Incorporation of new isotope techniques for tracing water pollutants used as a mean for the understanding of land use impacts on water resources. Identifying sources of Nitrates and Phosphate in Fuquene Lake

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Introduction

The local environmental organization (CAR) in collaboration with CIAT and Andean Watershed/CONDESAN-GTZ project made an agreement to jointly participate in a study conducted to identify the main sources of nitrates draining into the Lake. GTZ is providing the funds and coordinating some of the activities; CAR also providing funds is contributing with field technicians' knowledge and CIAT is coordinating the technicalities of the research. CONDESAN is coordinating the whole process as part of its research on payments for environmental services in the Andes. These are considered strategic alliances for carrying out research and development in the Andes upper catchments as part of the Challenge Program on Water and Food initiative. The current work is only a piece in a research for development process triggered by CONDESAN in the area. This result corresponds to one of the research components related with the tracing and location of nitrate and phosphate pollutants.

Preliminary studies assert that the cattle systems are the main source of nitrates from ammonia fertilizers, urine and manure from the animal population (JICA and CAR, 2000). However, other land uses in the region as potato growers and several milk industries located in the area seems to have a shared responsibility in the discharge of pollutants to the water system. Controversy about the mechanisms and volumes on which nitrates and phosphates are getting into the water system suggested the need of further research that the current project wants to address using $\delta^{15}N$ and $\delta^{18}O$ natural isotopes. It is expected that the isotope "signature" left by each of the sources can be identified in the sink waters of the system (Figure 9).

For using isotopes techniques and therefore, identify source of non-punctual water pollutants, the following steps were conducted:

1. Compilation of previous studies of water pollution and revision of hydrological modeling results (Activity 1.1.)
2. Definition of sampling protocol, according with suggestions of the lab that provided the spectrometer of mass, in order to take field samples, its *in situ* and posterior treatment, application of reactive, transportation to lab and analysis.
3. SWAT Modelation of nutrient fluxes originated by organic and mineral sources around Fuquene lake watershed, to selected sample sites according with predicted values of pollutants.

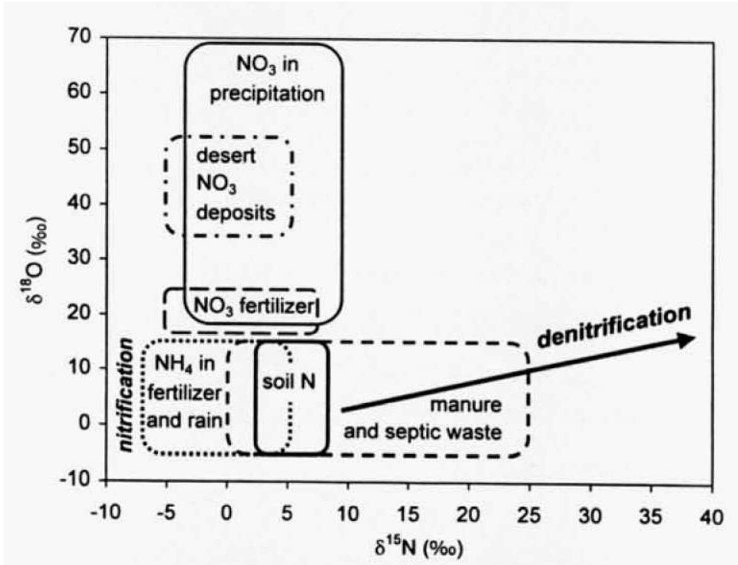

Figure 9. Scheme of frequent ranges of d15N and d18O for different N sources
(Source: Kendall and McDonnell, 1998)

Preliminary Results

Based on the integration of primary and secondary information considered in the current study, is it possible to conclude that the Fuquene Lake eutrophication process is due to the complementary actions of chemical and organic residues coming from farming and cattle activities, wasted waters from main towns and from natural erosive processes occurring in the area. The relative contribution of these sources varies in space and time accordingly to the schedule of crops and pasture management practices. Derived from the spatial extrapolation, contributing values for the sub-watersheds indicate that those numbered 8, 12 and 15 contributes with more that 50% of the nitrogen and phosphorous found in the whole watershed. This area includes Carmen de Carupa, Ubaté and Lenguazaque towns together with the flat part of Ubate valley. The zones contributing the less (below 10%), are the sub-watersheds 10 and 13 located in the east and west part of Fuquene Lake. The other sub-watersheds contribute with the remaining 40% of pollutants.

Figure 10 shows results obtained from tracing sources of water pollutants in the watershed using d15N. The contribution of wasted waters seems to be higher that the assigned to this in previous studies. Control measurements to this type of source are relatively easy considering their punctual location and the existing water treatment plants that need to start functioning. Previous studies (JICA and CAR, 2000) showed that livestock systems are the main source of N in the lake by the contribution of organic N containing in manure. However, isotope techniques show that contribution of N by cattle ranchers located just around the lake seems lesser than previous reports demonstrated. This first stage of sampling provides results that allow the proposal of new hypothesis about the significant role of fertilization in lake pollution. Subsequent analysis of d18O will provide more accurate results.

If final results confirm the hypothesis, the potential alternatives for those livestock systems could be related with the renewing of pastures with legumes species, minimum tillage for terrain adequation and low fertilized forages production in other watershed sites.

Clearer identification of the pollutant sources will aid in the identification of stakeholders to negotiate the alternative solutions for this problem in the region.

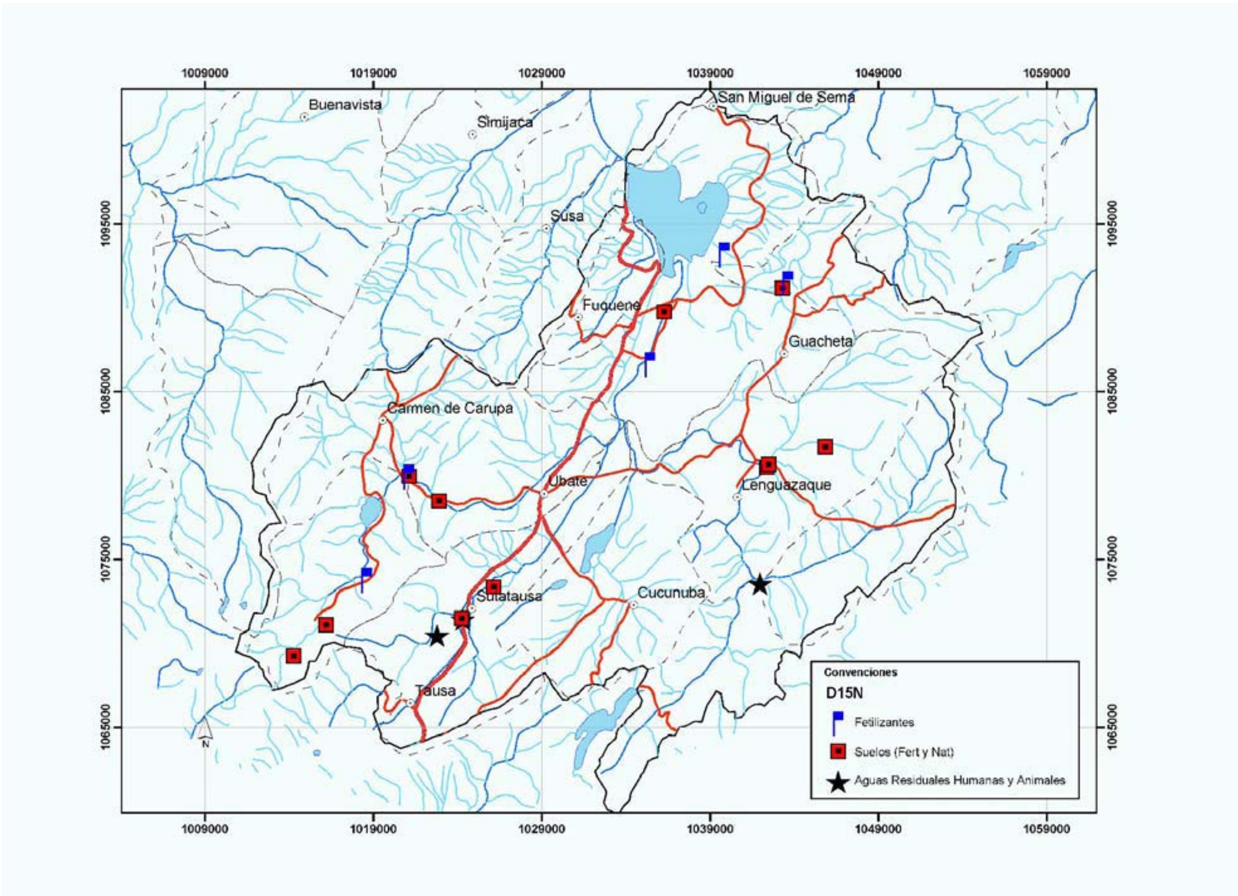

Figure 10. Sources of N using isotopes techniques (d15N)