agricultural fields are concentrated there. The majority of residents of that area are living in the village Heights of Aripo, a few residents are living or farming beneath the village. Both of the groups were subjects of the interview.

The aim has been to interview as many respondents as possible, since it has been problematic to reach farmers due to their vague spatial distribution and householders due to a short time available to find them at home. Therefore farmers were selected according to their spatial accessibility and time availability, independent of their gender, age or type of crops they grow. Non-farmers were selected according to their time availability, when the aim was to interview at least as many heads of households as regular family members, independent of their gender or age. Both farmers and non-farmers were interviewed either in their households or in public places (local grocery shop, village square, local cultural centre).

About 30 farmers have got estates in the village and about 40 to 50 non-farming householders are living there. 22 farmers and 22 non-farmers living in the Aripo valley have been interviewed during the fieldwork with the questionnaire about their willingness and awareness (Annexes D and E). This questionnaire comprises two parts. First part focuses on the farmers' and non-farmers' awareness of negative effects of pesticides. The second part focuses on questions about interviewee's willingness either to accept a compensation for limiting or stopping using pesticides (in case of farmers) or willingness to pay certain amount of money to help to limit or stop the pesticide use in the Aripo valley (in case of local non-farmers).

Another 22 interviews were conducted with the farmers about their general farming practices (Annex B) whereby some of the farmers were already interviewed with the former questionnaire and some were approached for the first time.

The combination of structured and semi-structured type of interview has been used in order to achieve a balanced conversation with the interviewees. To get an overview of farmers' opinions regarding the topics of the research questions, two kinds of interview blueprint have been used. One was designed in advance with interview duration of approximately half an hour and the other has been adopted from a previous project's activities with the length of approximately forty minutes. In further one, there were questions asking for information, which has not been analyzed in this thesis, but for the further project's needs it was desirable to keep the same interview pattern.

After the survey was conducted, the question "Are you aware of the fact that pesticides can remain in the soil for a long time?" had to be removed from further analysis, because it had been obvious it was a leading question and the results would not indicate the real situation.

During the research, interviewees were always willing to join the survey. In the case that some were not available at that moment, there was no problem to make an appointment with them for a later time. Some of the interviewees did not know what to answer to certain questions (i.e. to estimate their income), but no one explicitly refused to give an answer. In the case of one farmer only, it was not possible to see the bottles of the pesticides he used. In all other cases the farmers were open to show them.

2.3.2 Data management

The descriptive statistics was used for the analysis of the demographic data and some of the farming characteristics as well as for the description of the proportion of answers to the close ended questions about awareness and willingness of both interviewed groups.

Further, Spearman correlation has been used to measure the non-linear relationship between variables measured on an ordinal scale of measurement, it means that our observation has been placed into rank order. At the same time it is needed to measure the significance of the correlation. To test our hypothesis whether there is any correlation in the population or not, the "null hypothesis" needed to be confirmed or refuted. Should the null hypothesis be rejected, the result is statistically significant. Only significant results are highlighted and being discussed.

Finally a Chi square has been used to assess the difference in the perception of the two groups – farmers and non farmers. The chi square test should not be performed if frequency of any variable is less than 5. This rule has not been breached since the frequency of both farmers and non-farmers reached 22. Only significant results of the Chi square test are discussed in the thesis.

3. Results

3.1 Demographic and farm characteristics

The majority of the farmers interviewed were male (86%) full time farmers (68%), 60% of them were older than 50 with primary education (46%). Unlike the farmers, the non-farming householders interviewed represent a younger population (only 30% older than 50 years), with higher education (36% primary education only or none) and with a higher percentage of women (50%), mainly housewives. 73% of interviewed non-farmers represented a head of household while almost 82% of interviewed farmers stated that they were the head of their household. Further, 72.5% of the non-farmers interviewed have an annual income below TT $60,000 (~7,614 EUR) and the same income rate corresponds with the farming population.

The local farmers grow mainly cocoa, watercress, christophene, peppers, and other vegetable. Almost one half (46%) of farmers answered that their crops had been affected by pests or plant diseases for the past two years. Common types of pests and diseases are fungus, mealybugs, white flies, water snails, ants, mites, beetles, worms, parrots, squirrels. Application of artificial fertilizers, chicken manure (23%) and pesticides is common. 50% of interviewed farmers' plots are bigger than 5 acres, but one third (32%) of them are smaller than 5 acres. Sources of water for the farms are rain (64%), water from the river and other streams (22%) and public (9%) and private standpipes (5%). Farmers mentioned the lack of infrastructure (45%) and pests or diseases (36%) as the major problems affecting their farming.

3.2 Pesticides used in the Aripo valley

Based on the interviews conducted with the local farmers, a list of pesticides used by the community was compiled (Table 4 below and appendix A) and it shows that Paraquat, Glyphosate, and Cypermethrin are the most used types of pesticides. All three chemicals are toxic to aquatic species and can be accumulated in soil.

3.2.1 Paraquat

Paraquat is a highly toxic contact herbicide with high mortality of microbiological organisms, phytoplankton and zooplankton (Leboulanger et al., 2009). It is classified by WHO (2009) as a

moderately hazardous pesticide. In 2001 it was the third best selling pesticide worldwide even though it was suspected to have a connection with many farmers' deaths or injuries (Wesseling et al., 2001). The chemical has been banned in the European Union since 2007 (EU, 2007). Paraquat is not easily degraded chemically or microbiologically and demonstrates long-term persistence in river waters with more than 80% remaining after 56 days of incubation (Wang et al. 1994). Target plant species are unable to metabolize it and tend to contain the residues. Paraquat from decomposed plants is usually adsorbed to soils and sediments, where it is biologically unavailable. However, it does not decompose significantly for many years. (Eisler, 1990) In surface soils the halftime of decomposition is almost 3 weeks (Eisler, 1990). Once in the food chain, paraquat can have delayed toxic effects causing death of mammals and sensitive species of birds are negatively affected by receiving daily dose (Eisler, 1990).

3.2.2 Glyphosate

Glyphosate is a non-selective contact herbicide, classified as a slightly hazardous pesticide (WHO, 2009). It is decomposed in the environment to intermediate metabolites glycine and mainly AMPA, which is further degraded to carbon dioxide. Little data is available about the toxicity of the main degradation product AMPA. FAO (2001) states, that "on the basis of toxicity data and application rates, the risks for birds, mammals, aquatic organisms, bees, earthworms and micro-organisms in soil in observance of corresponding risk management measures are regarded as slight." Nonetheless, despite being biodegraded in the soil, glyphosate is frequently found in freshwater ecosystems, where its degradation is slower, due to lower content of microorganisms than in the soil. The half time of dissipation from water ranges from a few days to two weeks (WHO, 1994).

3.2.3 Alfa-Cypermethrin

Alfa-cypermethrin is a neuro-poison used as an insecticide. It is classified by WHO (2009) as a moderately hazardous pesticide. Alfa-cypermethrin is highly toxic for aquatic invertebrates and fish, due to poor ability to metabolize the chemical (Hartnik et al., 2008). Alpha-cypermethrin is

not soluble in water and it is adsorbed rapidly in sediments (Sarıkaya, 2009). In aerobic conditions, its soil half-life is 4 days to 8 weeks (Sarıkaya, 2009).

3.2.4 Others

Profenofos is another pesticide used in the Aripo valley. According to EPA (2000) it is highly to very highly toxic to fish and aquatic invertebrates and it can accumulate in their bodies. Profenofos is not persistent in the soil (EPA, 2000).

Methomyl is a highly toxic insecticide to fresh water fish and very highly toxic to aquatic invertebrates on an acute basis (EPA, 1998), even when its half time for photodecomposition in water is approximately 1 day (Aktar et al., 2008). Nonetheless, in soil the half time presents 34 days and it has a potential for groundwater contamination (EPA, 1998).

Ametryn is a highly soluble in water and persistent herbicide in soil with slight toxicity for mammals and fish, but high toxicity for crustaceans. (Farre, 2002).

Table 4: Pesticides used in the village of Aripo

Commercial name	Active ingredient	Field of action	Soil Half Life Time	Number of farmers using this pesticide
Gramoxone	**Paraquat**	H	1.4-7.2 years[1]	**11**
Gramoxone Super	**Paraquat, pyridine**			**1**
Weedless	**Paraquat**			**2**
Fastac	**Alpha - cypermethrin**	I	7-15 days[2]	**4**
Cypro	**Profenofos and Cypermethrin**	I	0-15 days[2]	**4**
Round-up	**Glyphosate isopropylamine**	H	3.3-6.9 days[3]	**4**
Trounce 480	**Glyphosate isopropylamine**			**1**
Algrass	**Glyphosate**			**1**
Swiper	**Glyphosate**			**2**
Vydate	**Oxamyl**	I	8-50 days[4]	**2**
Copper sulphate	**Cu**	F		**3**
Viking	**Ametryn**	H	3-8 days[5]	**3**
Regent	**Fipronil**	I	28- 34 days[6]	**1**
Acrobat	**Dimethomorph**	F	12-19 days[7]	**2**
Surf-Ac	**Alcohol ethoxylate, alkylphenol ethoxylate**	H	2 days[8]	**1**
Rizolex 50	**Tolclofos-methyl and Thiram**	F	1[9]-30[10] days	**1**
Basta 200 SL	**Glufosinate-ammonium**	H	8 days[11]	**1**
Champion	**Cu**	H		**1**
Lanate	**Methomyl**	I	0.97-1.25 days[12]	**1**
Carbendazim 50 SC	**Methyl benzimidazol-2-ylcarbamate**	F	up to 28 days[13]	**1**

[1] Cheah et al. (1998)
[2] Gupta et al. (2011)
[3] Liu et al. (2010)
[4] Ou and Rao (1986)
[5] McDonald et al. (1999)
[6] Shuai et al. (2011)
[7] Liang et al. (2011)
[8] Knaebel et al. (1990)
[9] Griffith and Matthews (1969)
[10] Mackay et al. (2000)
[11] Accinelli et al. (2004)
[12] Aktar et al. (2008)
[13] Liu and Hsiang (1994)

3.3 Willingness to limit the use of pesticides

3.3.1 Awareness rate of farmers and non-farmers

The survey done among farmers and non-farmers has shown differences between the awareness of the health risk the users are facing. Interviewed farmers are more aware of that aspect of pesticide use in comparison with the residents who do not do farming. In contrast to that, the non-farmers expressed bigger awareness of their health risk regarding the pesticides residues remaining on the farmers' produce than farmers did.

Both groups mainly agreed that pesticides can have a negative effect on aquatic ecosystems. Nonetheless, more than half of interviewed farmers were not aware of the negative effect on soil ecosystems. The percentage and chi square test results can be seen in the table 5 below.

Table 5: Results of the survey among farmers and non-farmers about awareness issues (n=22)

	Farmers		Non-farmers		χ^2 (p<)[a]
Issue	Agree(%)	Don't agree (%)	Agree (%)	Don't agree (%)	
The health risk for farmers	41	59	18	82	12.7 (0.001)
A possibility that pesticides can affect consumers health	27	73	55	45	16.2 (0.001)
Pesticides affecting the soil negatively	45	55	64	36	6.5 (0.05)
Affecting fish and other animals in the river	68	32	68	32	0.0 (0.99)
The negative effect of pesticides on the natural habibats around fields	55	45	41	59	0.3 (0.95)

[a] Outcomes of the non-parametric Chi square test with probability alpha level of significance

Further, major differences were found in the awareness of the possible ways in which pesticides can get into the river stream from farmers' fields (Fig. 4). More than half of the interviewed farmers claimed that there is no way for the chemicals to get into the river from their farms in comparison with the non-farmers who expressed major opinion that runoff is the main possible way.

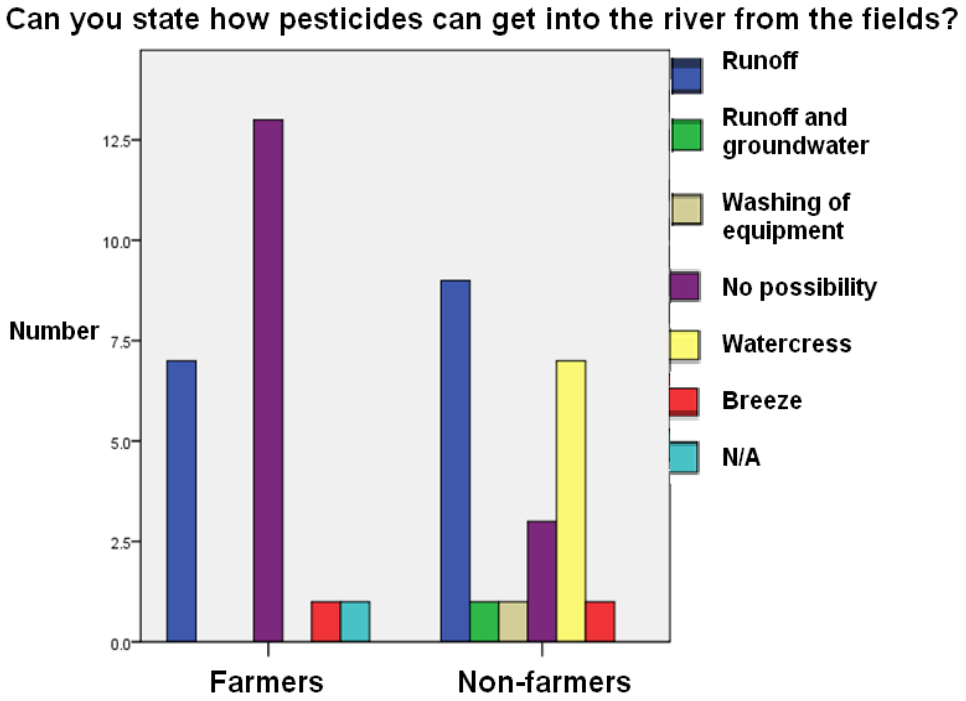

Fig. 4: Opinion of farmers and non-farmers about getting of pesticide into the river.

3.3.2 Influences of awareness and willingness level

Using the Spearman's correlation method, variables of age, education and income of farmers and non-farmers were correlated to the awareness of particular issues and willingness to limit or stop using pesticides. Each awareness/willingness issue was then correlated to each other in order to find if there is any relationship. Only the statistically significant results are mentioned in the table and only the results which are further discussed are described in the text.

The numbers represent the strength of a tendency of the correlated variables and it is being interpreted according to Cohen (1988, pp. 79-81) as follows: small strength=0.10 to 0.29, medium=0.30 to 0.49, strong tendency=0.50 to 1. The positive and negative signs show either the positive correlation or the negative correlation between variables. For example, as can be seen in the table 6 below, the variable "Age" is negatively correlated to "Education" and the opinion that pesticides can have a negative effect on the environment. It means that the higher age of the farmers, the less educated they are, but the more they are aware about the

negative effects of pesticides on the environment (since the “yes” answer is always ranked by number 1 as the youngest age and the lowest level of education).

Table 6 shows only correlations with a medium and strong tendency on the level of significance 0.05 and stronger. An example of the strong tendency to negative relationship is the correlation of farmers’ income and their awareness of the health risk for consumers, when consuming pesticide residues on the products. The higher income the farmers receive, the more they are aware of the health risk for consumers (since “agree” answer is ranked by number 1 and “do not agree” by number 2).

Tab.6: Correlation between f the different variables from the interviews with the farmers (n=22)

	Age	Income	Education	Health risk for consumer	Soil affected	Way of getting pesticides into river	Neg. effect on environment	Accept to use less pesticides	Accept to stop using pesticides	Way of compensation	Interval of compensation
Age			-0.43*				-0.44*				
Income				-0.62**							
Education											
Health risk for consumer											
Soil affected						0.46*					
Way of getting pesticides into river								0.50*			
Neg. effect on environm.									0.47*		-0.44*
Accept to use less										0.57**	0.52*
Accept to stop using											
Way of compensation											0.94**
Interval of compensation											

** Correlation is significant at the 0.05 level.*

*** Correlation is significant at the 0.01 level.*

Further, there is a strong tendency for the willingness to accept compensation for using less pesticide to be influenced by the opinion on how pesticides can get into the river. The majority of farmers who answered that there is absolutely no way in which pesticides can get into the Aripo River and surrounding streams also agreed with the compensation. The willingness of farmers to accept a compensation for stop using pesticides on their farm is strongly correlated to their perception of a possibility that pesticides can have any negative effect on the environment. These farmers who agreed with the possibility that pesticides can have any negative effect on environment mainly agreed to stop using them, while those who do not think there is any environmental risk did not agree to stop it. No significant relationships were found between the level of education and the awareness of pesticide use.

Tab.7: Correlation of the different variables from the interviews with the non farmers (n=22)

	Age	Income	Health risk for farmer	Pesticides remain on the product	Soil affected	Fish affected	Neg. effect on environment	Pay to use less pesticides	Pay to stop using pesticides	Way of compensation	Interval of reg. pmnt
Age		0.53*			0.49*						
Income										0.44*	
Health risk for farmers				0.43*			0.57**				
Pesticides remains on the product					0.64**	0.55**	0.57**	0.55**		0.47*	0.47*
Soil affected							0.44*	0.50*		0.60**	0.63**
Fish affected								0.58*	0.43*	0.46*	
Negative effect on environm.									0.54**	0.51*	0.62**
Pay to use less pesticides									0.43*	0.90**	0.80**
Pay to stop using pesticides										0.56**	0.54**
Way of compensation											0.91**
Interval of reg. pmnt											

** Correlation is significant at the 0.05 level.*

*** Correlation is significant at the 0.01 level.*

The non-farmers' answers concerning the different questions appeared to be much more correlated than in the case of farmers, as can be seen in the table 7 below. The income is significantly increasing with interviewees' age, while the higher age, the lower awareness of the fact that soil could be affected by pesticides ("agree" answer is ranked by 1 and "do not agree" is ranked by 2). Non-farmers' awareness of the fact, that fish and other aquatic species can be also affected by pesticides, has a strong tendency to positively influence their willingness to pay for less using of pesticides as same as that soil can be affected and that pesticides can remain on the farmers' products.

3.3.3 Willingness to limit vs. stop using pesticides

Regarding the willingness of farmers to be compensated for reduction in using pesticides, almost 80% would accept the compensation. Nonetheless, the majority refused the possibility of not using pesticides at all. Also more than half of the interviewed non-farmers supported the idea of limited use only. The exact ratios and the chi square test results are mentioned in table 8 below.

Table 8: Willingness of the farmers and the non farmers to be compensated or to pay (n=22)

	Farmers		Non-farmers		χ^2 (p<)[a]
Issue	Agree	Don't agree	Agree	Don't agree	
Willing to limit the amount of pesticides	77	23	68	32	2.0 (0.95)
Willing to stop using pesticides	27	73	45	55	7.0 (0.01)

[a] Outcomes of the non-parametric Chi square test with probability alpha level of significance

3.3.4 Preferred type of compensation

The farmers as well as non-farmers mostly preferred a regular method (59% and 73%) of compensation (or payment) in a monthly interval (55% and 64%). The most frequent sum of money the contributors (non-farmers) have been willing to contribute indirectly to the receivers (farmers) is TT $100, followed by TT $200 on the second place. In contrast to non-farmers, the most numerous group of farmers presents those who prefer monthly payment of not closer specified "thousands of dollars".

4. Discussion

This study aims to investigate the environmentally significant behavior of residents of the Aripo valley, in other words, the environmental attitude of farmers and non-farmers, living in the Caroni watershed affected by pesticides, using the contingent valuation method and WTP/WTA concepts.

During the study, few constraints have been faced. The research site accessibility has been dependant on the time availability of the project's team, availability of the department's van and availability of a driver, which made the research site less accessible. From this reason, the pilot-testing of the interviews was not possible due to narrowed period of the fieldwork.

4.1 Farmers' private-sphere environmentalism

The most used pesticide by farmers in the Aripo valley has been paraquat. This ranking corresponds with the rest of Trinidad and Tobago, where paraquat was the best selling pesticide in 2005 along with glyphosate on the second place as it is in the Aripo valley (Pinto Pereira et al., 2007). Long term effects of paraquat are not known, since there is no reliable data available. Moreover, the practices of pesticide use are often not appropriate in the Aripo valley, as the pesticides are used for multiple purposes as a general poison. Even if the pesticides were applied to a smaller part of the agricultural area, the farmers' fields are often placed on steep slopes, which enhance the runoff of the chemicals directly into the streams and the river. Further, there is no buffer zone between the streams and farmers plots. This finding was not a part of the survey, nonetheless, since two interviewees expressed an opinion that the river can be polluted by spraying pesticides close to the banks and washing of equipment in the river, there should be a serious concern about this issue.

Although almost every farmer was interviewed, none was able to provide complete information about the amounts of chemicals he/she applied. It either means that the fertilizers and pesticides are used in an unorganized way or farmers did not provide the information on purpose. Neither of the reasons is a positive fact. The main concern of the local farmers is an improvement in the infrastructure and for some of them also labor shortage. It shows farmers' effort to facilitate and develop their farming.

4.2 Contingent awareness

The attention is given to bivariate correlations since most studies to my knowledge have not used multivariate analyses and hence the results could not be compared with any other studies done in the past.

The correlation of three demographic variables (age, education, income) to the knowledge or awareness of interviewees has shown unexpected results, whereby no significant relationships were found between the level of education and the awareness of pesticide use. It can be concluded that the level of school education has no influence on the extent of interviewees' awareness of pesticide use issues. Nonetheless, two relationships were found with the variable "age" and one correlation with the variable "income".

Usually the young population is being seen as more flexible or accepting reforms more readily. Moreover, in the past few decades the media have regularly been exposing us to information about various ecological topics and environmental risks. Hence, the part of population which has been raised in this era is supposed to be more aware or at least more familiar with environmental topics. This was not confirmed in the Aripo valley. The higher age of the interviewees, the less educated they are, but the more they are aware of the negative effects of pesticides on the environment. There can be a natural explanation to that inverse result. Since school education appeared to have no influence and the younger population is expected to be more environmentally educated by media, the next variable is a personal experience. The older the farmer is; the longer farming experience including using pesticides he has.

Farmers' answers to the question about negative environmental effects were not supported by any description or explanation, therefore, it cannot be explicitly concluded that farming experience makes any difference. Also any purely personal interest influencing the answers cannot be excluded, since the interviewees knew from the beginning of the interview, that a financial compensation would be discussed.

Nonetheless, the farming experience can also be confirmed as a reason for higher awareness thanks to the results of non-farmers, whereby the older non-farmer, the less aware that soil could be affected by pesticides. This result brings us back to the hypothesis about better informed younger population.

As Van Liere and Dunlab (1980) mention: “the upper and middle classes have solved their basic material needs and thus are free to focus on the more aesthetic aspects of human existence.” Even if the interviewees do not belong to the upper or the middle class (according to their average annual income), the positive correlation between income and environmental attitude is significant in the case of farming interviewees. Among farmers, the opinion on the health risk that consumers can face when consuming farmers’ produce is influenced by their income, whereby the richer the farmer is, the more aware he is. The income of non-farmers significantly increases with the interviewee’s age, but does not influence their awareness.

Regarding farmers, an easy explanation could be a linkage between income and the level of education and then awareness, nonetheless, as mentioned above; the education has absolutely no influence on the research population awareness. Hence any multivariate relationships between the income, education and awareness cannot be confirmed.

The part of the survey which was focused on the awareness of the risks when using pesticides has shown the importance of personal involvement and concern of the interviewee. Differences between the awareness of farmers and non-farmers regarding the health risk that farmers are facing correspond with that importance. As expected, the users of chemicals (farmers) were more aware of the risk for their health then the non-farmers, who are not operating with pesticides. In logical contrast to that, the non-farmers expressed bigger awareness of their health risk regarding the pesticides residues remaining on the farmers’ produce than farmers did.

In the next case, more than half of farmers did not express any awareness that soil could be affected by pesticide use. Since the opinions were not enhanced by any additional interview, the reason for such an answer is not known. Nonetheless, based on the observations it can be concluded that some of the farmers interviewed took a defensive position of their pesticide use and therefore they could be answering according to the pattern to not come to any harm.

An even more obvious example of such behavior presents the question about the possible ways in which pesticides can get into the river stream from the farmers’ fields. More than half of the interviewed farmers claimed there is absolutely no way in which the chemicals could get into the river from their farm. In contrast to them, the non-farmers expressed major opinion that runoff is the main possible way. In general, the farmers, who are supposed to be more knowledgeable about natural mechanisms and who have experience in farming with pesticides

for dozens of years, expressed lower awareness than non-farmers, who are usually not in direct contact with these chemicals.

4.3 Farmers' vs. Non-farmers' willingness

There is a common trend in both groups' willingness either to limit or to stop using pesticides. The majority of both groups were open to contribute to lower use of pesticides. As expected, farmers were more enthusiastic about the possibility to be compensated by receiving a payment than non-farmers were about the scenario in which they would contribute by paying a certain fee. The farmers' understanding of the hypothetical situation, in which they would be allowed to use only limited doses of chemicals, can be considered very good, because most of the interviewees were interested mainly in the mechanism of possible controls and punishments for not following the rule. In comparison with farmers, the non-farmers were not interested in any additional information.

Farmers' willingness to accept compensation seems to be correlated to the answer on the question about possible ways in which pesticides can get into the river from their farm. While more than half of farmers answered that there is absolutely no way in which pesticides can get into the river, the majority also agreed with the compensation.

The statistical correlation does not confirm a real relationship between the interviewees' statements, as it is probably in this case. It has already been mentioned above that even if not based on the data obtained from the questionnaires, in my opinion some of the interviewed farmers adopted preventive defensive attitude when answering questions related to their way of farming and chemical use. Therefore more than half of farmers did not state any possibility for how they could indirectly pollute the river through their plots.

While farmers' willingness depends on two parameters ("How can pesticide get into the river from your farm" and "Can pesticides have any negative effect on the environment"), the non-farmers' willingness is strongly correlated to two times more questions about their awareness including fish, soil, residues on products and negative effects in general.

Opposite to the limited pesticide use stands the scenario of not using pesticides at all. Majority of farmers refused the possibility of not using pesticides at all. This decision was based on the

belief, according to interviewees, that the farming would be impossible without using any pesticide, since plant diseases and pests are common in the area. The minority who would be willing to stop using pesticides is significantly influenced only by the opinion that pesticides can have a negative effect on the environment. Also more than half of the interviewed non-farmers supported the idea of limited use only with the same argument that farmers could not do farming without pesticides, but those, who would agree, were also driven by the possible risk for fish and aquatic ecosystem. During the fieldwork, only one interviewee expressed some knowledge about tools of alternative farming, as organic pesticides and other organic farming practices.

For farmers it was difficult to state any particular sum of money, they were not willing to decide immediately even if they were ensured that the survey is purely hypothetical. Farmers' preference of the amount of money they should receive ("thousands of dollars") was always explained by the interviewees not because of the inability to determine the amount of money, but after exhausting list of constraints, which the farmer would have to face with limited doses of pesticides available.

For non-farmers it can be easier to estimate how much they can afford to lose from their budget. Nevertheless their preference of TT $100 and TT $200 is being relatively high according to the average annual income of non-farmers, which is recalculated approximately TT $ 4,300 a month. This unexpectedly high willingness to pay can be explained by the fact that interviewees were ensured the survey is hypothetical only and it is not done for governmental needs. Therefore non-farmers expressed more than their actual ability to pay their favor with the idea of limited pesticide use, which is the important information this survey was researching.

Jacobsen and Hanley (2008) in their study confirm the effect of Environmental Kuznetz Curve, when they assessed 145 WTP estimates from 46 CV studies from different countries along with corresponding GDP per capita and conclude that the richer the country is, the higher WTP for conservation is observed than in a poorer country. According to the World Bank (2012) GDP per capita in Trinidad and Tobago is US $15,365 (in comparison with the Netherlands where it is US $46,904 or USA with US $47,153). GDP per capita can be as good an indicator as WTP (Jacobsen and Hanley, 2008). Nevertheless, when it is needed to explore the attitude of a particular region or community, the variable of income is important to use as one of the examined influences of WTP. In the case of this study, the local WTP does not

necessarily correspond with the GDP per capita as an indicator of Environmental Kuznetz Curve principle, which is more and more questioned over past decade (Stern, 2004).

In general, the residents of the Aripo valley were open to contributing to “prevention”. Pesticides are perceived as a threat for the ecosystem in general, but rather not as a problem for the village, nor for the water quality. One of the possible watershed management techniques should be installing and maintaining buffer zones along the streams and the river, which are often missing in the Aripo valley. An even more functional measure for avoiding ecosystem damage would be following the example of EU and banning of such chemicals as paraquat.

According to Jacobsen and Hanley (2008), together with rural development, income increases and hence WTP for nature conservation too. This can be utilized for long term planning of nature conservation. Nevertheless, this study did not confirm the relationship between income and WTP/WTA in the research population. As Landell-Mills and Porras (2002) mention, even the awareness of environmental issues does not have to necessarily reflect the WTA/WTP. Usually the users of the environmental services have to believe first that these are threatened and that their personal contribution will be used effectively and equally (free riding will be prevented) and finally, users have to believe that the natural resources they would protect brings welfare to them. This was confirmed in this study by the questions about the awareness of health risks either for farmers or for consumers. Personal interest is needed to be enhanced by the governmental incentives to increase the awareness of particular pesticide issues.

5. Conclusion

The conclusion in this chapter presents a brief answer to my research questions from the chapter 2.2.

My first research question aims to explore how do the farmers in the Aripo sub-catchment use pesticides and which pesticides are mainly used. The two most used pesticides in Trinidad, paraquat and glyphosate, are the ones being most used in the Aripo valley. The combination of such a chemical as paraquat, which has been banned within the European Union, and the fact that farmers either were not able or willing to say how much and how often do they use the pesticide is alarming and it should capture our attention.

The second research question asks about the extent, to which the farmers are willing to accept compensation and the non-farmers willing to pay for the environment-friendly pesticide use. On the other side of the coin stand both groups of interviewees expressing their high willingness to limit the use of pesticides. Even if farmers expressed relatively low awareness of impact of pesticides and, primarily, even if more than half of farmers said that there is absolutely no way in which pesticides can get into the river, the majority agreed with the limited use of pesticide. Nevertheless, neither farmers nor non-farmers supported the idea of not using chemical pesticides at all, since the local farming is fully dependant on the chemicals, according to interviewees.

References

Accinelli, C., Screpanti, C., Vicari, A., Catizone, P. (2004) ‚Influence of insecticidal toxins from Bacillus thuringiensis subsp. kurstaki on the degradation of glyphosate and glufosinate-ammonium in soil samples', in: *Agriculture, Ecosystems & Environment*, vol. 103, no. 3, pp. 497-507.

Aktar, M., W., Sengupta, D., Chowdhury, A. (2008) ‚Degradation dynamics and persistence of Quinolphos and Methomyl in/on Okra (Ablemoschus esculentus) fruits and cropped soil', in: *Bulletin of Environmental Contamination and Toxicology*, vol. 80, no. 1, pp. 74-77.

Alkins-Koo, M., Lucas, F., Maharaj, L., Maharaj, S., Phillip, D., Rostant, W., Surujdeo-Maharaj, S. (2004) 'Water Resources and Aquatic Biodiversity Conservation: A Role For Ecological Assessment Of Rivers In Trinidad and Tobago'. Paper presented at The Second Caribbean Environmental Forum (CEF-2), 'Energising Caribbean Sustainability', Port of Spain, Trinidad and Tobago.

Amigues, J., P., Boulatoff, C., Desaigues, B., Gauthier, C., Keith, J., E. (2002) 'The benefits and costs of riparian analysis habitat preservation: a willingness to accept/willingness to pay contingent valuation approach', in: *Ecological Economics*, vol. 43, no. 1, pp. 17-31.

Anderson, T.L.; Grewell, J. B. (2000) 'Property Rights Solutions for the Global Commons: Bottom-Up or Top-Down?' In: Duke Environmental Law & Policy Forum, Vol. X, No. 2, Spring 2000.

Arrow, K., Solow, R., Portney, P., R., Leamer, E., E., Radner, R., Schuman, H. (1993) Report of the NOAA Panel on Contingent Valuation. Washington, D.C., p. 41.

Bromilow, R., H., Robert J. Baker, Martin A. H. Freeman and Katrina Gorog (1980) 'The Degradation of Aldicarb and Oxamyl in Soil', in: Pestic. Sci. 1980, 11, 371-378.

CANARI (2002) Incentives for watershed management in Trinidad: Results of a brief diagnostic. Prepared through the project "Markets for watershed protection services and improved livelihoods" by Krishnarayan, V. And Pantin, D., CANARI Technical Report No. 316.

CariWatNet (2010) Unpublished data. CariWatNet project, Trinidad and Tobago.

Casey, J., F., Kahn, J., R., Rivas, A., A., F. (2008) 'Willingness to accept compensation for the environmental risks of oil transport on the Amazon: A choice modeling experiment', in: Ecological Economics, vol. 67, pp. 552-559.

CIESIN (2010) Place II: Available datasets. Available online at: http://sedac.ciesin.columbia.edu/place/datasets.jsp. Accessed: 23 June 2011.

Chang Yen, I., Bekele, I., Kaloo, C. (1999) ‚Use Patterns and Residual Levels of Organophosphate Pesticides on Vegetables in Trinidad, West Indies', in: *Journal of AOAC International*, vol. 82, no. 4, pp. 991-995.

Cheah, U., B., Kirkwood, R., C., Lum, K., Y. (1998) 'Degradation of Four Commonly Used Pesticides in Malaysian Agricultural Soils', in: Journal of Agricultural and Food Chemistry, vol. 46, no. 3, pp. 1217-1223.

Cohen, J. (1988) Statistical power analysis for the behavioral sciences (2nd ed.). Hillsdale, NJ: Erlbaum.

Day, M., J. and Chenoweth, M., S. (2004) 'The karstlands of Trinidad and Tobago, their land use and conservation', in: *The Geographical Journal*, vol. 170, no. 3, pp. 256-266.

Eisler, R. (1990) Paraquat hazards to fish, wildlife, and invertebrates: a synoptic review. U.S. Fish and Wildlife Service Biological Report 85, 28 pp.

EMA (1998) State of the environment report. Environmental Management Authority , Trinidad and Tobago.

EMA (2005) Water Pollution Management Program. Environmental Management Authority, Trinidad and Tobago.

EPA (1998) Reregistration Eligibility Decision (RED): Methomyl. Office of prevention, pesticides and toxic substances, Washingthon D.C.

EPA (2000) Reregistration Eligibility Decision (RED): Profenofos. Office of prevention, pesticides and toxic substances, Washingthon D.C.

EPA (2011) What Is A Pesticide? Available online at: http://www.epa.gov/kidshometour/pest.htm. Accessed August 7, 2011.

EU (2007) Judgment of the Court of First Instance (Second Chamber, Extended Composition) in Case T-229/04: APPLICATION for annulment of Commission Directive 2003/112/EC of 1 December 2003 amending Council Directive 91/414/EEC to include paraquat as an active substance (OJ 2003 L 321, p. 32). Sweden vs. European Commission. 11 July 2007.

FAO (2001) FAO specifications and evaluations for plant protection products: Glyphosate. Food and Agriculture Organization of the United Nations, Rome. Available online at: www.fao.org/ag/AGP/AGPP/Pesticid/Default.htm. Accessed 6 March 2012.

FAO (2002) International Code of Conduct on the Distribution and Use of Pesticides. Revised Version, adopted by the Hundred and Twenty-third Session of the FAO Council in November 2002. Food and Agriculture Organization of the United Nations, Rome.

Farre, M., Fernandez, J., Paez, M., Granada, L., Barba, L., Gutierrez, H., M., Pulgarin, C., Barceló, D. (2002) ‚Analysis and toxicity of methomyl and ametryn after biodegradation‘, in: *Analytical and Bioanalytical Chemistry*, vol. 373, pp. 704–709.

Fernandez, M., Ibáñez, M., Picó, Y., Mañes, J. (1998) ‘Spatial and Temporal Trends of Paraquat, Diquat, and Difenzoquat Contamination in Water from Marsh Areas of the Valencian Community (Spain)’, in: *Environmental Contamination and Toxicology*, vol. 35, no. 3, pp. 377-384.

Griffith, R., L., Matthews, S. (1969) ‘The persistence in soil of the fungicidal seed dressings captan and thiram’, in: Annals of Applied Biology, vol. 64, no. 1, pp. 113-118.

Gupta, S., Gajbhiye, V., T., Sharma, R., K., Gupta, R., K. (2011) ‘Dissipation of cypermethrin, chlorpyriphos, and profenofos in tomato fruits and soil following application of pre-mix formulations’, in*: Environmental Monitoring and Assessment*, vol. 174, no. 1-4, pp. 337-345.

Hadker, N., Sharma, S., David, A., Muraleedharan, T., R. (1997) ‘Willingness-to-pay for Borivli National Park: evidence from a Contingent Valuation’, in: *Ecological Economics*, vol. 21, no. 2, pp. 105-122.

Hamilton, D., J., Ambrus, A., Dieterle, R., M., Felsot, A., S., Harris, C., A., Holland, P., T., Katayama, A., Kurihara, N., Linders, J., Unsworth, J., Wong, S., S. (2003) ‘Regulatory limits for pesticide residues in water’. IUPAC Technical Report, in: *Pure and Applied Chemistry*, vol. 75, pp. 1123–1155

Hanemann, W., M. (1994) ‘Valuing the Environment Through Contingent Valuation‘, in: *The Journal of Economic Perspectives*, vol. 8, no. 4, pp. 19-43.

Hartnik, T., Sverdrup, L., E., Jensen, J. (2008) ‘Toxicity of the pesticide alpha-cypermethrin to four soil nontarget invertebrates and implications for risk assessment’, in: *Environmental Toxicology and Chemistry*, vol. 27, no. 6, pp. 1408-1415.

Henson, S. (1996) ‘Consumer willingness to pay for reductions in the risk of food poisoning in the UK’, in: *Journal of Agricultural Economics*, vol. 47, no. 4, pp. 403-420.

Homer-Dixon, T.F. (1999) ‘Environmental Scarcity, Ingenuity and Adaptation’. In Homer-Dixon, T.F. (ed.) *Environment, scarcity, and violence*. Oxford: Oxford University Press.
Luke, M., Froberg, J., Doose, M. and Masumoto, H. (1981) in: *J.Assoc. Off. Anal. Chem*., vol. 64, pp. 1187–1195.

Jacobsen, J., B. and Hanley, N. (2008) ‘Are There Income Effects on Global Willingness to Pay for Biodiversity Conservation?’, in: *Environmental and Resource Economics*, vol. 43, no. 2, pp.137-160.

Knaebel, K., B., Vestal, J., R., Federle, T., W. (1990) ‘Mineralization of linear alkylbenzene sulfonate (las) and linear alcohol ethoxylate (lae) in 11 contrasting soils’, in: *Environmental Toxicology and Chemistry*, vol. 9, no. 8, pp. 981–988.

Kotchen, M., J. and Reiling, S., D. (2000) ‘Environmental attitudes, motivations, and contingent valuation of nonuse values: a case study involving endangered species’, in: *Ecological Economics*, vol. 32, pp. 93–107.

Langford, I.H., Skourtos, M.S., Kontogianni, A., Day, R.J., Georgiou, S., Bateman, I.J. (2001) ‘Use and nonuse values for conserving endangered species: The case of the Mediterranean monk seal’, in: *Environment and Planning A*, vol. 33, no. 12, pp. 2219-2233.

Leboulanger, C., Bouvy, M., Pagano, M., Dufour, R., A., Got, P., Cecchi, P. (2009) ‘Responses of Planktonic Microorganisms from Tropical Reservoirs to Paraquat and Deltamethrin Exposure’, in: *Environmental Contamination and Toxicology*, vol. 56, no. 1, pp. 39-51.

Landell-Mills, N and Porras, T. I. (2002) ‘Silver bullet or fools’ gold? A global review of markets for forest environmental services and their impact on the poor’, in: *Instruments for sustainable private sector forestry series*. International Institute for Environment and Development, London.

Liang, H. , Li, L., Li, W., Wu, Y., Zhou, Z., Liu, F. (2011) ‚Dissipation and residue of dimethomorph in pepper and soil under field conditions‘, in: *Ecotoxicology and Environmental Safety*, vol. 74, no. 5, pp. 1331-1335.

Liu, L., X., Hsiang, T. (1994) ‚*Bioassays for benomyl adsorption and persistence in soil*‘, in: Soil Biology and Biochemistry, vol. 26, no. 3, pp. 317-324.

Liu, Y., Wu, X., Yang, M., Zhu, G. (2010) ‘The environmental risk assessment of herbicide glyphosate on various Chinese cultivated soils’, in: *Proceedings of International Conference on Digital Manufacturing and Automation*, ICDMA, vol. 2, pp. 679-682.

Mackay, D., Shiu, W.Y., Ma, K., C. (2000) *Physical-chemical properties and environmental fate*. Handbook. Chapman and Hall/ CRCnetBase.

Mahabir, S. (2004) Integrated Water Resource Management in Trinidad and Tobago. Interim Report IR-04-008 of International Institute for Applied Systems Analysis. Laxenburg, Austria.

McDonald, L., Jebellie, S., J., Madramootoo, C., A., Dodds, G., T. (1999) ‘Pesticide mobility on a hillside soil in St. Lucia’, in: *Agriculture, Ecosystems and Environment*, vol. 72, no. 2, pp. 181-188.

Mycoo, M. (2005) ‚Shifting Paradigms in Water Provisioning Policies: A Trinidad Case Study‘, in: *International Journal of Water Resources Development*, vol. 21, no. 3, pp. 509-523.

Mycoo, M. (2011) ‚Conflicting Objectives of Trinidad's Water Pricing Policy: A Need for Good Water Pricing and Governance', in: *International Journal of Water Resources Development*, vol. 27, no. 4, pp. 723-736.

National Research Council (2002) The Drama of the Commons. Washington DC: National Academy Press.

Ongley, E., D. (1996) Control of water pollution from agriculture. Irrigation and drainage paper 55. Report prepared for FAO, Rome.

Ou, L., T., Rao, P., S., C. (1986) 'Degradation and metabolism of oxamyl and phenamiphos in soils', in: *Journal of Environmental Science and Health - Part B Pesticides, Food Contaminants, and Agricultural Wastes*, vol. 2, no. 1, pp. 25-40.

Pahl-Wostl, C., Craps, M., Dewulf, A., Mostert, E., Tabara, D., Taillieu, T. (2007) 'Social learning and water resource management', in: *Ecology and Sociaty*, vol. 12, no. 2, art. 5.

PEMSEA (2010) Stakeholders' willingness to pay for coastal management: Puerto Galera, Oriental Mindoro'. Draft report. Regional Programme on Partnerships in Environmental Management for the Seas of East Asia of GEF/UNDP/IMO.

Phillip, D., A., T., Rawlins, S., C., Baboolal, S., Gosein, R., Goddard, C., Legall, G., Chinchamee, A. (2007) ‚Relative importance of the various environmental sources of Cryptosporidium oocysts in three watersheds', in: *Journal of Water and Health*, vol. 6, no. 1, pp. 23-34.

Pickering Laboratories, Inc. (2006) Method Abstract for Post-column Liquid Chromatography 117 http://www.pickeringlabs.com/distributor-catalog/M_117.asp

Pinto Pereira, L., M., Boysielal, K., Siung-Chang, A. (2007) 'Pesticide regulation, utilization, and retiler's selling practices in Trinidad and Tobago, West Indies: current situation and needed changes', in: *Public Health*, vol. 22, no. 2, pp. 83-89.

Ramlal, B.; Baban, S., M., J. (2007) ‚Developing a GIS based integrated approach to flood management in Trinidad, West Indies', in: *Journal of Environmental Management*, Vol. 88, no. 4, pp. 1131-1140.

Ragbirsingh, Y. and Souza, G. (2005) 'Site sustainability for Aquaculture Development on the Caroni River Basin, Trindiad West Indies Using GIS', in: *GCFI:56*, pp. 661-673.

Rose, C.M. (1986) "The Comedy of the Commons: Commerce, Custom, and Inherently Public Property", *Faculty Scholarship Series* Paper 1828. Available online at: http://digitalcommons.law.yale.edu/fss_papers/1828. Accessed: 27 June 2011.

Sampath, M. (1982) An Investigation of Levels of Organochlorine Pesticides and Polychlorinated Biphenyls in the Caroni Swamp. University of the West Indies, St Augustine, Trinidad and Tobago.

Sarikaya, R. (2009) Investigation of Acute Toxicity of Alpha-Cypermethrin on Adult Nile Tilapia (Oreochromis niloticus L.), in: *Turkish Journal of Fisheries and Aquatic Sciences*, vol. 9, pp. 85-89.

Schneiderman, J., S. and Reddock, R. (2004) 'Water, women and community in Trinidad, West Indies', in: *Natural Resources Forum*, vol. 28, pp. 179-188.

Shanmugasundaram, P.; Kandasamy, O. S.; Senthil, A. (2005) 'Persistence of paraquat in water under aquatic weed control.' In: *Aquatic weeds: problems, control and management,* eds. Mathur, S. M.;Mathur, A. N.;Trivedy, R. K.;Bhatt, Y. C.;Mohnot, P., Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, India. pp. 82-85. Available at http://www.cabdirect.org/abstracts/20063102691.html?freeview=true

Shuai, X., Chen, J., Ray, C. (2011) 'Adsorption, transport and degradation of fipronil termiticide in three Hawaii soils', in: *Pest Management Science*, vol. 55, no. 12.

Stern, D., I. (2004) 'The Rise and Fall of the Environmental Kuznets Curve', in: *Word Development*, vol. 32, no. 8, pp. 1419-1439.

Stern, P., C. and Dietz, T. (1994) 'The Value Basis of Environmental Concern', in: *Journal of Social Issues,* vol. 50, no. 3, pp. 65-84.

Stern, P., C., Dietz, T., Abel, T., Guagnano, G., A., Kalof, L. (1999) 'A Value-Belief-Norm Theory of Support for Social Movements: The Case of Environmentalism', in: *Research in Human Ecology*, vol. 6, no.2, pp.81-97.

Stern, P., C. (2000) 'Toward a Coherent Theory of Environmentally Significant Behavior', in: *Journal of Social Issues*, vol. 56, no. 3, pp. 407–424

Surujdeo-Maharaj, S. (2010a) CariWatNet Report on the Preliminary Sampling Exercise. Unpublished. CariWatNet, The University of the West Indies, Trinidad and Tobago.

Surujdeo-Maharaj, S. (2010b) CariWatNet Preliminary Report on the Wet Season Sampling Exercise. Unpublished. CariWatNet, The University of the West Indies, Trinidad and Tobago.

Székács, A. and Darvas, B. (2012) ‚Forty Years with Glyphosate'. In: Herbicides - Properties, Synthesis and Control of Weeds, ed. Abd El-Ghany Hasaneen, M., N., InTech, pp. 492. Available at http://www.intechopen.com/books/herbicides-properties-synthesis-and-control-of-weeds

Togridou, A., Hovardas, T., Pantis, J., D. (2006) 'Determinants of visitors' willingness to pay for the National Marine Park of Zakynthos, Greece', in: *Ecological Economics*, vol. 60, no. 1, pp. 308–319.

Turpie, J., K. (2003) 'The existence value of biodiversity in South Africa: how interest, experience, knowledge, income and perceived level of threat influence local willingness to pay', in: *Ecological Economics*, vol.46, no. 2, pp. 199–216.

Van Liere, K., D., Dunlap, R., E. (1980) 'The Social Bases of Environmental Concern: A Review of Hypotheses, Explanations andEmpirical Evidence', in: *The Public Opinion Quarterly*, vol. 44, no. 2, pp. 181-197.

Vanslembrouck, I.; Van Huylenbroeck, G; Verbeke, W. (2002) 'Determinants of the Willingness of Belgian Farmers to Participate in Agri-environmental Measures', in: *Journal of Agricultural Economics*, vol. 53, no. 3, pp. 489-511.

Villeneuve, A.; Larroudé, S., Humbert, J., F. (2011) Herbicide contamination of freshwater ecosystems: impact on microbial communities. In: Pesticides – Formulations, Effects, Fate. Stoytcheva M. (Ed.), pp. 285-312, InTech, Rijeka, Croatia. Available at http://www.intechopen.com/books/pesticides-formulations-effects-fate/herbicide-contamination-of-freshwater-ecosystems-impact-on-microbial-communities

Wang Y, Yen J, Hsien Y, Chen Y (1994) Dissipation of 2,4-D glyphosate and paraquat in river water, in: *Water Air Soil Pollution*, vol. 72, pp.1–7.

Wesseling, C., B. van Wendel de Joode, C. Ruepert, C. León, P. Monge, H. Hermosillo, T. Partanen (2001) ‚Paraquat in developing countries', in: *International Journal Occup. Environ. Health*, vol. 7, pp. 275–286.

WHO (2002) Reducing and eliminating the use of persistent organic pesticides: Guidance on alternative strategies for sustainable pest and vector management. Prepared by Mörner, J., Swedish University of Agricultural Sciences; Bos , R., WHO and Fredrix, M., Wageningen University. Available online at:

http://www.who.int/water_sanitation_health/resources/pesticides/en/index.html. Accessed: 28 July, 2011.

WHO (2009) The WHO recommended classification of pesticides by hazard and guidelines to classification 2009. WHO, Geneva, 2009. Available at http://www.who.int/ipcs/publications/pesticides_hazard_2009.pdf

WHO (1994) ENVIRONMENTAL HEALTH CRITERIA 159: GLYPHOSATE. INTERNATIONAL PROGRAMME ON CHEMICAL SAFETY. Prepared by H. Mensink and P. Janssen, National Institute of Public Health and Environmental Hygiene, Bilthoven, The Netherlands.

World Bank (2012) GDP per capita (current US$). Available at http://data.worldbank.org/indicator/NY.GDP.PCAP.CD. Accessed 17 June 2012.

Appendices

A. Pesticides used in the Heights of Aripo

Function (W=weedicide, I=insecticide, F=fungicide,

Commercial brand name (number of users)	Active ingredient	WHO hazard	Chemical class	Function	Soil Half Life Time
Gramoxone (11)	**Paraquat** (1,1' -dimethyl-4,4'-bipyridinium) Paraquat dichloride (1,1', dimethyl-4, 4'-bipyridinium dichloride)	Moderately hazardous	Bipyridilium	W	1.4-7.2 years
Round-up (4)	**Glyphosate isopropylamine**	Unlikely to present hazard in normal use		W	3.3-6.9 days
Fastac (4)	**Alpha - cypermethrin**	Moderately hazardous	Synthetic pyrethroids	I	7-15 days
Trounce 480 (1)	**Glyphosate isopropylamine**	Unlikely to present hazard in normal use		W	3.3-6.9 days
Cypro (4)	**Profenofos** (O-4-bromo-2 chloro-phenyl)-O-ethyl s-n-propyl phosphorothioate; **Cypermethrin**	Moderately Hazardous		I	0-15 days
Vydate (2)	**Oxamyl** [N,N-dimethyl-2-methylcarbamoyloxyimino-2-(methylthio)acetamid]	Highly hazardous	Carbamate	I	8-50 days
Copper sulphate (2)	**Cu**	Slightly hazardous		Multi use pesticide	
Algrass (1)	**Glyphosate**	Unlikely to present hazard in normal use		W	3.3-6.9 days
Gramoxone Super (1)	**Paraquat dichloride, Paraquat emetic, Pyridine**	Moderately hazardous	Bipyridilium	W	1.4-7.2 years
Viking (3)	**Ametryn**			W	3-8 days
Swiper (2)	**Glyphosate**	Unlikely to present hazard in normal use		W	3.3-6.9 days
Regent (1)	**Fipronil**			I	28- 34 days
Acrobat (2)	**Dimethomorph**		Cinnamic Acid Derivative	Used as I, but F	12-19 days
Surf-Ac (1)	**Alcohol ethoxylate, Alkylphenol ethoxylate**			W	2 days

Carbendazim 50 SC (1)	**Carbendazim (Methyl benzimidazol-2-ylcarbamate)**		Benzimidazole	F	up to 28 days
Rizolex 50 (1)	**a) Tolclofos- Methyl** **b) Thiram**		a)Organophosphate ester b) Dimethyldithiocarbamate	F	1-30 days
Weedless (2)	**Paraquat dichloride**	Moderately hazardous		H	1.4-7.2 years
Basta 200 SL (1)	**Glufosinate-ammonium**			H	8 days
Champion (1)	**Cupric hydroxide**			Multi use pesticide	
Lanate (1)	**Methomyl**	Unlikely to present hazard in normal use		I	0.97-1.25 days

B. Interview Schedule

This Interview Schedule was developed and used by Boogert and Henstra (2010) as a part of the CariWatNet project activities.

The schedule will be adapted to fulfill the needs of the consistent data collecting for the project as well as the needs to collect the data to answer my research questions.

Interview Schedule

Date: _____

1.0 Interviewer Information

1.1 Name:

_____

2.0 Farmer

2.1 GPS location: _____

2.2 Name:_____

2.3 Address:_____

2.4 Farming area or address:

2.5 Telephone:_____ Email: _____

3.0 Demographic data farmer

3.1 Gender: Male [ ] Female [ ]

3.2 How old are you? _____Years

3.3 What is your ethnicity? Indian [ ] African [ ] Chinese [ ] Mixed [ ] Other _____

3.4 What religion do you practice, if any?

Hindu	[ ]	Roman Catholic	[ ]	Muslim	[ ]	Pentecostal	[ ]
Presbyterian	[ ]	Anglican	[ ]	Protestant	[ ]	7-day-adventist	[ ]
Jehovah witness	[ ]	Rastafarian	[ ]	Baptist	[ ]		

Other_____

3.5 Are you the head of the household? Yes [ ] No [ ]

3.6 Do you farm full-time or part-time? Full-time [ ] Part-time [ ]

3.7 If part-time, what is your other occupation?_____
_____

3.8 If part-time, what percentage of income is obtained from farming?
Less than 25% [ ] 50%-74% [ ] 25%-49% [ ] More than 75% [ ]

3.9 How long have you been a farmer? _____years

3.10 How many persons live in your household? (i.e. share at least one common meal per day)(child = 18 years and younger) Children _____Adult Males _____ Adult Females_____

3.11 What is the highest level of education you have?
Primary [ ] University [ ] Secondary [ ] Gov't prog. [ ]
Other (specify) [ ] _____

4.0Farm characteristics

4.1 What type of farmer have you been over the last year?
Crops [ ] Livestock [ ] Other (specify) [ ] _____

4.2 What livestock did you rear over the last year? Did you produce it for your own usage or for sale?

Livestock type	**Number**	**Acreage/pasture**	**Own production/sale**	**Additions**
Cattle-beef			Own [ ]/ Sale [ ]	
Cattle-dairy			Own [ ]/ Sale [ ]	
Chicken-eggs			Own [ ]/ Sale [ ]	
Chicken-meat			Own [ ]/ Sale [ ]	
Fish			Own [ ]/ Sale [ ]	
Goat-diary			Own [ ]/ Sale [ ]	
Goat-meat			Own [ ]/ Sale [ ]	
Rabbit			Own [ ]/ Sale [ ]	
Sheep-diary			Own [ ]/ Sale [ ]	
Sheep-meat			Own [ ]/ Sale [ ]	
			Own [ ]/ Sale [ ]	
			Own [ ]/ Sale [ ]	
			Own [ ]/ Sale [ ]	
			Own [ ]/ Sale [ ]	

4.3 How many parcels (pieces) of land did you crop farm over the last year? **(see table below)**

Parcel no.	**Acreage**	**Own/use family holding/squat/lease; rented/state land/other**
1		Own [ ]/use family holding [ ]/squat [ ]/lease; rented [ ]/state land [ ]/other [ ]
2		Own [ ]/use family holding [ ]/squat [ ]/lease; rented [ ]/state land [ ]/other [ ]
3		Own [ ]/use family holding [ ]/squat [ ]/lease; rented [ ]/state land [ ]/other [ ]
4		Own [ ]/use family holding [ ]/squat [ ]/lease; rented [ ]/state land [ ]/other [ ]
5		Own [ ]/use family holding [ ]/squat [ ]/lease; rented [ ]/state land [ ]/other [ ]
6		Own [ ]/use family holding [ ]/squat [ ]/lease; rented [ ]/state land [ ]/other [ ]

5.0 Crop production

5.1 Did you use manure/fertilizers/pesticides last year to grow your crops? Yes [ ] No [ ]
What were the costs per unit/total costs of the manure/fertilizers/pesticides? *(specify unit!)*

Manure/Fertilizers/Pesticides	Costs/unit; Total costs

5.2 Did pests or diseases affect your crops for the last two years? Yes [ ] No [ ]
Which crops were affected? Which pest/disease affected the crop? What acreage was affected by the pest/disease? Which pesticides were used to deal with what pests and diseases?

Crop	Pests	Diseases	Acreage	Pesticide

5.3 Over the last year, what crops and what acreages did you cultivate? **(see table below)** Did you produce it for own consumption or for the market? How often did you grow these crops last year? What was the total production of each crop you grew last year? (pounds/year or acre) Did you use manure/fertilizers/pesticides ? What types of manure/fertilizers/pesticides did you apply? What was the amount of manure/fertilizers/pesticides that you applied each time (bags/truckloads/other)? How frequent did you apply the manure/fertilizers/pesticides (per crop cycle)? When in the cropping cycle did you apply the manure/fertilizers/pesticides? When was the last time you applied it (date)?

Fruit vegetables	**Acreage/ cycle**	**Own /sale**	**Crop cycles/year**	**Total prod**	**Manure**	**Freq/crop**	**when in crop cycle**	**fertiliser**	**Freq/crop**	**when in crop cycle**	**pesticide**	**Freq/crop**	**when in crop cycle**
Avocado													
Banana													
Beet root													
Bhagi													
Bodi													
Broccoli													
Cabbage													
Carrot													
Cassava													
Cauliflower													
Cedar													
Celery													
Chive													
Christophene													
Citrus													
Cocoa													
Coconut													
Coffee													
Corn													
Cucumber													
Dasheen													
Dasheen bush													
Eddoes													
Fine thyme													

Hot peppers													
Karilee													
Fruit vegetables	**Acreage**	**Own /sale**	**Crop cycles/year**	**Total prod**	**Manure**	**Freq/crop**	**when in crop cycle**	**Fertiliser**	**Freq/crop**	**when in crop cycle**	**pesticide**	**Freq/crop**	**when in crop cycle**
Lettuce													
Mahogany													
Melongene													
Ockro													
Pakchoi													
Parsley													
Passion fruit													
Paw Paw													
Pimentos													
Plantain													
Poui Bhagi													
Pumpkin													
Same bean													
Shadow Bene													
Squash													
String bean													
Sweet peppers													
Sweet potato													
Teak													
Tiopi Tambo													
Tomatoes													
Water cress													
Yam													

5.7 Did you work on your farm over the last year? Yes [ ] No [ ]

5.8 If yes, how many days/week? _____ Weeks/ year? _____

5.9 Did you use family labor on your farm last year? Yes [ ] No [ ]

5.10 If yes, how many family members? _____ How many days/week? _____ Weeks/ year? _____

5.11 Did you use hired labor on your farm last year? Yes [ ] No [ ]

5.12 If yes, how many laborers? _____How many days/week?_____ Weeks/ year? _____

6.0 Problems of cultivation

6.1 What is the source of water supply on your farm?

Rain	[ ]	Spring catchment	[ ]	Private pipe	[ ]
Pond	[ ]	Public stand pipe	[ ]	River	[ ]
Truck borne	[ ]	Other (specify) _____			

_____

6.2 What do you think about the quality of the water you use? Good [ ] Fair[ ] Poor[ ]

6.3 If fair or bad, what do you consider to be the source of the pollution?

_____

__

_____

__

_____

__

6.4 What are the main problems that you face in growing your crops?

Water shortage	[ ]	Water flooding	[ ]	Water pollution	[ ]
Salt water intrusion	[ ]	Soil erosion	[ ]	Soil sedimentation	[ ]
Yield reduction	[ ]	Pests/diseases	[ ]	Infrastructure	[ ]

Other

_____

6.5 Do any of these sources affect your farming? If yes, how do they affect it?

_____

__

_____

__

6.6 What have you been doing to cope with these problems (see question 5.1) and are there, according to you, viable solutions to the problems you face?

Problem:_____
___

How have you dealt with

it?_____

What do you consider a better

solution?_____

_____
__

_____
__

Problem:_____
___

How have you dealt with

it?_____

What do you consider a better

solution?_____

_____
__

_____
__

Problem:_____
___

How have you dealt with
it?_____

What do you consider a better
solution?_____
_____
__
_____
__

Problem:_____
___

How have you dealt with
it?_____

What do you consider a better
solution?_____
_____
__
_____
__

6. 7 Have you noticed changes in yield/ growth of crops in the past 5 years?
Yes [ ] No [ ]
_____
_____

6. 8 Have you noticed changes in government support in the past 5 years?
Yes [ ] No [ ]

_____
__

_____
__

6. 9 Have you noticed changes in water availability and/or pollution in the past 5 years?
Yes [ ] No [ ]

_____
__

_____
__

6.10 Do you plan to cultivate the same crops in the future? Yes [ ] No [ ]

If no,
why(not)?_____

_____
__

C. Interview blueprints

The following interview blueprints are based on the research questions B and C, respectively on their sub-questions B1, B2 and C1, C2.

Interview blueprint 1

Interview with farmers

B1) How are the farmers aware of the risky pesticide use practices?

- To find out if the farmers are aware of any risk that pesticide use could cause.
    - Health problems
        - Of farmers exposed to the chemicals
        - Of consumers eating the pesticide residues with the products
    - Ecosystem damage
        - Accumulation in the environment of some of them
        - Toxicity for aquatic and soil species
        - Runoff of the chemicals to the river
        - Undesirable effects of excessive use of pesticides.

B2) What is the acceptable compensation for the limited pesticide use?

- To find out if the farmers would be willing to accept any compensation for limited pesticide use
    - Yes/No
- To find out if the farmers would be willing to accept any compensation for non-pesticide use
    - Yes/No
- To find out which form of compensation would be acceptable and how much for it.
    - Non-monetary type of compensation
        - What kind of non-monetary compensation
        - In which intervals received
    - One-time compensation payment
        - How much would be a farmer willing to receive for one-time payment.
    - Regular compensation payments
        - Intervals of payments (monthly, annually)
        - How much for each interval
    - Combination – initial payment on the beginning and then regular compensation.
        - Intervals of payments (monthly, annually)
        - How much for each interval

        - How much for the initial payment

Interview blueprint 2

Interview with non-farmers

C1) How are not farming householders aware of the effects of pesticides on the environment?

- To find out if the non-farmers are aware of any risk pesticide use could cause.
    - Health problems
        - Of farmers exposed to the chemicals
        - Of consumers (themselves) eating the pesticide residues with the products
    - Ecosystem damage
        - Accumulation in the environment
        - Toxicity for aquatic and soil species
        - Runoff of the chemicals to the river
        - Undesirable effects of excessive use of pesticides.

C2) What is the acceptable environmental cost to pay?

- To find out if non-farmers would be willing to pay any costs to limit pesticide use on agricultural fields in Aripo sub-catchment.
    - Yes/No
- To find out if non-farmers would be willing to pay any costs to stop using pesticides on agricultural fields in Aripo sub-catchment.
    - Yes/No
- To find out how much would non-farmers be willing to pay (random order)
    - Monthly
        - TT $10
        - TT $1000
        - TT $500
        - TT $750
        - TT $50
        - TT $100
        - TT $200
        - TT $300
        - TT $20
        - TT $30
    - Annually
        - TT $10
        - TT $1000
        - TT $500

        - TT $750
        - TT $50
        - TT $100
        - TT $200
        - TT $300
        - TT $20
        - TT $30
    - As an one-time contribution
        - Largest contribution willing to pay or:
        - TT $10
        - TT $1000
        - TT $500
        - TT $750
        - TT $50
        - TT $100
        - TT $200
        - TT $300
        - TT $20
        - TT $30
        - more

D. Interview guide for interviewing farmers

Interview Schedule CariWatNet Project

Survey of farmers in Aripo catchment

Name of interviewer: Katerina Hroudova

Date, time:

Introduction:
My name is Katerina Hroudova. I am from the University of West Indies and I am collecting data for the CariWatNet Project. The project aims to develop integrated watershed plans for Aripo, to improve the environment you live in through cooperation with local residents.
I would like to ask you a few questions about the use of pesticides in Aripo, to get to know your point of view on this issue. It will take about twenty minutes.

Name of interviewee:

_____

Address and contact information:

_____

_____

1. Demographic information

1.1 Gender: Male ☐ Female ☐

1.2 How old are you? _____Years

1.3 What is your ethnicity? Indian ☐ African ☐ Chinese ☐ Mixed ☐ Other _____

1.4 What religion do you practice, if any?

Hindu	☐	Roman Catholic	☐	Muslim	☐	Pentecostal	☐
Presbyterian	☐	Anglican	☐	Protestant	☐	7-day-adventist	☐
Jehovah witness	☐	Rastafarian	☐	Baptist	☐	Other_____	

1.5 Are you the head of the household? Yes ☐ No ☐

1.6 What is the average annual income of your household?

_____

1.6 How many persons live in your household? (i.e. share at least one common meal per day)(child = 18 years and younger) Children _____ Adult Males _____ Adult Females_____

1.7 What is the highest level of education you have?

Primary ☐ Secondary ☐ University ☐ Gov't prog. ☐ Other _____

2. Awareness part

2.1 Are you aware of the health risk when you are using pesticides?

_____

2.2 Do you think there is a possibility that the residues on your produce can affect consumer's health?

_____

2.3 Could the use of pesticide affect the soil?

_____

2.4 Do you think fish and other animals in the river can be affected by the use of pesticides?

_____

2.5 Are you aware of the fact that pesticides can remain in the soil for a long time?

_____

2.6 Can you state how pesticides can get into a river from your farm?

_____

2.7 Can pesticides have any negative effects on the natural environment around you?

_____

_____

_____

_____

_____

3. Compensation part

3.1 Would you be willing to accept compensation from the Extension office to pay you for using pesticides in smaller amounts?

_____

3.2 Would you be willing to accept compensation from the Extension office to pay you for not using pesticides at all?

_____

If answer to 3.2 is no, then 3.3 is related to 3.1.

If answer to 3.2 is yes, then:

3.3 I will read three ways of compensation and can you tell me in what way would you be willing to receive the compensation?

a) One-time payment

If yes, how much?

_____

b) Regular payment (monthly, annually)

If yes, in which interval?

_____

If yes, how much monthly?

- TT $10
- TT $50
- TT $100
- TT $200
- TT $300
- TT $400

- TT $500
- TT $700
- TT $1000
- Other?

If yes, how much annually?

- TT $500
- TT $700
- TT $1000
- TT $2000
- TT $3000
- Other?

c) Combination (smaller initial payment and then regular payment)

If yes, how much for the initial payment?

_____

If yes, which interval of the regular payment (monthly, annually)?

_____

If yes, how much monthly?

- TT $10
- TT $50
- TT $100
- TT $200
- TT $300
- TT $400
- TT $500
- TT $700
- TT $1000
- Other?

If yes, how much annually?

- TT $500
- TT $700

- TT $1000
- TT $2000
- TT $3000
- TT $4000
- TT $5000
- Other?

E. Interview guide for interviewing non-farmers

Interview Schedule CariWatNet Project

Survey of non-farmers in Aripo catchment

Name of interviewer: Katerina Hroudova

Date, time:

Introduction:
My name is Katerina Hroudova, I'm from the University of West Indies and I'm collecting data for the CariWatNet Project. The project aims to develop integrated watershed plans for Aripo, to improve the environment you live in through cooperation with local residents.
I would like to ask you few questions about the use of pesticides in Aripo, to get to know your point of view on this issue. It will take about twenty minutes.

Name of interviewee:

_____

Address and contact information:

_____

_____

1. Demographic information

1.1 Gender: Male ☐ Female ☐

1.2 How old are you? _____Years

1.3 What is your ethnicity? Indian ☐ African ☐ Chinese ☐ Mixed ☐ Other _____

1.4 What religion do you practice, if any?

Hindu ☐ Roman Catholic ☐ Muslim ☐ Pentecostal ☐

Presbyterian ☐ Anglican ☐ Protestant ☐ 7-day-adventist ☐

Jehovah witness☐ Rastafarian ☐ Baptist ☐ Other_____

1.5 Are you the head of the household? Yes ☐ No ☐

1.6 How many persons live in your household? (i.e. share at least one common meal per day)(child = 18 years and younger) Children _____Adult Males _____ Adult Females_____

1.7 What is the average annual income of your household?

_____

1.8 What is the highest level of education you have?

Primary ☐ Secondary ☐ University ☐ Gov't prog. ☐ Other _____

2. Awareness part

2.1 Are you aware of the health risk for farmers when they are using pesticide?

_____

2.2 Do you think there is a possibility that pesticides can remain on the produce you are buying?

_____

2.3 Can the use of pesticides in farming affect the soil negatively?

_____

2.4 Do you think fish and other animals in the river can be affected by the use of pesticides?

_____

2.5 Are you aware of the fact that pesticides can remain in the soil for long time?

_____

2.6 Can you state how pesticides can get into the river from farmers' fields?

_____

2.7 Can pesticides have any negative effect on the natural environment around farmers' fields?

_____

_____

_____

3. Payment part

3.1 Would you be willing to pay to the Extension office for farmers a sum of money to limit the amount of pesticides that farmers use?

_____

3.2 Would you be willing to pay to the Extension office for farmers a sum of money for farmers to stop using any pesticides?

_____

3.3 If yes, in what way would you be willing to make the payment to the Extension office?

a) One-time contribution

If yes, how much?

- TT $20,000
- TT $10,000
- TT $9000
- TT $8000
- TT $7000
- TT $6000
- TT $5000
- TT $4000
- TT $3000
- TT $2000
- TT $1000
- Other?

b) Regular payment (monthly, annually)

If yes, in which interval? _____

If yes, how much monthly?

- TT $1000
- TT $700
- TT $500
- TT $400
- TT $300
- TT $200
- TT $ 100
- TT $50
- TT $10
- Other?

If yes, how much annually?

- TT $5000
- TT $4000
- TT $3000
- TT $2000
- TT $1000
- TT $700
- TT $500
- Other?

F. Notes from Community Development Meeting in the village of Heights of Aripo

Organizing body: Ministry of Community Development, Community Development Fund (CDF)
Date: 24th August, 2011
Notes:
CDF officer's speech
– Dengue fever and HIV in Trinidad
– The aim of the government: to change strong top-down approach for bottom up, therefore this meeting was organized. CDF wants to see locals' development plans and hear their needs.
– Suggestion to collaborate with other communities.
– Government is trying to involve CSOs and NGOs in the community development
– Still ensuring that the government and the village are partners
– Call for the proposals (the main purpose of the meeting)
Information from Andrenette Blackburn (Vice President of the Aripo Youth Development Organisation)
– The village has about 30 – 40 farmers
– There is no farmers' association
– The Aripo Youth Development Organisation aims to promote organic farming (Aripo farmers don't practice it yet)
– Heights of Aripo should focus on eco-tourism.
Information from Genevieve Seejol, the Secretary of Heights of Aripo village council
– Email: Bigbobtheboss@yahoo.com, phone number 335-9685
– The village council meets twice a month.
– She will call us what is the date of next village council meeting.
– She lives in Aripo close to Peter Martinez (first interview).
Information from other participants
– There is a new NGO focused on "esthetical development" of Heights of Aripo.
– The village school is willing to participate in any activities.
– One of the churches needs a bus for their activities.
– The Minister of Community Development Nizam Baksh visited the village in the afternoon.

G. A map of upstream part of Aripo sub-catchment

The GIS data available were used for the visualization of the spatial layout of the land use.