

Report:
Research project on Atmospheric Deposition to lake Atitlán in
Guatemala

From Catherine Last

General part

Motivation and application

The undergraduate studies in biology are very general since they cover all the different work fields and give just little opportunity to specialize in a field or gain some deeper practical skills. Therefore my advice for all undergraduate students is to collect some practical experience in the fields you're interested in.

The reason I applied for this research project in the field of limnology in Guatemala was to gain an insight in the practical work of a limnologist, to experience how research works in another country and to practice my Spanish language skills.

I got interested in this particular project, because it connects general aquatic studies with environmental management. Even though my project was focused on fundamental research, during my internship I gained insight into the difficulties of the management of lake Atitlán such as the lack of communication between the communities and the locals' lack of trust in the communities' decision makers.

To me the passion with which the people work on the environmental conservation of the region was particularly impressive!

My supervisor Margaret Dix has been working here in Guatemala for more than 40 years after she graduated from Harvard. Since then she and her husband have dedicated their lives to build up the biology department at the Universidad del Valle. In addition to that they have been focusing on the environmental problems of Lake Atitlán for the past years. I got to know Margaret Dix as a great scientist and a person who is not just focusing on the theoretical science but also understands how to communicate with the locals and how important this communication is to change their environmental perception and behaviour.

Preparation for the project

To attend an internship in Guatemala you don't need a special visa. You can stay in Guatemala for 90 days without a visa. However it is important to hold a probative ongoing or return flight ticket. This serves as proof that you are going to leave the country after the 90 days. Especially with a transit in the USA this is an important factor. The American guardians will ask you many peculiar questions and won't let continue your journey without such an evidence. (like an ongoing flight ticket).

There is also the opportunity to book buses from Guatemala to Mexico for just around 200Q, but I feel certain that a bus ticket wouldn't be a valid proof for the guardians. Therefore I bought an ongoing flight ticket before I started my journey and I could enter Guatemala.

If you transit through the USA, you need an ESTA, which is less than a visa, but which is needed when changing the airplane on US american ground. You can easily apply for it via

internet and it costs about 20 U\$.

I found out that there are cheaper flights from Amsterdam with DELTA and KLM than from Germany (they were 200€ cheaper at the time I booked it). It might be worth to compare the flight costs. Or you get a special deal with a student travel agency. Also it might be worth to take a flight through Panama City instead of the United States as it would be less complicated to transit in Panama compared to the USA. For me the transit in the USA was quite stressful since I had to worry two times about being able to leave the country towards Guatemala, because the US-American guardians didn't trust me. They didn't believe why I wanted to stay in Central America for such a long time (almost 5 months in total, because I travel afterwards) and checked my ongoing flight ticket twice although I had already bought an ESTA online in advance. Just be ready to face some difficulties when you have a transit in the USA!

Medical preparation

If you have never visited the tropics before, it is worth to make an appointment with a "Tropenzentrum" a few months before your trip. They will advise you on tropical diseases and any vaccinations you might need.

The region of lake Atitlán isn't stereotypically tropical though. I haven't heard of any problems with Zika, Malaria or Yellow fever here, but some people suffer from Dengue fever. And there are loads of mosquitoes during the rain period (between June and September). For travelling to Panama, or if you enter another Latin American country after you visited Panama it is obligatory to get a Yellow fever vaccination. If you plan on travelling after your internship you should gather information about typical diseases, medication and vaccination. I didn't get Malaria prevention, because there exist many bad side effects and you rarely catch the deadly type of Malaria here. I would recommend to use a strong mosquito spray instead, but of course that is everybody's own decision.

If you just stay in the Guatemalan highlands you needn't worry too much about diseases like Malaria, Yellow fever and so on. You should worry about the water quality though. Always drink "agua pura" from bottles, or filtered water or water that was boiled at high temperatures for at least 5 minutes. Also brush your teeth with bottled water and keep your mouth closed while showering. I got a parasite after my first week here and had to take antibiotics. Then I got problems every few weeks for just a day from the food or fruit juices my family prepared. I also caught a flu, because the weather was changing from cool and rainy to windy and cold. Just make sure you take a pullover, fleece or soft-shell jacket, a rain jacket, rainproof shoes and rain trousers with you. If you feel cold during the night, ask for another blanket - during nighttime you're at the biggest risk to get sick.

Getting around and living in Guatemala

Guatemala City is a big, busy and not very safe city. I didn't stay there for a long time. To get to lake Atitlán you can book a bus on the internet (e.g. with the agency 'Atitrans') and tell them where to pick you up - directly at the airport or in another part of the city. There are also cheaper opportunities ("chicken buses") but I would recommend to book a bus at a tour agency in the beginning. There are plenty of opportunities to get used to the chicken buses between Sololá and Panajachel or other places. If you take a local bus you should be aware of the risk: they are overloaded and the drivers drive like crazy plus I've heard that accidents happen quite frequently.

If you take a shuttle like "Atitrans", just tell them to drop you off in front of the Universidad del Valle, on the street to Sololá.

It often is very cold and wet in Sololá during the rainy season. This period reaches from June to October. Travelling might be more comfortable before or after this period.

The Universidad del Valle is based a little bit North of the city Sololá on an altitude of 2300 meters. During my stay there it was raining almost every afternoon and night. The weather in Panajachel is very different: it rains much less (I know that, as my project included weekly rain collection in Pana and the campus of the University) and you will get to see the sun much more often.

I stayed at EMA'S Comidas in front of the University. This is a family run albergue without a lot of things around. It is right next to main street, so it's easy to find, but you will also hear the traffic a lot! It is the easiest way to stay there in the beginning, as it is very close. Dona Marta and Adrian Saloj are very welcoming, hearty people and Marta will cook for you three times a day. You will live together with the local teachers and students from the campus, which will train your Spanish skills and let you get to know the local people. And if you want you can learn how to prepare Tortillas and help a bit. If you want more quietness or a place more downtown with opportunities of going out in the evenings or trying different restaurants, you can also find cheap accommodation in Sololá or Panajachel and take the chicken bus and colectivo to university every day.

Free time at lake Atitlán

At lake Atitlán you will get to see an amazing landscape, get to know a very interesting, ancient culture and enjoy the nature around you! You can get along with Spanish perfectly. I didn't speak a lot of Spanish when I arrived here. I had to learn it pretty fast and it worked well. Just few people speak English, but making your way to the lake will be possible with English, too. If you're interested in languages you can also try to learn some words of a Mayan language.

It was nice to have time to explore the villages around the lake on my free weekends. Every village has its own traditional clothes and the people speak different Mayan languages: Kaqchikel, Quiché and Tz'utujil are the main ones around the lake. My favourite villages were San Juan and San Antonio Palopo. Hiking a volcano is exhausting (you will need some time to adapt to the altitude, the little oxygen and the different climate), but worth it! Xela and laguna Chicabal are also very close and worth a visit.

Internship

The Universidad del Valle is a very small university. It has three different campuses and it is a private university which is one of the best in Guatemala. The laboratories on the Campus Altiplano (Sololá) are very basic. Most of the times I found the things I needed for my experiment, but sometimes I had to be inventive - which is a great training for a scientist! During my internship I also helped with the monthly monitoring of the lake and rivers and the analysis of the samples. I learned the methods of Indofenol to detect the concentration of Ammonium, the method of Hydrazin to detect the concentration of Nitrates and Nitrites, the method of Ascorbic Acid to detect the concentration of Orthophosphates and the detection of Total Nitrogen and Total Phosphorus amounts.

A very interesting part for me was to visit and participate in the Symposium "Agua continentales de las Américas: Presente y futuro" that took place in Panajachel during my internship and was organized by the Universidad del Valle and the organisations Amigos del Lago de Atitlán and AMSCLAE. The presentations on aquatic research and the management of water systems in different countries were highly interesting and I got to talk with experienced researchers personally and met other biology students and professors from other Guatemalan Universities.

Technical part

Lake Atitlán is located at an altitude of 1,562 m in an 84,000 year old caldera of volcanic origin in the highland of Sololá in Guatemala. In 2009 a cyanobacterial bloom led to an alarm for the local government and put a focus on the importance of a change in the environmental management of lake Atitlán.

The input of nutrients, especially nitrogen and phosphorus, into aquatic ecosystems leads to a shift in the limitation of phytoplankton growth. It can change the proportion of nutrients and therefore the ratio of the nutrients limiting the lake's productivity. Nitrogen and phosphorus regulate and promote the growth of phytoplankton in lakes. (Wetzel, 2001)

Monitoring of the nutrients of lake Atitlán and the nutrients entering the lake through surrounding rivers showed that an important amount of nutrients enter the lake through the discharge of waste waters, natural tributaries and the drainage of agricultural fields. (Gómez Pérez, 2015)

Different authors validate the dry and wet atmospheric deposition as an even more important source than the input from agricultural runoff. Galloway et al. (2008) estimate the atmospheric deposition as the most important process of anthropogenic supply of reactive nitrogen to terrestrial and marine ecosystems. The totality of N circulating in the biosphere has increased more than 100% as a result of industry, population growth and deforestation. (Galloway et al., 2008)

A former study "Deposición atmosférica de nitrógeno y fósforo como fuente de ingreso de nutrientes al Lago de Atitlán, Sololá" suggests that nutrients entering the lake's surface through atmospheric deposition have a long input on the lake's system. This study included weekly data of wet and dry atmospheric deposition collected from a pilot station between February and September 2014. The amount deposited on the lake's surface area was estimated 5.15 metric tons of inorganic soluble phosphorus, 66.4 metric tons of dissolved inorganic nitrogen and 5.15 metric tons of dry deposition. The deposition of inorganic soluble phosphorus and nitrogen was connected to rain precipitation.

Several studies on atmospheric deposition of different nutrients to lake systems exist in other parts of the world. The monitoring of atmospheric deposition from 2014 did not bring enough data to estimate the real amounts of deposited nutrients yet.

Based on the former publication, the aim of this study is to establish a modified method of the collection of wet and dry atmospheric deposition that can be used for long-term monitoring of the atmospheric nutrient deposition and to collect further data of wet and dry atmospheric deposition of nitrogen and phosphorus through this modified method to compare with the results of 2014. A further aim is to include the collection of data of the

atmospheric deposition in the future monitoring by the Universidad del Valle campus Altiplano.

Materials and methods:

To estimate the amount of nutrients deposited from atmospheric sources, I established a pilot station with two different buckets to collect the wet and dry atmospheric deposition of nitrogen and phosphorus. The particles of dry atmospheric deposition bind on dry surfaces and the particles of wet atmospheric deposition bind on wet surfaces, therefore I set up two different buckets for each station: a dry one and one with 2 l of demineralized water as a wet surface.

To compare the recent data with the data of 2014, I set up one station, the "control station" with a similar construction to the former study. The buckets are not covered with screens. Both depositions are collected weekly and the dry deposition additionally gets collected every day after rainfall to start with a dry surface again.

High contamination with insects made it necessary to cover the other buckets of the monitoring stations with screens. I used plastic screens for agriculture and applied them on top of the bucket in a U shape, so falling raindrops would not bounce off the screens to the surrounding. Both types of deposition of the monitoring stations get collected weekly. One monitoring station is placed at the campus of the University next to the control station and another one is placed closer to lake Atitlán on the roof of a Hotel in Panajachel.

During the project I changed the setup of the pilot station many times. I found valid information about the construction of monitoring stations for atmospheric deposition in other publications. Especially Blake et al. (2009) was helpful to evaluate the station's construction. Nevertheless different problems occurred, like insects and plant material flying into the pilot stations. My biggest uncertainty was to figure out if the results we gained were reasonable or if there were some undetected errors in the setup, because the only data we could compare the results with were the ones from 2014, which have been higher than expected.

Furthermore I organized another pilot on the other side of the lake in Santiago Atitlán for the future, so there will exist more data from different places around the lake to compare (in total the control station and the monitoring station on the Campus, the monitoring station in Panajachel and the one in Santiago Atitlán).

The weekly collected samples of the wet and dry deposition were stored in the laboratory and one part was filtered for the further analysis of ammonium, nitrates and nitrites and orthophosphates. Another part was stored raw for the further analysis of total nitrogen and total phosphorus amounts.

My coworkers of the research team and I analysed the samples of the atmospheric deposition together with the samples of the rivers and the lake. The results showed the concentrations of ammonium, nitrates and nitrites, orthophosphates and total nitrogen and total phosphorus in the collected water samples.

Results

As we got our first comparable results one week before the end of my internship there was not enough time left to really interpret the data and draw conclusions. My part of the project was to establish a pilot station for the collection of water samples that would give data of the atmospherically deposited nutrients and to gain first results.

My first results showed relatively high amounts of atmospherically deposited soluble Nitrogen and less high amounts of deposited soluble Phosphorus.

The future aims of the study are to compare the amounts of deposited nitrogen and phosphorus with the climatic parameters obtained by a meteorological station of the University. Another aim will be to evaluate the construction of the pilot station and compare the results of the different stations around the lake. It will also be important to compare the results with the results of the study from 2014. The final goal is to estimate the importance of atmospheric deposition as a nutrient source for lake Atitlán through the comparison of the amount of nutrient input with the one from the rivers.

I will stay in contact with the research team and I am excited to see more results.

Thank you for offering me this internship and this opportunity to get to know the Guatemalan culture and environment! I learned a lot during my stay, personally and study-related. I am glad I had this experience and I got to know some great people and made some good friends here!