2006-1369: SERVICE LEARNING PROJECT IN BRAZIL: FROM CONCEPT TO REALITY

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Abstract
Environmental engineers are uniquely positioned to make a significant contribution towards improving the human condition in underdeveloped areas. A sabbatical leave provides an excellent opportunity for faculty to apply their knowledge to benefit humanity as well as experience the challenges of engineering in underdeveloped areas of the world. My sabbatical project is to join an effort in Brazil to bring adequate drinking water to an area beset by drought and poverty. The Brazilian Rotary Club, Campinas Alvorada, has an ongoing project to install water tanks and low-tech filters in households in Chapada do Norte. This project presents considerable challenges for the engineer, but the benefits are many: learning first–hand the challenges involved in implementing technology in an under-developed region, enriching the classroom experience through the knowledge gained, and fostering greater understanding of engineering in a global setting. This paper relates the steps necessary to actually make the project happen: applying for sabbatical, procuring funding, arranging travel and living arrangements, getting the necessary travel documents, and performing the preliminary research of low tech treatment alternatives.

I. Description of Project

In May, 2006, I will spend approximately one month in Chapada do Norte, Brazil, assisting in an effort to bring adequate drinking water to an area beset by drought. Due to a complex series of circumstances exacerbated by the destruction of the rainforest, the area has severe water shortage problems during the dry season. The city has a population of 17,000, and is one of the poorest in the state of Minas Gerais. Historically, agriculture has been the main economic activity, but today, many men leave the region to work in sugar cane farms in Sao Paulo. Women remain behind, taking care of the fields and children, but they have inadequate medical and dental care. From May to November, when there is little rain, many people must walk miles to get sufficient water and carry enough for the household and farm animals.

Because the financial resources of the people of Minas Gerais are so limited, cost-effective rainfall catchment systems have been chosen for the proposed solution to the water supply problem. Rainfall catchment systems have enjoyed increasing popularity internationally, especially in similar dry climates with low population densities. Rainwater can provide a relatively safe source of water for a range of purposes including drinking, washing, bathing, and gardening. For example, in South Australia, 37% of the population uses rainwater as a source of drinking water [1].

While in Brazil, I will be working directly with an engineer from the Brazilian Rotary Club of Campinas Alvorada. I will assist the installation of the rainfall catchment systems and the evaluation of the suitability of the systems. The systems consist of catchment and delivery, storage, and filtration units. Of primary concern with this project is the ability to store a sufficient quantity of water to overcome the water deficit during the dry season. In addition, the systems must be inexpensive, easy to maintain and operate, and provide water that is drinking-water quality even after extended storage time.

Harvesting of rainfall generally occurs off an impervious surface, including roofs, ground, and rock. Roof catchments are the most common type and galvanized, corrugate-iron sheets, corrugated plastic, and tiles all make good surfaces. Many grass and mud roofs are not suitable for high-quality collection because they can discolor the water [2]. Care must be taken that no surface containing potential contaminants comes in contact with the water, including lead flashing and toxic paints. Ground catchment surfaces include paved areas such as roads and parking lots and yield considerably more water than roofs, but the potential is much higher for water contamination and thus is rarely used for drinking water.

The water is collected during a rain event and is channeled to a storage reservoir. For roof catchments, the water is delivered through gutters and downpipes. The storage reservoir can be above-ground tanks (used for roof catchment), sub-surface tanks (used for ground catchment), or dammed reservoirs for larger catchment systems. Above-ground tanks will be used for this project. The tanks can be constructed from various materials including metal, wood, plastic, fiberglass, brick, and concrete. The size requirement for a single household varies from $1m^3$ to $40m^3$, depending on usage and the length of the dry season [2].

My role at the site will be to evaluate the current design with a view to suggesting design modification to improve collection and storage efficiency and safety, given rainfall patterns, materials available for construction, etc. Many roof catchment systems are poorly designed, leading to very low efficiency. Having an engineer with technical expertise present during the construction can minimize mistakes. Common mistakes are hydraulic problems and include incorrect sizing of gutters and downpipes, improperly positioning of overflow and outlet pipes, and incomplete usage of the roof area [2].

Another contribution that I can make to the project on-site is in the area of water quality. Rainwater itself can contain contaminants but can also become contaminated during harvesting and storage. Atmospheric pollutants such as sulfur and nitrogen oxides have lead to acid rain (low pH) and are becoming more of a problem in Brazil. Heavy metals and hydrocarbons can also be present in rainwater. When pH is low, leaching of metals such as lead can be a significant problem. In addition, rainwater can pick up harmful bacteria from roof surfaces and in the storage tank. I will test the water for bacterial indicators, pH, and other appropriate measures as appropriate. With the results of testing, measures can be taken to eliminate the source or to treat the water.

II. Incorporation into Coursework

Clearly this project has the potential for realizing significant improvements in the lives of the local population in Chapada do Norte. My technical contribution to the project will help with the overall effectiveness of the systems. But in addition to the benefits to the local population, I will also realize benefits by participation in this project. There are benefits to be realized in the classroom and benefits in my research area.

In the U.S., our methods for drinking and wastewater treatment are among the best in the world and we teach our students these techniques. However, much of the world's population does not have the resources to utilize these technologies. If we want our students to have a global outlook and understanding, we must incorporate into the classroom the complex social, technological, and financial issues faced by engineers doing work in other areas of the world. Unlike many of our current sources, rainfall catchment systems provide a sustainable water supply, and sustainability is an important aspect to engineering design projects. This project will give me first-hand knowledge of the complexities of engineering in an under-developed area. I teach courses in drinking water treatment and water resources which would benefit greatly from this first-hand experience. In addition, a design project for the senior capstone design course could be modeled on this project.

Specifically, this project can be a learning tool to illustrate the determination of sustainability. In Criterion 3 Program Outcomes and Assessment, the ABET Engineering Accreditation Commission identifies skills that engineering graduates should possess. These include the ability to design a system with realistic constraints including sustainability, economic, social, political, and manufacturability [3]. These constraints tend to be hard to incorporate into a design project when the student is primarily focused on the technical aspects. My plan is to use this sabbatical project to fully integrate these design constraints in a design project for a water resources course. Sustainability, in particular, has eluded many engineering senior design projects, but should be a top design constraint in environmental engineering projects. Sustainability can be defined as the ability to meet the present needs while at the same time does not compromise the ability to meet future needs. Evaluating the sustainability of water resource systems requires a multi-disciplinary approach so as to incorporate socio-economic aspects, the use of natural and environmental resources, enhancement and conservation of natural and environmental resources, public health, and the flexibility of the infrastructure to adapt to changing circumstances [4]. With this project, sustainability indices can be defined and compared to those from other types of water supply projects, such as development of a reservoir.

III. Relationship to current research

I chose this project in part because it is directly related to research I am currently engaged in. I am working on a project examining the efficacy of using rainfall catchment systems in the Rhode Island area to alleviate water shortage problems. With this project, methods and materials for rainfall collection, storage, and treatment will be evaluated in order to design a system that would be adequate to meet average household water usage requirements. As in the Brazil project, the system must be cost-effective, easy to install and maintained, and provide a significant benefit to the user. Here too, the systems' components will include a catchment system, storage unit, and filter. Because the need is not as great as in Brazil, the cost-benefit ratio will be very different and therefore, the system design may differ from the one used in Brazil. Other differences include water quality differences and social acceptance issues.

The Brazilian project and the Rhode Island project share a commitment to developing a sustainable strategy for supplying water. While the problem in Rhode Island is not as dire as in Brazil, water supplies are frequently unable to meet the demand of a growing population. In many coastal Rhode Island communities, salt water intrusion has limited the capacity of groundwater to completely provide adequate water supply for household use. In areas that are not served by a public water system, inadequate groundwater supplies can mean that households must curtail water use during the summer months when groundwater levels are at their lowest. While the ancient practice of rainwater collection could alleviate the strain on water supplies during the peak months, few households have the knowledge necessary to choose the best system to meet their needs. The available options are many due to significant advancements in materials and filtration; too many for the average person to evaluate. The product of this research will be a design for a system that will best meet the needs of Rhode Islanders and will be an improvement to the traditional technology.

The overlap between the two projects has real benefits. The experimental and design work conducted in Rhode Island can be directly applied to the current and perhaps future projects in Brazil. Being on site in Brazil and working on the construction of the systems will afford me the opportunity to observe first hand the best techniques.

IV. Planning

Making the project a reality requires a considerable amount of planning, from making contacts in the host country, to procuring funding, making travel arrangements, and learning the language. Planning from afar can be difficult but is easier with help from someone local to the project. From my experience, it is by far easier to join an existing project than to start a new one, because the planning is simplified.

There are many agencies doing similar work in all areas of the world. I first heard about this project from a Rotary club representative from Brazil who visited the Roger Williams campus last spring. Professional clubs and organizations such as the Rotary club, is an excellent source of information and contacts, and should be utilized when looking for a project. Once I contacted the project engineer, it was clear that the project could benefit from my expertise and that I would benefit from the project.

Funding for international projects like this one is available from many organizations including World Bank, United Nations, Oxfam, and professional organizations such as the American Water Works Association's Water For People program. Funding for this project was sought from various sources. The Brazilian Rotary club has procured the funding for construction of the systems from various international agencies. Because the project directly supports the mission of the university to develop an appreciation of global perspectives and a commitment to community service, funding for my travel to Brazil was sought from my institution. Many universities have grants available for international projects, and may have a service-learning program to apply for funds from. Separate funding was sought from the Rhode Island Water Resources Center for the project in Rhode Island, to fund a student working on application of rainfall catchment systems in the local area. There are funds available, and may be awarded especially if the project fits in well with the mission of the funding agency.

In making the travel arrangements, I have benefited greatly from help from the engineer from the Brazilian Rotary club. While in Brazil, I will stay with a host family, arranged by the Rotary engineer. Staying with a host family will be a wonderful cultural immersion experience as well as cut down on costs.

Before I go, there are many things that I must do to prepare. Travel to Brazil requires a current passport and tourist visa, obtainable from the Brazilian consulate. I will also need immunizations against disease. Information about required immunizations can be found online at http://www.cdc.gov/travel/vaccinat.htm. And because my effectiveness is dependent on my ability to communicate, I have been taking intensive Portuguese lessons. I am also working on developing additional contacts in Brazil to foster more opportunity for technical exchange.

V. Conclusion

Service learning projects should be considered for anyone with a sabbatical opportunity. A project such as this affords an exciting opportunity to use engineering skills to better the human condition. But the benefits to the academic are also considerable: providing a rich cultural experience, a learning experience to use in classroom, and professional experience directly related to current research. I am appreciative of the opportunity and look forward to the trip with great excitement.

References

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