

## ENVIRONMENTAL ENGINEERING IN GUATEMALA

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### Introduction

During the summer of 2001 the author spent 10 weeks in Guatemala as a recipient of a Fulbright-Hays Lectureship Award. The award was given to teach undergraduate and graduate environmental engineering courses at the Universidad del Valle, a private university in Guatemala City. This paper describes the country of Guatemala in general, the Fulbright program, requirements for the undergraduate degree in civil engineering and contents of environmental coursework, and environmental problems and potential remedies in the areas of potable water treatment, wastewater treatment, solid waste management and air pollution control.

### Guatemala

Guatemala is a beautiful country located just south of Mexico, north of El Salvador, and west of Honduras and Belize in Central America. It borders both the Pacific Ocean and the Caribbean Sea. The country is slightly smaller than the state of Tennessee and has a population of approximately 13,000,000 people. The current population growth rate is an estimated 2.6 percent, resulting in a population doubling time of 27 years. Infant mortality rate is near 46/1000 live births and life expectancy at birth is 67 years. Illiteracy hovers around 30%. Gross domestic product per capita is near \$3,700 and the country primarily exports coffee, sugar and bananas. The country has approximately 40 volcanoes, 5 of which are considered active, and Lake Atitlan, one of the most beautiful lakes in the world. The jungle region, located in the northern part of the country, contains the Mayan ruins of Tikal. Many improvements in the country infrastructure make travel much easier than in years past. Foreign investment has increased markedly since 1996, after the end of a 36-year guerilla war, and many luxury hotels, restaurants can now be found in Guatemala City, population 3,000,000, and at popular tourist sites. Services and amenities for the vast amount of the population that live in the countryside are very marginal at best

## Fulbright Scholar Program

Sponsorship of the Fulbright-Hays Scholars Program is through the Bureau of Education and Cultural Affairs of the United States Department of State. Funding is primarily through an annual appropriation from the United States Congress. The administration of the Fulbright Program is made with the assistance of the Council for International Exchange of Scholars, a private non-profit organization, and a number of other private organizations.

Since 1946 the Fulbright Scholar Program has made available grants for the opportunity for college and university faculty, as well as independent scholars and professionals, to conduct research and lecture in countries all around the world. The stated mission of the Program is to increase mutual understanding between the people of the United States and the people of other countries and to assist in the development of friendly, sympathetic, and peaceful relations between the United States and other countries of the world. Each year approximately 850 scholar awards are made for travel to more than 125 countries. Approximately  $\frac{1}{4}$  of the grants are to conduct research and  $\frac{3}{4}$  to lecture or a combined lectureship research activity. The program is open to participants of every academic rank, from instructor to professor emeritus and includes private and public citizens from all walks of life. Grantees come from approximately 500 colleges and universities and private and public agencies in all 50 states each year.

Stipends are typically around \$2500/month with a housing and subsistence allowance of \$1100/month. Adequate funding for travel and a book allowance is included. Additional funding for travel and subsistence for dependents is provided.

## University Civil Engineering Education

The author's assignment was to present undergraduate environmental lectures to senior level students at the Universidad del Valle, a private university in Guatemala City. The Universidad del Valle has an enrolment of approximately 3,000 undergraduate students and offers degrees in a number of different disciplines. Tuition, which is equivalent to approximately \$6000/academic year, can only be afforded by the wealthier. The public university, Universidad de San Carlos, offers essentially a free education to citizens of the country. The civil engineering program involves 5 years of study and includes a thesis or final report. Graduation entitles the student to use the name "Ingeniero" and to practice civil engineering as a professional engineer. The civil engineering program is one with broad course offerings and is patterned after degree requirements offered in the United States. Students are expected to score 525 on the TOEFL examination before beginning the second semester of the sophomore year. U.S. textbooks are often used in classes due to the inadequacies of textbooks translated into

Spanish. Only one basic semester long course is offered in the area of environmental engineering. That course strongly emphasizes the hydraulic aspects of water and wastewater treatment plants and does not cover the overview of all aspects of environmental engineering as found in most U.S. civil programs today. The faculty is largely made up of very senior practicing engineers and engineers who have retired from active practice. Most have advanced engineering degrees from U.S. institutions or institutions of higher learning from other universities in Central and South America. Starting salary for new civil engineering graduates is equivalent to approximately \$12,000/year, the same compensation for most full-time engineering faculty members.

### Environmental Problems and Remedies

Due to the fact that Guatemala is a poor and developing country experiencing a large population growth very little attention is paid to environmental improvements. An increasing environmental awareness has resulted in passage of environmental regulations. Lack of funding, however, has prevented enforcement. Listed below are observations that were made in each sub-discipline of environmental engineering.

**Potable Water Treatment.** Protection of public health is the primary concern of governmental officials. Due to the association of communicable diseases and water supplies, water treatment for potable use receives primary attention. Guatemala City, itself, has 5 conventional water treatment plants. Adequate treatment is provided, however, problems exist in the distribution system due to low hydraulic pressures and lack of maintenance of a sufficient disinfectant residual concentration. The quantity of water provided is a capacity of approximately 40 gallons/capita/day. Wealthier citizens purchase bottled water for drinking and culinary purposes. The quality of water provided in the smaller rural areas is lacking and disease outbreaks of typhoid and occasionally cholera do occur. Population growth is placing great demands on existing facilities.

**Wastewater Treatment.** The City of Guatemala provides no wastewater treatment for domestic and municipal wastewater. Wastewater treatment for some of the industries does exist. At present 2/3 of the untreated sewage flow enters Lake Amatitlan, located 10 miles south of the city. Lake Amatitlan, of volcanic origin, is in a high eutrophic state and for all intents and purposes, is a sewage lagoon for the city. Many former expensive vacation homes located on the lake are now deserted and cholera is known to be present in the area. Continual presence of algal blooms and water hyacinths and evidence of sewage solids has caused increased awareness of environmental deterioration in the country.

Treatment of wastewater is found in some of the smaller villages in the country. Most are small package-type treatment plants that include, grit removal, primary clarification, trickling filters, secondary sedimentation, anaerobic sludge digestion and sludge drying beds. Disinfection of secondary effluent is occasionally provided. Utilization of treated sludge solids for agricultural purposes and digester gas for energy purposes is made.

**Solid Waste Management.** Many improvements are needed in the area of solid waste management in the Guatemala City. Adequate pickup service is provided, but no provision is made for a managed sanitary landfill. At present, all of the solid waste in the city is transported to the disposal site, a ravine. Approximately 1500 scavengers make their living picking through the waste for recyclables and food. The average scavenger can earn \$6.00/day through their efforts. A number of the scavengers live on the site. Smells are strong and rancid. Medical students from the public Universidad de San Carlos periodically attend to the scavengers. The disposal site is nothing more than an open dump with a very high population of buzzards intermixing with all of the scavengers at the site.

**Air Pollution Control.** Guatemala City sits in a valley. The present number of cars and increased factory activity has made for visible air pollution problems. There are no air pollution control laws.

### Summary and Conclusions

The opportunity to travel and live in another country is an excellent and broadening experience from both a personal and professional viewpoint. Many experiences can be brought back to the United States and shared with students. From a personal standpoint, I have been able to expose students in an introductory course in environmental engineering to conditions faced in developing countries and to develop and enrich a Public Health Engineering course that is geared toward low-cost solutions to improve environmental conditions in developing countries.

Joseph H. Sherrard is a Distinguished Professor of Environmental Engineering. He has published over 130 technical articles and is the recipient of the ASCE Walter L. Huber Award and the Wesley W. Horner Award. He has received 3 Fulbright-Hays lectureship awards to assist the country of Ecuador and one award to assist the country of Guatemala.

References: Park, K. "The World Almanac and Book of Facts 2002."