WATER FOR LIFE: Sustainable and innovative water solutions for vulnerable communities in China and Colombia

Corporación Universitaria Minuto de Dios, Colombia
Environmental Science and Engineering College in Nankai University, China
Universidad de los Andes, Colombia

Proposed country of implementation: Colombia / China

Contact person: Juan Camilo Silva
Email: jc.silva121@uniandes.edu.co

International Project Team Members:

Diego Andrés Ríos	Colombia
Juan Camilo Silva	Colombia
Miguel Ángel Palacios	Colombia
Hao Zhang	China
Hui Xian	China
Wenchao Li	China
Yuefei Ruan	China
Zhao Wang	China

TABLE OF CONTENTS

1. MANAGEMENT SUMMARY

1.1 Purpose and Description of the Project

As of 2002, one in six people worldwide – 1.1 billion total – had no access to clean water. About 400 million of these are children[1]. In Colombia, approximately 30% (13.6 million people) of the total population lives in rural areas. Out of this 30%, 39.7% does not have access to a water supply system, 60% does not have sanitary units or a sewer system and only 11% have access to safe drinking water[2]. In China water is not only scarce, but it is also seriously contaminated by the toxic and harmful substances that are discharged into rivers and lakes every year. A countrywide survey for rural drinking water and sanitation launched by the Chinese government from August, 2006 to November, 2007 showed that 44.36% of rural drinking water does not meet basic health and safety standards.

The purpose of the project is to improve the availability and quality of drinking water in Colombian and Chinese rural communities, through the joint design and implementation of water filtering technologies that respond to each country's unique water conditions, to reduce the proportion of the population without sustainable access to safe drinking water by providing the tools and technical know-how required to build, use and maintain water filters allowing them to carry out an active role in their community's improvement and growth which will hopefully result in a long term sustainable project. The team believes that this project will help reduce child mortality in rural areas where people don't have access to safe drinking water, reduce water borne illnesses and improve the overall quality of life.

The project plans to achieve this purpose through the implementation of slow sand filters in the Torres rural community located in Cundinamarca, Colombia and through the joint design and implementation of a water filter capable of removing the chemical compounds and bacteria found Wuqing's water, a district located in Tianjin, China. The slow sand filters have been specifically designed based on the presence of dangerous micro organisms in otherwise clean and unpolluted water, providing an affordable and simple way to improve the quality, flavor and color of the water at a relatively low cost. In Wuqing, people can't drink water directly due to excessive fluoride, salt and high levels of arsenic, ferromanganese and microbial indicators which exceed the standards. Because of this, Wuqing's water must be treated by reverse osmosis filters which have a very high cost making it difficult to expand their use.

The project proposal whishes to address each country's main problem while promoting mutual help in each country's area of expertise. As such the team has developed a cooperation strategy which will promote an active technological exchange, in which the Colombian group will focus on the bacteriological problem and help the Chinese group adopt and modify these technologies while working together to come up with solutions to address the presence of harmful chemical compounds in China and Colombia's water. This will allow both countries to tackle a wider variety of problems which will hopefully benefit a larger number of people.

---

[1] *Taken from: http://www.unicef.org/mdg/environment.html. 25/04/09*

[2] *La infancia, la adolescencia y el medio ambiente sano en los planes de desarrollo departamental y municipal: una mirada a la planeación local a favor de los derechos de los niños, las niñas y los adolescentes colombianos*. UNICEF, procuraduría general de la nación, marzo de 2005. Capítulo 3 página 77

With this in mind, the aims of our project are: (i) to apply engineering knowledge and know-how in the design and installation of water filtering technologies that respond to the economical and social characteristics of Chinese and Colombian rural communities; (ii) to develop ecologically sustainable and culturally appropriate water solutions; (iii) to establish a long term relationship between the two countries in order to develop filtering technologies and implementation processes that respond to each country's needs and; (iv) to reduce deaths and illnesses related to the consumption of unsafe water in these communities.

1.2. Organization of the Project Team and Progress of Work

The International Project Team is composed of engineering students and teachers from Colombia and China working together to provide safe water to rural communities in a sustainable fashion. The project is supported by Los Andes University, Corporación Universitaria Minuto de Dios and the Environmental Science and Engineering College in Nankai University.

The team meets once a week to coordinate the project, share information and discuss recent progress. Furthermore, the team is divided into two subgroups. These subgroups are:

- Technical team: This team is composed mainly of civil, environmental and chemical engineering students. Their main task is the research of water filtering technologies which might be appropriate for the different communities as well as carrying out the tests required to prove their effectiveness.
- Organizational team: This team is composed mainly of industrial engineering students. Its main task is to aid the communities in the technology transferring process so they can adopt it as their own which is crucial for the long term sustainability and expansion of the project.

In November 2008 the two teams began to communicate through a Colombian exchange student at Nankai University to evaluate the possibility of developing a joint proposal for the Mondialogo Engineering Award, which finally lead to the creation of the International Project Team by late December. Weekly meetings were scheduled during late January to share technical and organizational know-how and discuss the implementation of the project in China and its expansion in Colombia. During March the team began discussing the elaboration of the project proposal which included the definition of tasks, deadlines as well as communication and feedback strategies. During February, the Colombian group continued to monitor the functioning of some filters installed during December 2008, making necessary adjustments. Since March 2009, the group has been searching for new communities with water problems, evaluating the expansion of the project in the current community and working on alternative filter designs which might respond better to different contexts. The Chinese group has taken water samples from rural communities in order to evaluate the possibility of implementing the same slow sand filter used in Colombia, determine necessary modifications and propose alternative filters which might be better suited to China's particular water conditions.

2. CONCEPT AND PROOF OF INTERNATIONAL COOPERATION AND INTERCULTURAL DIALOGUE

Colombia:

The partnership was initiated by the Colombian group thanks to the presence of an industrial engineering student from Los Andes University in Nankai who had been previously involved with the water filter project in Colombia. The team has grown together throughout the entire process learning about the importance of teamwork and cooperation in order to achieve bigger goals.

Cultural diversity has represented a challenge and an opportunity for both groups. It has made communication harder due to the language barrier and different ways of thinking, which have made mutual understanding harder to achieve, but, the extra effort required to communicate has allowed a richer exchange of ideas, providing unique insights into the other group's culture and pushing each group to consider alternative designs and ways of implementing the project. International cooperation has allowed both groups to explore different possibilities regarding the design and implementation of the project due to the differences between each country's rural communities and each country's available water filtering technologies. This project has been an outstanding chance for the team to apply the engineering knowledge acquired throughout our careers to real problems and to learn and think about alternative approaches thanks to the cultural diversity.

China:

Holding the same purpose to solve the water problem in rural areas, 13 students from the Environmental Science and Engineering College in Nankai University formed a team, together with the group in Columbia, and began working on this project. We have improved our communication skills and spirit of teamwork, not only among the Chinese group, but also between ourselves and the foreign students.

Throughout the process, we have maintained the unity of the team with a clear division of work. We keep close ties with the Colombian team and contact them every week by Skype and exchange e-mail communications regularly. Despite the great difference between the two countries' time and culture, we always try hard to learn each other's culture and customs, to understand each other and overcome difficulties. Through the international cooperation and communication, we have learned a lot about the methods used in other countries to solve water problems, which promotes us to think more and come up with good new ideas, improving each other's device through the exchange of technology of this will allow us to cooperate together in harmony to promote the smooth progress of the project.

3. EVIDENCE OF COOPERATION

3.1. Institutions involved

The institutions involved in Colombia are Los Andes University and the Corporación Universitaria Minuto de Dios, and in China, the Environmental Science and Engineering College in Nankai University. These universities have supported the project with teacher advice, the use of laboratories, experimental guidance and some funds to cover expenses.

3.2. Outline of discussion and development of idea and project proposal

The original idea emerged on August, 2007 in Colombia, when the Community Innovation Project (CIP) team was formed. During the second semester of 2007, the team focused on finding an appropriate location and the appropriate technology. The results: to work in the Torres community and to implement slow sand water filters. The filter was designed during the first half of 2008 and the project was implemented over the second half of the year

During November 2008, thanks to the presence of an exchange student at Nankai University, the Chinese group joined the team. They saw this project as a great opportunity to contribute to one of the biggest environmental problems in China. The initial idea was to use the Colombian filter design in China, but early research and water sample tests performed by the Chinese group determined that the filter needed modifications due to the presence of dangerous chemical substances in water, in addition to the microbiological problems similar to the ones found in Colombia. As a result of the cooperation and the experience of the Colombian group, the following results were produced: a plan to expand the project in new areas in Colombia, the plan to implement the project in Tianjin, with a location already defined and an appropriate filter design, and a cooperation strategy to research new and better technological solutions and a sustainable model to implement them.

3.3. Prototype development and associated activities

The group in Colombia is currently finishing their first successful implementation experience in Torres. The joint work between the students, the teachers and four volunteer families, has allowed the project to grow and expand with 16 families currently being beneficiaries and 40 more on the way. The groups is also evaluating the implementation of the project in Lerida, Tolima in an educational institution with over 1.000 students and staff members that don't have regular access to safe water. The Chinese group is currently carrying out further water samples and analysis to determine the most suitable filter to address Wuqing's water problems. The team has also scheduled meetings between the teachers and students from both countries in order to discuss alternative filter designs which might be more effective and cheap.

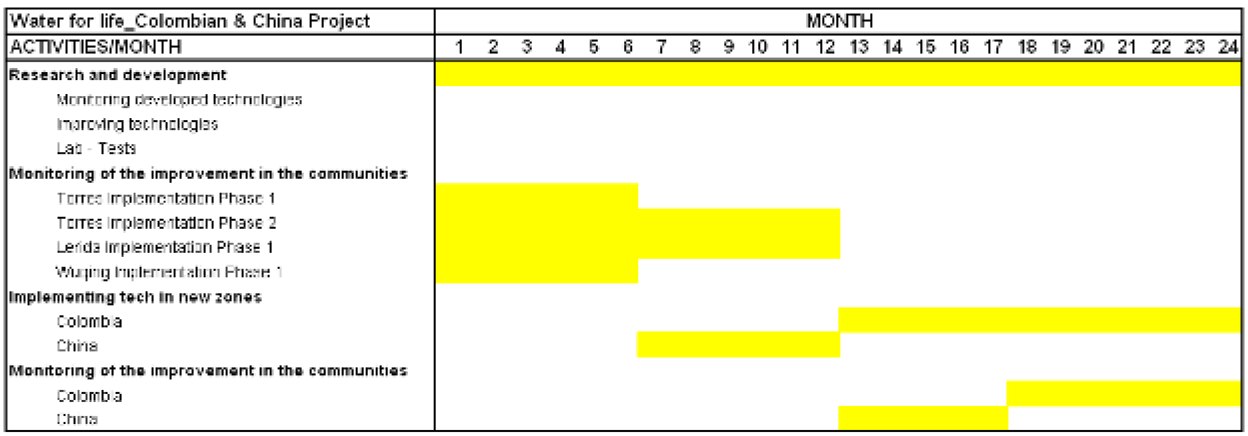
The Colombian group has designed and implemented a slow sand filter which is currently being used in the Torres district (see appendix) with excellent results. This filter removes water pathogens through the use of a superficial biological layer which develops on the upper sand layer of the filter after 2 to 3 weeks. The group in Colombia is also researching and evaluating alternative filter designs which might be cheaper and better suited to different water problems. The Chinese group has designed a prototype (see appendix) based on the Colombian filter with the necessary modifications based on the tests results from Wuqing's water samples. Both groups are currently hard at work to design a filter which effectively removes the chemical compounds found in Tianjin's water.

3.4. Likely cost of implementing the proposed project

The estimated cost of the project is 7.243 USD in Colombia and 2.940 USD in China, over a two year period, for a grand total of 10.183 USD. This cost includes transportation of equipment, materials and staff to the communities, purchase of the parts required to assemble the filters as well as research and development of alternative filtering technologies and the necessary water sample recollection and analysis.

3.5. Time frame for implementing the proposed project

The project proposal will be carried out over the course of two years (from April, 2009 to April, 2011, totaling 24 months), in Colombia and China. The project will continue during 2012 as specified in the cooperation strategy (see appendix) but the associated activities are not included in the following schedule. At the end of his period the project will have benefited an estimate of 5.000 people in Colombia based on current developments and growth rate. The estimated number of beneficiaries in China is still under consideration.



The research and development activities refer to the design, research and evaluation of different filtering technologies to improve the current devices by making them more effective, cheaper to build and easier to maintain and install. By monitoring the improvement in the communities the group refers to the monitoring of the water obtained from the filters and the general health conditions of the population to see if the project is having the expected effect. The implementation of technology in new zones refers to the team's plans to expand the project in existing or entirely new rural communities. Further detail can be found in the appendix.

3.6. Appendix

3.6.1. Outline of project cooperation

Cooperation strategy:

The team has developed a project cooperation strategy for the following three years. Details can be found in the Cooperation Calendar. The following strategy has been defined based on the characteristics of the two countries:

Technical aspects:

During the first year, Colombia just will work with communities that have bacteriological problems, and research will be centered on this topic. In the case of China, the technology now available from Colombia will be used to face the bacteriological problem, and research will be focused on ways to eliminate the chemical compounds found in the water samples from Wuqing. The expected result of this process is the design and construction of a water filter that addresses both problems as effectively and efficiently as possible.

During the second year, China and Colombia will be able to implement the project with communities with both bacteriological and chemical problem, always working in a feedback process of knowledge in the national and international levels.

A committee will be in charge of the knowledge information exchange, so that information is always available to all members of the project team, which is a requirement for the successful development of water filtering technologies capable of handling bacteriological and chemical problems effectively.

Organizational structure:

In order to achieve this strategy, sustainability and technical comities will be formed. In each committee, there will be two students from each country. Each national team is autonomous to elect their representatives, but they must assure that they will remain on the committee during a six month period, with the possibility of reelection. These comities will meet at least once a month, before the meeting of the General Committee.

The General Committee will meet on the last weekend of each month. Here will take part two representatives from the two comities (one from each country), and one teacher from each country as advisors. The teachers can be different each time, since they don't have a direct responsibility with the General Committee and they carry out a mere counseling position. The tasks of this Committee are:

- Check progress towards the accomplishments of the project.
- Evaluate and give feedback on all implementation processes, based on the project indicators presented below.
- Manage the financial recourses that are obtained from International cooperation, and supervise their use.

Funds obtained from third parties will be divided equally among both countries, although exceptions can be made under special circumstances such as new implementation opportunities. The student groups will be able to manage their funds autonomously but they must inform the General Committee on how this money is being spent.

3.6.2. Project indicators

The team considers that it is necessary to develop and use indicators to evaluate the project's effectiveness and progress. With this in mind both groups worked on the following set of indicators hoping that they will help us throughout the entire process.

1. Percentage of the population with access to safe water:

$$PPADW = \frac{NHDW}{NH} * 100$$

Where, NHDW is the number of houses with access to drinkable water (regardless of the water source) and NH is the total number of houses.

2. Percentage of reduction of the presence of the compound XYZ in the water: This indicator will be used as the technical criteria to determine the best filter design in the community. The compound XYZ can be any of the chemical substances or bacteria found in the water samples.

$$P_{XYZ} = \frac{XYZ_t - XYZ_0}{XYZ_0} * 100$$

Where XYZ is the measure of this compound at the time t and at the initial time 0. The XYZ compound will be determined based on the community's most serious problems.

3. Percentage of filter's use: This indicator will help to illustrate if the solution is sustainable and culturally appropriate:

$$PFU = \frac{FU_t - FU_0}{FU_0} * 100$$

Where FU_0 is the number of filters installed, and FU_t the number of filters used at a specific time.

4. % of people with water borne diseases: This indicator will help measure the effectiveness of the water filtering technology and how well the community adopts it. It can be applied in each home or in the community:

$$PD = \frac{X}{NP} * 100$$

Where X is the number of people with some type of water related illness, and NP is the number of people in the household or the community.

3.6.3. Sustainability model

The current work, research and implementation have been developed with funds provided by the universities of the team members. In order for the project to be sustainable in the long term the team has discussed the following alternatives to multiply the effects of the initial investments carried out in the communities:

1. **Entrepreneur model:** The objective is that some members of the community establish an economic unit to produce and commercialize the filters in other communities that have a similar need. To achieve this, in addition to the technology transfer, the team will also provide advice regarding the creation of the enterprise.

   The main advantages of this alternative are the multiplier effect over other vulnerable communities and the contribution to the economic and social development of the area. The main challenge is the financial viability of the project.

2. **Community filter:** Instead of acting on each house, the objective here is to act over the water supply systems that already exist in the communities. In addition to the multiplier effect, this alternative provides a chance to work with private companies and government entities. The two main challenges are the adaptation of the technology and the political conflicts over these water supply systems.

3. **International cooperation to reduce costs:** Since production costs are relative lower in China, the importation of materials (or even filters) from China open the possibility to use the resources in a more efficient way. This can also contribute to reduce the costs in China. This strategy is complementary with the previous two.

3.6.4. Slow sand filter design parameters

The slow sand filter implemented in Torres is a simple system of crude water treatment, which removes water pathogens that promote diarrheal diseases and health problems. When the filter begins its operation, the water flows through the filter bed. The filter bed works with a superficial biological layer which requires 2 to 3 weeks to efficiently remove harmful microorganisms and reduce turbidity. During this period, an accumulation of organic matter will take place in the filter bed, which will be decomposed by the microorganisms, acting like an indirect disinfection agent. The quality of the exit water can be described in terms of the removal percentage, which is more than 95% of microorganisms (total Coliforms and E. Coli). Total disinfection is possible by adding a few drops of chlorine to the treated water.

The filter bed is formed by a fine layer and a rough layer of sand, which have a specific diameter of 0,3 - 0,45 mm and 0.7 - 1,2 mm respectively. The filter bed is supported by a layer of gravel of 1 - 2cm of diameter. The layers of fine sand, rough sand and gravel have a thickness of 40cm, 15cm and 15cm respectively. This material is disposed in a 40 liter polythene drum. The filter can produce approximately 70 liters of water per hour, which is sufficient to satisfy the needs of a family of 5 people. It is important to wash the material before placing it inside the drum, in order to eliminate impurities and microorganisms that can contaminate the filtering process.

The drainage network is located in the gravel layer that supports the system. This PVC drainage network is shaped like a fish skeleton (see figure 1) and is located in the base of the barrel to gather the treated water and transport it to the distribution or consumption point. The water entrance pipe allows the filter to be connected to the source, while facilitating the disconnection from the source through a valve in case the filter needs to be transported or repaired.

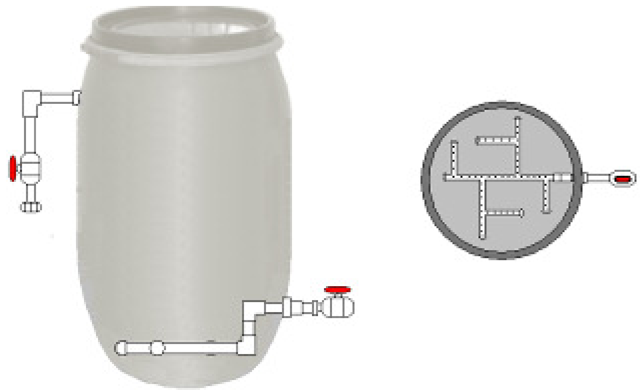


Figure 1. Filter bed structure and Drainage Network

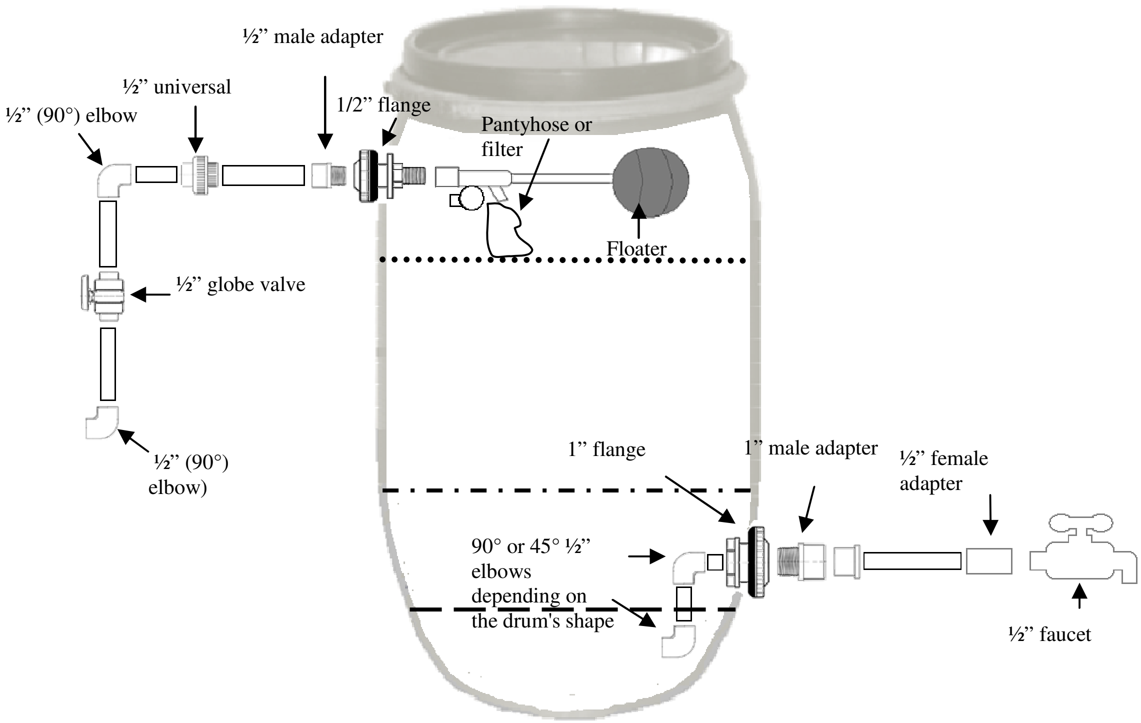
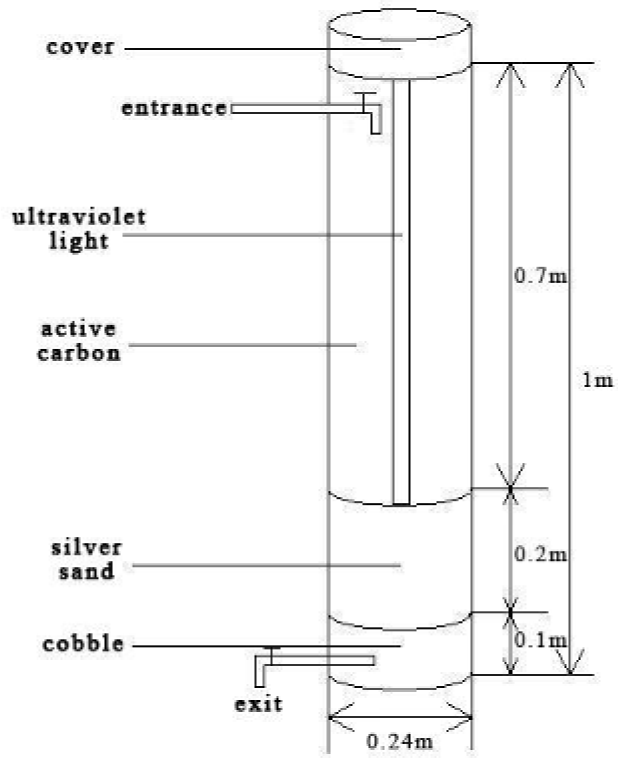


Figure 2. Filter design

The maintenance requires the removal of the upper 5 cm of the fine sand layer every 6 months, and its replacement with sand of the same characteristics. That’s because after the average period of operation, the biological layer has grown too thick and prevents the normal flow of water. After the replacement of the sand layer, it is necessary to wait between 1 and days for the biological layer to recover. During this period it is not recommended to use the water for human consumption.

3.6.5. Chinese filter design parameters



The Chinese group has developed a filter design based on the Colombian prototype and several tests performed on the water of the selected Tianjin communities. The Chinese filter proposes the use of ultraviolet light to exterminate bacteria, active carbon to eliminate As, Mn and Hg and also to remove smell and color. Meanwhile, silver sand and cobble are used to eliminate organic and inorganic matter in the water. Each layer of the previously mentioned materials has the thickness specified in the diagram.

The maintenance requires a removal of part of the active carbon every 6 months. The sand should be replaced three times a year, and the cobble should be washed at the same time.

3.6.6. Project budget

Colombia

The following budget shows the estimated costs of implementing the project in Lerida, and expanding it in the Torres district until the second semester of 2010. Costs are in US dollars.

	2009-2		**2010-1**		**2010-2**	
Expenses:	**Torres**	**Lerida**	**Torres**	**Lerida**	**Torres**	**Lerida**
Transportation	$ 261	$ 261	$ 130	$ 130	$ 87	$ 87
Experiments	$ 404	$ 796	$ 391	$ 783	$ 261	$ 522
Materials	$ 522	$ 1.043				
Maintenance costs			$ 130	$ 261	$ 130	$ 261
Others	$ 130	$ 130	$ 130	$ 130	$ 130	$ 130
Subtotal	**$ 1.317**	**$ 2.230**	**$ 783**	**$ 1.304**	**$ 609**	**$ 1.000**
Total	$ 7.243					

China

The following budget shows the estimated costs of implementing the project in Wuqing until 2010. Costs are in US dollars.

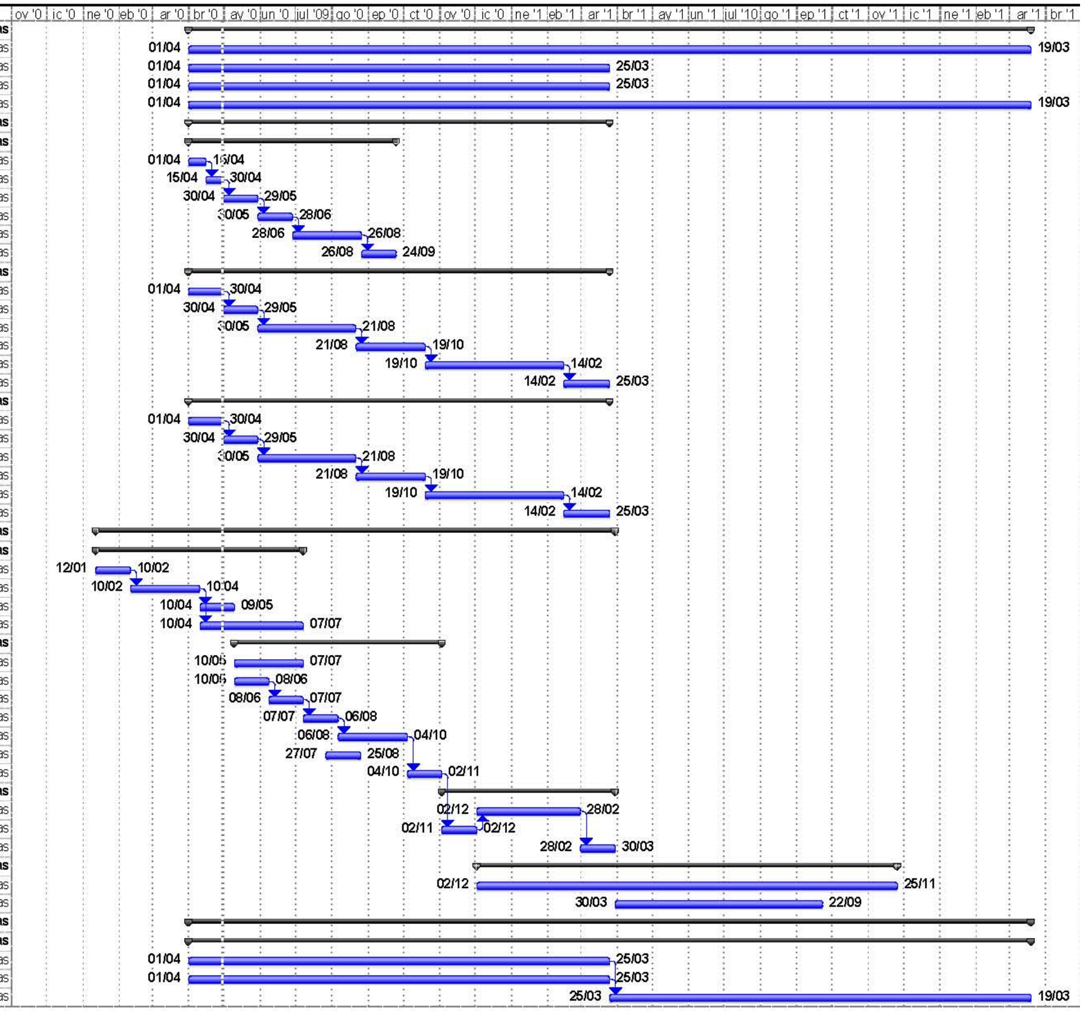
Location:	Wuqing District			
Expenses:	**2009/04**	**2009/09**	**2009/11**	**2010/03**
Transportation	$ 30	$ 150	$ 100	$ 100
Experiments	$ 50	$ 150	$ 200	$ 100
Materials	$ 100	$ 150	$ 500	$ 600
Maintenance costs	$ 20	$ 20	$ 200	$ 300
Others	$ 40	$ 30	$ 50	$ 50
Subtotal	**$ 240**	**$ 500**	**$ 1.050**	**$ 1.150**
Total	$ 2.940			

The following list explains briefly each expense:

- Transportation: This cost includes the cost of transporting the materials and the staff.
- Experiments: Cost of analyzing water samples and performing necessary tests on the filters.
- Materials: Cost of the materials required to build the filters.
- Maintenance costs: Cost of performing periodic maintenance on the filters.
- Others: Unexpected costs mostly associated to unscheduled visits to the communities, purchase of additional materials and such.

3.6.7. Project Calendar

Id	Nombre de tarea	Duración
1	**Research and development**	**730 días**
2	Monitoring technologies vereda Torres	730 días
3	Improving technologies	365 días
4	Lab-test	365 días
5	Monitoring of the improvement in the communities	730 días
6	**Colombia - Project Design and Implementation**	**365 días**
7	**TORRES IMPLEMENTATION PHASE 1**	**180 días**
8	First visit and water sample recolection	15 días
9	Appropriate Technology Design	15 días
10	Monitoring Laboratory	30 días
11	Installation	30 días
12	Laboratoy tests (affluent-effluent and hydraulics)	60 días
13	Evaluation, report and feedback	30 días
14	**TORRES IMPLEMENTATION PHASE 2**	**365 días**
15	First visit and water sample recolection	30 días
16	Appropriate Technology Design	30 días
17	Monitoring Laboratory	85 días
18	Installation	60 días
19	Laboratoy tests (affluent-effluent and hydraulics)	120 días
20	Evaluation, report and feedback	40 días
21	**LERIDA IMPLEMENTATION PHASE 1**	**365 días**
22	First visit and water sample recolection	30 días
23	Appropriate Technology Design	30 días
24	Laboratoy tests (affluent-effluent and hydraulics)	85 días
25	Installation	60 días
26	Laboratoy tests (affluent-effluent and hydraulics)	120 días
27	Evaluation, report and feedback	40 días
28	**China - Project Design and Implementation**	**450 días**
29	**PREPARATION**	**180 días**
30	Schedule progamming	30 días
31	Research and understand water problems in China	60 días
32	Initial filter design	30 días
33	Teacher advise	90 días
34	**WUQING IMPLEMENTATION PHASE 1**	**180 días**
35	Find an appropiate community volunteer homes	60 días
36	Improve current filter design	30 días
37	Buy the materials	30 días
38	Laboratory tests (affluen-effluent and hydraulics)	30 días
39	Laboratory tests	60 días
40	Prototype evaluation	30 días
41	Pilot test with volunteer families	30 días
42	**FINAL SUMMARIZATION**	**150 días**
43	Popularize the device in that area	90 días
44	Design a device which can be used widely	30 días
45	Complete the final report	30 días
46	**Implementing tech in new zones**	**365 días**
47	Colombia	365 días
48	China	180 días
49	**COOPERATION CALENDAR**	**730 días**
50	**Technical section**	**730 días**
51	Microbiological investigations in Colombia	365 días
52	Chemical investigations in China	365 días
53	Multi-purpose filter design phase	365 días



Proyecto: cronograma colombia
Fecha: mié 29/04/09

Tarea	Resumen	Progreso resumido	Resumen del proyecto
Progreso	Tarea resumida	División	Agrupar por síntesis
Hito	Hito resumido	Tareas externas	Fecha límite

Página 1

3.6.8. Cost of materials

The following list includes the costs of the materials required to assemble the slow sand filters currently used in Torres, Colombia. The number of items might change depending on the location of the filter and the water source.

ITEM	QUANTITY	UNIT VALUE (USD)	TOTAL VALUE (USD)
40 gallon plastic drum	1	$ 15,22	$ 15,22
1/2" PVC pipe	1	$ 0,58	$ 0,58
1/2" PVC T junction	6	$ 0,17	$ 1,04
1/2" PVC plugs	7	$ 0,13	$ 0,91
Plastic universal joint	1	$ 1,74	$ 1,74
Floating valve for drum	1	$ 6,96	$ 6,96
1/2" plastic globe valve	1	$ 0,87	$ 0,87
1/2" PVC elbows	2	$ 0,17	$ 0,35
1/2" flanges	2	$ 2,39	$ 4,78
chromed faucet	1	$ 2,17	$ 2,17
1/2" female adapter	1	$ 0,13	$ 0,13
1/2" male adapter	1	$ 0,13	$ 0,13
PVC solvent (cement)	1	$ 3,04	$ 3,04
cleaner (acetone)	1	$ 1,30	$ 1,30
fine sand (40-80)	3	$ 5,43	$ 16,30
rough sand (10-12)	1	$ 5,43	$ 5,43
gravel (1/2"-1/4")	1	$ 5,43	$ 5,43
TOTAL			**$ 66,41**

3.6.9. Test results

3.6.9.1. Water characterization tests

Type of sample: Water sample
Sample site:
- Colombia: Torres district
- China: Wuqing district

PARAMETER	UNITS	DATE	RESULTS	
			COLOMBIA	CHINA
ALKALINITY	mg/L-$CaCO_3$	07/11/2007	13,2	N/A
COLOR	U.Pt/Co	07/11/2007	10	N/A
EC	microm HOS / cm-18,7°C	07/11/2007	62,7	N/A
TOTAL HARDNESS	mg/L-$CaCO_3$	07/11/2007-12/04/2009	17,7	46
pH	pH	07/11/2007-12/04/2009	5,90	8,32
IRON	mg/L-Fe	07/11/2007	0,04	N/A
TURBIDITY	N.T.U.	07/11/2007-12/04/2009	0,644	0,574
COD	mg/L	12/04/2009	N/A	2,66
ARSENIC (As)	mg/L	12/04/2009	N/A	1,355
CADMIO (Cd)	mg/L	12/04/2009	N/A	0,0004
CHROMIUM (Cr)	mg/L	12/04/2009	N/A	none
LEAD (Pb)	mg/L	12/04/2009	N/A	none
MERCURY (Hg)	mg/L	12/04/2009	N/A	0,0018
SELENIUM (Se)	mg/L	12/04/2009	N/A	none
ALUMINIUM (Al)	mg/L	12/04/2009	N/A	none
IRON (Fe)	mg/L	12/04/2009	N/A	0,0602
MANGANESE (Mn)	mg/L	12/04/2009	N/A	0,2997
COPPER (Cu)	mg/L	12/04/2009	N/A	0,0033
ZINC (Zn)	mg/L	12/04/2009	N/A	0,0036
F	mg/L	12/04/2009	N/A	1
SO4-	mg/L	12/04/2009	N/A	156,26
NO3-	mg/L	12/04/2009	N/A	none
N(NH4+)	mg/L	12/04/2009	N/A	0,5
NO2-	mg/L	12/04/2009	N/A	none
Cl-	mg/L	12/04/2009	N/A	190,9
chroma	mg/L	12/04/2009	N/A	0,623

3.6.9.2. Slow sand filter affluent-effluent tests

Type of sample: Water sample
Sample site: Colombia: Torres

	SAMPLE ID:		AFFLUENT	EFFLUENT House 1	EFFLUENT House 2	EFFLUENT House 3	EFFLUENT House 4	
DATE	PARAMETER	UNITS	RESULTS					METHOD
01/08/2008	Total Coliforms	UFC/100mL	Countless	N/A	0	N/A	N/A	SM 9221 B
21/09/2008		UFC/100mL	8400	N/A	28	N/A	N/A	SM 9222 B
09/10/2008		UFC/100mL	10300	61	57	55	Countless	SM 9222 B
01/08/2008	E coli	UFC/100mL	Countless	N/A	2	N/A	N/A	SM 9221 E
22/09/2008		UFC/100mL	0	N/A	0	N/A	N/A	SM 9222 B
09/10/2008		UFC/100mL	0	0	0	1	10	SM 9222 B

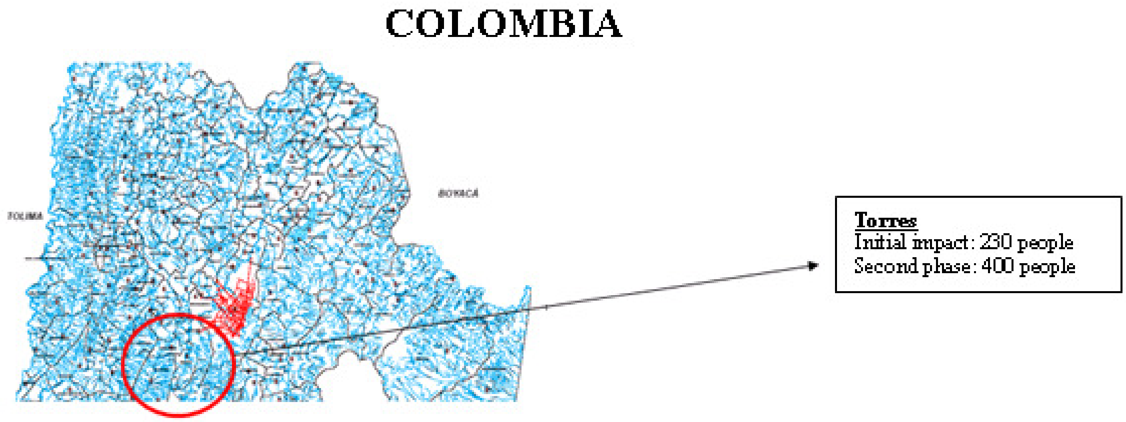
3.6.9.2. Slow sand filter hydraulics' tests

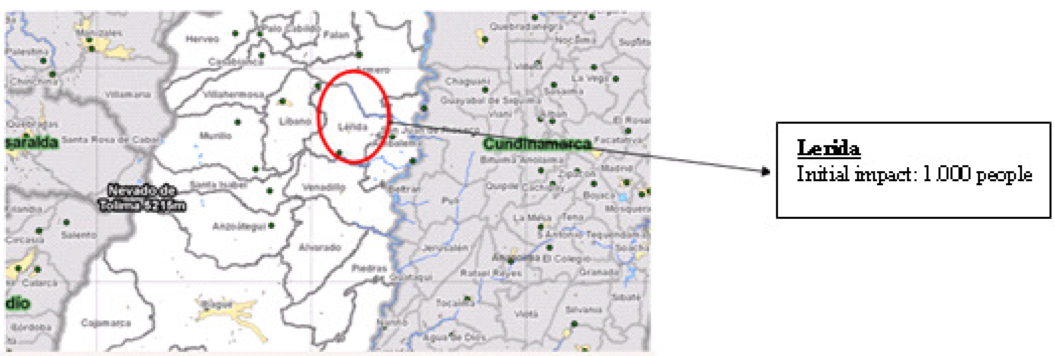
Sample site: Colombia

	FLOW MEASUREMENT						MISSED		
DATE	T1	T2	T3	TP	FLOW Lts/min	FLOW Lts/day	hi	hf	hd
16/04/2008	1,51	1,5	1,53	1,51	3,3	4757,71	63,8	20,8	43
23/04/2008	1,54	1,52	1,56	1,54	3,25	4675,32	63,2	20,6	42,6
30/04/2008	1,51	2,02	1,54	1,69	2,96	4260,36	63,01	20,8	42,21
07/05/2008	2,00	2,04	2,01	2,02	2,48	3570,25	63,5	20,8	42,7

3.6.10. Proposed communities of implementation

3.6.10.1. Colombia





The project has already begun to help 230 people in Torres with 400 more planned for the second phase. Currently the team is planning to expand our proposal to benefit an additional 1.000 people in Lerida. The following pictures show some of the Colombian group members transporting the material required to assemble the filters in Torres. The geography of the community and the weight of some of the materials forced the group to rely on mules in order to facilitate the process.

The pictures shown below show two of the four volunteer homes in Torres, where the water filters were initially installed. As can be seen in these pictures, Torres is located on mountainous terrain which complicates access to the area.

3.6.10.2. China

These pictures were taken during the water quality tests that were realized in order to determine if the place had the conditions for implementing the project. The water samples were taken on one government building and then taken to Nankai laboratories. The pictures might not show it, but the water samples obtained from the homes do not meet basic health standards.

4. CONCLUSION

Each day, water fit for human consumption is becoming scarcer due to pollution, deforestation and climate change among other reasons. Unclean water spreads diseases such as cholera and diarrhea, which kill five million people per year. Unsafe water poses a serious threat to people's health, spreading diseases that could be prevented through financially and ecologically sustainable means. As concerned college students, we wish to make a difference by improving the availability and quality of drinking water in marginal rural communities through our work and effort.

The development of the project proposal was an arduous process that has required a great deal of cooperation and effort from both groups and from the team as a whole. Communication was difficult at times, especially during the first meetings but it gradually improved as team members got to know each other better and a common language was developed. The time difference made it harder to schedule meetings that were convenient for the entire group, so it was decided to meet once a week, on Saturdays or Sundays, usually at 8 A.M Colombian time. To try and make significant progress each week, team members were assigned specific tasks which encouraged everyone to take an active role in the project and made it easier to keep track of progress, while leading to a great spirit of team work.

International cooperation played a fundamental role in the development of the project proposal. It helped broaden the initial scope of the project, making team members consider alternative filtering technologies and communities with problems other than the presence of harmful microorganisms. The work and communication between groups from different countries allowed the team to write a better proposal, which reflected different points of view, methodologies and ideas. We believe that the project has promoted inter-school exchanges, broadening the field of academic thinking and stimulating our passion for innovation. Cooperation has allowed both teams to come up with alternative filters. The Chinese group designed a device based on the structure of the device currently used by the Colombian group, making the necessary modifications according to their specific water conditions. During the course of the development process the students from both countries have grown close, developing a strong friendship which will help the future growth and development of the project. The project has also provided the foundations for current and future academic and cultural exchange between both universities.

Currently the team is working to design a water filter more suitable to China's specific water problems such as the presence of toxic substances, minerals and metals. Both groups plan to explore different alternatives, allowing each one to improve their respective device by making it more cost efficient, effective and easy to implement. In the end, wish to provide clean and safe water to those who do not have access to it, hoping that many people will benefit from our project. This is the significance of our project!

One of the special characteristics of this project is the fact that it has been developed between student teams from developing countries. Even though our countries and universities lack the financial and technological resources available in more developed countries, the team has managed to design, implement and plan solutions for serious problems which affect millions of people in our respective countries and many more worldwide. The team has not seen this situation as an obstacle, but rather as an advantage due to the fact that there is a better understanding of the problem and the communities affected by it.

5. SIGNATURES

Environmental Science and Engineering College in Nankai University
Tianjin, China

Teacher:

Signature: 李维尊 E-mail: liweizun@nankai.edu.cn Phone: 13512212566

Students:

Signature	E-mail	Phone
鲜卉	xianhuijy@163.com	15802288164
沈舒尹	sakuralisai@yahoo.com.cn	13821347778
俞风	Lanny-King@yahoo.cn	13752215134
陈静	810759256@qq.com	13902179763
张豪	807468242@qq.com	13652110869
阮悦飞	ruanyuefei0831@126.com	13902047435
文婕	dxhaw@126.com	13821137592
邵丹	shaodan_880322@126.com	15822711600
王钊	wzhinchina@163.com	15802286328
李文超	cckdl@163.com	15022001165
任广元	rgy@mail.nankai.edu.cn ~~[illegible]~~	13820393204

THE CORPORACIÓN UNIVERSITARIA MINUTO DE DIOS – UNIMINUTO
BOGOTÁ, COLOMBIA

The following faculty of engineering members, certify that the student DIEGO ANDRES GRISALES RIOS is registered at their respective institutions in the civil engineer program and that the proposal is the student's own work:

Teacher: JUAN FERNANDO PACHECO DUARTE

Signature: ______________________

E-mail: jpacheco@uniminuto.edu

Phone: 2 916520

Teacher: CAMILO ALBERTO TORRES PARRA

Signature: ______________________

E-mail: ctorres@uniminuto.edu

Phone: 2 916520

Programa de Ingeniería Civil
UNIMINUTO

Universidad de los Andes
Facultad de Ingeniería

Bogotá, April 29th 2009

Dear Sirs
MONDIALOGO
Unesco

The following faculty members certify that the student JUAN CAMILO SILVA and MIGUEL ANGEL GONZALEZ are registered at the ENGINEERING PROGRAMME in the UNIVERSITY OF LOS ANDES.

Professors and students from the departments of Civil Engineering, Environmental Engineering, Industrial Engineering and Chemical Engineering of the University *Corporación Universitaria Minuto de Dios* (http://portal.uniminuto.edu) and the University *Universidad de los Andes* (www.uniandes.edu.co) have been a consolidated team since two years ago. This team has worked to design and to implement technology for vulnerable communities in Colombia with solutions that are technically innovative, economically, socially and ecologically sustainable and culturally appropriate. Recently we have joined efforts with a group of engineering students from Nankai University (http://env.nankai.edu.cn/en/) in China, with whom we have been sharing technical information in order to improve the water filter technology and implement it in Colombia and China.

Andrea P. Maldonado R.

Teacher: Andrea Maldonado, Msc Environmental Engineering
Civil and Environmental Engineering Coordinator Programme
And-mald@uniandes.edu.co
+571-3394949 ext 2859

Maria Catalina Ram

Teacher. Maria Catalina Ramirez, PhD
Assistant Professor Industrial Engineering Department
mariaram@uniandes.edu.co
+571-3394949 ext 2880

Decanatura de Ingeniería
Edificio Mario Laserna | Carrera 1 Este No.19 A – 40 Piso 8° Bogotá, Colombia | Tels.: (57.1) 3324327 – (57.1) 3324328 | Fax: (57.1) 3324330
http://ingenieria.uniandes.edu.co | E-mail: info.ingenieria@uniandes.edu.co