
CHAPTER 1. INTRODUCTION



View of the Chaguana river basin, Ecuador

1.1. BACKGROUND

Banana is one of the most important products of exportations, from Ecuador. It represents more than 30% of the Ecuadorian exportations (Ecuadorian Central Bank 1998). To keep a high production level, Ecuadorian farmers are using pesticides and fertilizers on a frequent basis, and sometimes without technical advice. As a result, this chemical utilization has brought not only better crop production, but contaminants have been detected on some rivers and soils (ESPOL¹-VUB 1998).

In 1993, a complaint was taken to the courts by the shrimp-farming sector against banana farmers and pesticide importers. This complaint was related to a disease observed in shrimps, which the producers claimed that pesticides used in banana sector were causing. Some shrimp production was lost because of this disease called “Taura’s Syndrome” (Sindrome de Taura). Research, paid by shrimp farmers, was conducted to discover the origin of the disease. Traces of propiconazole and tridemorph, pesticides usually used in banana plantation were found in some shrimp’s tissue samples. As a result, the Ecuadorian Shrimp Association tried to sue some pesticide manufactures outside the country because of the use of “hazardous” pesticides in Ecuador. However, the research was not sufficiently conclusive to assure that pesticides caused the disease. Other pollutants (heavy metals) were also discovered on tissue samples. In addition, the shrimp sector has not reported more cases related to this disease since 1996, although the banana farmers are still using the same pesticides.

In 1999, the Escuela Superior Politecnica del Litoral (Ecuador) began a cooperation agreement with the Council of Flemish Universities (VLIR) to develop scientific research in several areas of interest. The entire program was named VLIR-ESPOL Project, and it was divided in six components. Among them, Component 4 is doing research towards the development of Environmental Management Systems on Aquiculture and Agriculture. To a certain extent, the component’s research focused on building a bridge between banana and shrimp producers by developing some tools that can explain and help to solve the interlinked environmental problems within their activities. For that reason, the component was divided in three main investigations:

¹ Escuela Superior Politécnica del Litoral

1. Determination of environmental impacts from the usage of pesticides in the Ecuadorian banana sector
2. Use of the benthos as an indicator of anthropogenic contamination in the natural shrimp populations
3. Development of an epidemiologic alert system for the shrimp farmers in the Gulf of Guayaquil.

The present thesis research deals with the first area of interest within Project 4 of the VLIR-ESPOL Programme. In 2003, the cooperation was renewed by adding a second phase to the programme. In the new phase, new research areas will take advantage of the work done in the first phase, including the present thesis. Because of the findings in the present research, the project team pointed that besides banana and shrimp sectors, other potential users in Ecuador could benefit from the research by expanding the initial project goals. Therefore, the new phase will deal with Integrated Watershed Management by assessing and developing environmental tools that could help Ecuadorian regulators in enforcing the existing law. Areas such as agriculture economics, biological monitoring of ecosystems (rivers and beaches), and use of GIS and Artificial Intelligence tools will be covered by the second phase.

In the same year 2003, the research team made an agreement with UNESCO to be part of the HELP programme (Hydrology for Environment, Law and Policy), and the study area of the present thesis was selected as a candidate HELP basin. Therefore, most of the research presented here will be used to develop more investigations within the HELP framework.

1.2. WORKING GROUPS

The promoter of this thesis was Prof. Dr. ir. Peter A. Vanrolleghem from the Department of Applied Mathematics, Biometrics and Process Control, Faculty of Agriculture and Applied Biological Sciences, Ghent University. In addition, there were other working groups inside and outside the project that collaborated in the development of this thesis:

- The Centre of Environmental Studies (CEMA – ESPOL, Ecuador) performed some environmental diagnostics in a banana farm within the study area. In addition, some social data were gathered in the selected basin.
- The Faculty of Earth Sciences (ESPOL, Ecuador) performed the soil analysis to obtain texture and soil-water contents. In addition, through two undergraduate theses, two

important topics for this research were accomplished: the hydrology and the hydraulics issues in the selected river basin (Guzman and Bonini 2003; Vivas 2004).

- The Centre of Aquiculture Services (ESPOL, Ecuador) performed the analysis in soil to obtain organic matter content, and BOD and solids content in water samples.
- The Commission of Atomic Energy (Ecuador) performed the laboratory analysis to quantify pesticides in water and sediment.

1.3. RESEARCH GOALS

This thesis research has focused on several goals and objectives within the framework of the VLIR-ESPOL project.

From the project point of view, this thesis has evaluated the fate of current pesticide contamination produced by a typical banana area in an Ecuadorian river basin by using monitoring and modelling. In addition, this research set the basis for new upcoming studies to be done in the frame of the VLIR-ESPOL project and in Ecuador in general.

From the research point of view, the thesis aimed to develop several modelling tools and some procedures to be used as part of the Environmental Tools that the VLIR-ESPOL project is planning to make available for Ecuadorian River Basin Management. In addition, this research aimed to increase the ESPOL know-how to turn ESPOL to an Ecuadorian Reference Centre for Environmental Modelling issues.

From the academic point of view, this thesis is intended to be used as a textbook at ESPOL University in courses such as Environmental Engineering, Hydrology, Modelling or GIS at the Faculties of Earth Sciences and Marine Sciences. In Ecuador, there is currently no official textbook that explains the procedures and limitations involving environmental modelling with an Ecuadorian Case Study. As it is stated in the thesis, poor developing countries such as Ecuador lack several tools that could help in evaluating a non-point pollution problem like it is done in well-developed countries such as Belgium.

From the author's personal point of view, this thesis is another step in enriching his own knowledge to become a more useful and experienced lecturer for his students. Whether the author works in research, academic or consultant areas in Ecuador, this is a contribution to improve the way scientific research is used in Ecuador.

1.4. THESIS OVERVIEW

The thesis is arranged in such a way that the reader can easily understand the scope and goals of the research. In addition, the text arrangement is intended to be used as a guiding textbook for assessing non-point pollution problems where a poor data-set is available.

Chapter 2 gives a review of available literature regarding pesticide issues. The chapter is divided in five sections: a description of the existing water quality regulations in Ecuador, the behaviour of pesticides in the environment, existing non-point pollution models, the use of GIS tools within environmental modelling, and background information regarding pesticides and banana issues in Ecuador.

Chapter 3 deals with the gathering of data to perform the pesticide assessment. It is pointed out that in poor-developing countries such as Ecuador data collection is quite difficult and sometimes impossible. Existing data could be outdated, in non-standardised formats and usually recorded frequencies lower than the models need. This chapter shows some procedures to generate secondary data from measured or existing scarce data (named as primary data) in order to run some models to predict chemical concentrations as near as possible to field data measured during this research.

Chapter 4 explains the evaluation and two screening or compartmental models, EXAMS and EQC, which helped in visualizing the way pesticides are grossly distributed in the environment. A comparison between the outcomes of both models is presented. In addition, it is also shown the the evaluation, calibration and outcome comparison between two spatially-integrated models, AGNPS and SWAT models. AGNPS model is a runoff-based model that evaluates mainly agrichemicals attached to sediment transported in a river. However, other agricultural practices such as fertilisation, irrigation and livestock management can also be evaluated. Although SWAT model is also a runoff-based model, it mainly focuses in the chemical interaction between soil and water compartment. Both models are the most used for pesticide management purposes worldwide.

Chapter 5 gives the conclusions of the research, and presents some recommendations to be considered for future researchers and Ecuadorian regulators to improve the way non-point pollution problems should be assessed.