Construction of Dry Sanitation Latrines in Rural Southern Mexico

Internship Final Report

Project realized by

Engineers for a Sustainable World USA

and

Consultoría, Proyectos e Investigación, S.C., Mexican NGO

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Table of Contents

Executive Summary:

The proper disposal of human waste is a problem in developing countries and especially in rural areas. Mexico desperately needs a sanitation solution combined with education to improve current sanitation habits. This report documents the Chiapas project realized by the NGO COPIN (Consultoría, Proyectos e Investigación) and two ESW (Engineers for a Sustainable World) volunteers in the summer of 2005 to implement such a solution in the rural community of Damasco, Chiapas. It includes a description of the current sanitation solutions and information about the DSL technology implemented. The report describes the volunteers' objectives for this internship, project outcomes, conclusions, and recommendations. In the appendices are the volunteers' personal reflections and technical documentation. This report is meant as an evaluation of this first phase of the Chiapas project as well as documentation of this experience to aid future volunteers working on this project.

The construction phase of the Chiapas project consisted of deciding the kind and amount of materials needed to construct a dry sanitation latrine as well as determining the cost per latrine for fundraising purposes. The volunteers also had to determine construction details of the design and engage the community in this phase of the project. All of these activities were aimed at gaining experience with the technology and with working in the community as well as creating a relationship between all parties involved to ensure the continuation of the project.

The next phase of the project consists of community education about the use and maintenance of the DSLs. The volunteers hope that the use of the DSLs and sanitation education will decrease the occurrence of vector borne diseases and lead to a better quality of life. This project, COPIN's first one, will hopefully lead to the organization's growth and more projects. The volunteers gained experience in the area of international aid work and in the running of a project. This was a learning experience for all and the volunteers are confident that it will lead to positive changes and future collaborations between ESW, COPIN and the community of Damasco.

Background:

In Chiapas, like in many other regions of Mexico, the majority of the rural population lacks an adequate system to dispose of raw sewage. This sanitation problem leads to a high occurrence of vector-borne diseases and the contamination of ground water. Currently rural populations use either pit latrines or have reverted to open air defecation, yet neither of these alternatives provide a solution to the sanitation problems.

Open air defecation is common in rural zones and especially in indigenous communities. The unburied excrement causes the proliferation of flies, diseases, and is often consumed by free-roaming domestic animals such as chickens, dogs, cats and turkeys. Some families have built traditional pit latrines to deal with this problem. During the rainy season, though, the latrines overflow due to the collapse of the dirt pit walls resulting in the spread of vector-borne diseases. During the dry season the latrine smells bad and attracts flies because of a lack of maintenance and adequate supervision.

Education combined with action is needed to raise awareness of the need for a better sanitation solution and to implement the solution. While the rural poor are generally aware of the connection between inadequate sanitation and vector-borne illnesses, this knowledge has not translated into the necessary action, construction and adoption of adequate sanitation solutions due to the lack of awareness of available technologies, technical know-how to implement them, and insufficient funds.

Participating Organizations:

COPIN was founded by Alejandra Lemus Gomez in 2002 with the specific objective of assisting rural communities in providing adequate sanitation solutions to accompany the work begun by the state water and sanitation commission, CEAS. COPIN is the product of Ms. Lemus' frustration over the insufficient time and resources afforded by the state programs to educational efforts, project follow-up, and sanitation. Engineers for a Sustainable World is a US-based non-profit organization founded at Cornell University in 2001 with a network of professionals and students working to reduce poverty and improve global sustainability. The University of Texas's ESW chapter was founded in 2003 with the objective of providing opportunities for UT engineers to learn about sustainability both on-campus and by working in developing communities.

Community:

The community of Damasco was chosen for this project due to the need for a sustainable and effective sanitation solution, community organization, acceptance of the technology and willingness to participate both in the construction process and subsequent education.

Established in 1994 in the municipality (similar to a county) of Teopisca, Damasco is a community of 71 families of indigenous Tsotsils who were expelled from other communities, either due to differing religious beliefs or due to the political unrest in the region at the time. They support themselves primarily through subsistence agriculture (maize and beans), with some production of vegetables and other agricultural products for sale in regional markets. Economic resources are scarce, and education levels are generally low. Community members have experimented with unlined pit latrines, but, due to the above-mentioned problems, many have reverted to open-air defecation. Locally available materials include sand and gravel mined in the community. Although some community members also have woods planks, the sale of this wood is illegal in Chiapas.

Project:

The project consists of the relationship between COPIN, a Mexican civil society and the University of Texas at Austin chapter of the Engineers for a Sustainable World to identify the most appropriate sanitation solution for the community of Damasco and the participation of ESW members in the construction process. Subsequently, COPIN will organize and educate the community to ensure the correct and continued use of the DSLs as well as promote better sanitation habits.

Dry Sanitation Latrine Technology:

One technology that has been demonstrated to meet the communities' preferences and be appropriate to the region's climate conditions is the dry sanitation latrine. Dry Sanitation Latrines (DSLs) were first built in Vietnam in the 1950s and more recently have been built in various communities in the state of Chiapas.

DSLs consist of a moveable toilet with a urine separator that is placed over the chamber in use (called the active chamber). The organic material is stored in this chamber and lime or ashes are added to it after each use to produce an alkaline environment. When the chamber is two-thirds of the way full, it is filled with lime or ashes, the chamber is sealed and the toilet is moved to the second chamber. Once the second chamber has been filled, the first one is emptied. The resulting organic material is harmless and odorless. By alternating the chamber used and creating an alkaline environment in its interior, the pathogens are destroyed.

Despite the effectiveness and appropriateness of this technology, the lack of community education and continual supervision to ensure the correct use and maintenance of the DSLs has caused a minimal impact in the habits of the populations where they have been built. DSLs are the best sanitation solution for the rural-indigenous population when accompanied by family and community directed education. Because DSLs can be reused and they do not contaminate the environment they are a sustainable solution to the rural population's sanitation needs.

Participating Organizations and their Responsibilities:

This list of the responsibilities of each entity participating in the project was made by the volunteers at the beginning of the project.

COPIN

- Introduce the volunteers to the community
- Assist the volunteers in their tasks (find a skilled construction worker, relevant material companies, inform the volunteers on how to deal with local people, set up relationships with local authorities, etc.)
- Oversee the maintenance and ensure the correct use of the sanitary unit during and after the volunteers leave
- Provide continuing sanitation education
- Provide accommodations and moral support to the volunteers

ESW Volunteers

- Manage the finances
- Make the materials list
- Oversee and participate in the construction process
- Project a professional image in accordance with the organizations represented
- Establish relationships with the community and COPIN to ensure the project's continuation

Damasco Community

- Provide local materials, tools and aid in the construction
- Participate in education session and community meetings
- Correctly use and maintain the dry sanitation latrine
- Aid in communication with the community (Tsotsil-Spanish translations)

Internship Objectives:

A few weeks into the project the volunteers made a list of some short term and long term objectives for the project which are listed below:

Short term Objectives

- Establish a partner relationship between ESW volunteers, COPIN and the Damasco community
- Learn the local construction techniques
- Learn and improve the dry sanitation latrine technology
- Familiarize ESW volunteers, COPIN and the Damasco community with the dry sanitation latrine technology (function, effectiveness)
- Estimate and minimize unit cost of a DSL for fund raising purposes and to maximize the number households served
- Manage financial and human resources efficiently

Long Term Objectives

- Establish a partner relationship between ESW volunteers, COPIN and the Damasco community to ensure future collaboration and opportunities
- Improve the quality of life of the community
- Provide a sustainable sanitation solution
- Promote and ensure the participation of Damasco community members during the construction, operation and maintenance of the dry sanitation latrines
- Decrease the occurrence of vector borne diseases and contamination of the water table
- Continue to research and improve the present dry sanitation latrine design
- Attain a greater sensibility, education and awareness about sanitation issues within the community for larger impact
- Continue the project to achieve the construction of 71 dry sanitation latrines

Internship Outcomes:

We arrived in Chiapas with two possible designs and with the objective to maximize the number of families served, yet we also knew that the community would have to decide what design would be implemented. With this in mind, our first weekend in Chiapas we gave a presentation at a community assembly in Damasco on the details and positive and negative aspects of the DSL and Lined Pit Latrine designs. The community voted unanimously for the dry sanitation latrine. During this assembly the community pledged to aid us by providing locally mined sand and gravel as well as unskilled labor.

Once the community chose the DSL, we spent the next week visiting material vendors to create a unit cost estimate and thus an estimate of how many DSLs we could build with the available funds. We concluded that we had enough funding for at least nine DSLs and that, depending on time constraints and any unforeseen costs, we could build up to twelve latrines. The following weekend we divided the community up into zones of three neighboring houses and a raffle was held to decide the order in which we would build in each zone.

During this week we also visited with the municipal authority to let them know of our presence and ask for funding for COPIN's education program and the employment of a skilled construction worker to aid in the construction. The municipality agreed to send a skilled worker but turned down the education funding request.

The following week we began our daily trips to Damasco. The first week we met the homeowners from the first zone and started to prepare the construction site. Despite the municipality's promise to provide a skilled worker, they were slow to keep their word. Many days were spent waiting and traveling to Teopisca (the municipal seat) to speak with the municipal authorities about this short-coming. Finally, the municipality sent the promised worker and the construction took off. We worked with the construction worker to decide design details. Our role was to oversee the construction, buy materials, organize community members for the construction, and also to participate in the construction process. After a few days of work, the worker was absent for a day because of payment issues with the municipality. As a result, the municipal authority chose to send us a new worker. Again we had to wait several days for the municipal authority to

keep his word and we had to travel to Teopisca to pressure him to act. Once the new worker arrived construction again took off. We completed the cement bases of the first zone and moved on to the second one. When we were about to start work on the third zone, the skilled worker stopped coming to work. The municipality informed us, after much insistence on our part to find out where he had gone, that the worker no longer wanted to work in Damasco and promised to find a new one. After waiting a week for the promised worker, we decided to hire one on our own.

With the new worker and a month left to work, we completed the cement bases in two weeks. Due to the lack of time and our desire to finish a week before the end of our stay, we chose to hire another skilled worker to build the corrugated metal shelter while the first worker installed toilets and sealed the chambers. The construction phase of the project ended on August 5 with the construction of nine dry sanitation latrines. On Sunday, August 14 a meeting was held in Damasco to formally conclude this first phase of the project.

Conclusions and Recommendations:

We feel that we successfully created a lasting relationship between COPIN, the community of Damasco and ESW. Though we ran into a few problems concerning community participation and construction know-how, in the end the community, COPIN and us were satisfied with the results. Due to the fact that this was the first time all parties involved took on the construction of DSLs, these two months of work were primarily a learning process for all.

Many of the problems we ran into resulted from the fact that this is COPIN's first project and our first time working with the DSL technology. There was a lack of communication which did not allow us to help each other in dealing with the problems that arose. These problems can be grouped into ones with the community, technical problems, and logistical issues.

We found that we needed greater communication with community leaders in order to organize inhabitants as well as to decide DSL placement. An accurate map of the community including topographical details and home placement needs to be made before the start of the project. Meetings with the community should be better planned (for example the DSL raffle) and more communication with the community leader is necessary.

Technical details such as the kind of materials necessary, amounts of materials needed and the best method of anchoring the shelter to the cement base should have been talked over with and decided before-hand. Although COPIN knew the answers to such questions, ineffective communication with them led us to have to deal with them on our own.

We had difficulty in finding a skilled worker and helpers. The skilled worker should be hired directly by COPIN and the volunteers. Although the community has to be in agreement on how they will provide the unskilled helpers, we recommend that one helper be hired by the community that will work on the construction during its duration. A detailed work schedule should be made for each week and given to the community

leader specifying the work dates and what is needed of each homeowner. We recommend for the volunteers to have direct communication with COPIN concerning community customs and culture before their arrival in Damasco.

The construction we completed was only the first phase of the project, now COPIN must follow up with intensive education sessions with the DSL owners to ensure the correct use of the technology and to change the sanitation habits of the community. Though the construction phase of the project was completed successfully, there are still many issues to be resolved that will determine the ultimate success of the project in Damasco. Such issues include the effectiveness of the DSLs in eliminating pathogens and the willingness of the community to participate in education sessions, use their DSLs and maintain them correctly. Depending on the observations of COPIN after the DSLs start to be used, ESW members working on the project can make adjustments to the design and recommendations to the community to modify the use of the technology.

Personal reflections: Amanda Dulcinea Cuéllar

I decided to go to Chiapas first of all to help my country and as a test to see if I truly want to work in international aid. The first month of my stay I was perfectly happy with my work. I loved talking to the people in Damasco. My strength, I found, is the social part of our work. Towards the beginning of the second month, though, I started to get tired of our work and its accompanying problems, and to dread going to work everyday. I would worry about the problems we would be faced with during the day. Yet my conversations with the ever good-spirited inhabitants of Damasco would make my day enjoyable despite my fears. My stress level was very high during the last month of work in Chiapas. This was partly due to my character, but was also because I felt that Marie and I were alone in our work. COPIN members were busy and we usually tried to solve the problems we had on our own. I also felt no ESW or ESW-UT support during our stay in Chiapas. I was never completely sure of our role and responsibilities during the project, but sometimes I think we were left to do the job of others.

Even though the people of Damasco were always friendly and seemed to enjoy our presence, I never felt that they truly understood the importance of our work the way we saw it. I believe they appreciated our effort and were excited to have a new DSL in their home, but I don't feel that this project resulted from their initiative, thus they saw it as ESW and COPIN's project, but not as their own. This situation as well as many cultural and historical events combined to create in them some indifference towards our work. For instance, on the day that the governor of Chiapas visited Teopisca, all the men of the community traveled to Teopisca to see him even though we had spoken to several of them and they had promised to help us work at their homes.

This trip taught me more than I expected. I learned that though I may identify a problem and solution in a communtiy, it is not enough. The community must also see this need and be convinced of the solution implemented. I also really enjoyed learning about a different region of Mexico and its people. There are many events in the history of Mexico

that have combined to shape the attitudes of the people of Chiapas. I think I have gained a greater understanding of these circumstances and their effect on the people of this region.

Overall I think this trip was a learning experience for all involved and the problems we had resulted from our lack of experience. I am confident that the lessons learned will not be ignored and that positive changes will result. Though I set out to test my desire to work in international aid, I have not come to a decision yet. I think I need to try a few more options out to find where I can most effectively meet the needs of the developing world.

Personal Reflections: Marie-Andreé Beaudoin

The first meeting we had with the community of Damasco was the first step into the culture. All the people were sitting in front of us around a basketball court. The women in traditional dress were knitting surrounded by their numerous kids. On the other side, the men were sitting proudly in their chairs wearing ponchos and sombreros and were starring at me with an extreme curiosity. It was probably the first time a white, blue eyed, blond haired girl came into their community to talk about the benefits of the dry sanitation latrine technology. I could see in their eyes the hope they had that we would increase their quality of life a little bit.

During the entire project, we had to face problems and keep a constant motivation to continue. It was hard physically and psychologically, but the fact that we were responsible of the success or the failure of the project gave us enough strength to keep going.

I learned a lot about project organization, human resources management, and anticipation of potential problems and argumentation with Mexican people.

The main objectives were to create a long term relationship with the different groups involved, to start the construction and training phases and to produce a descriptive document with all recommendations necessary to continue. Even though we finished only nine latrines, we succeed in all the above objectives and we started this project well.

I received smiles, respect and personal growth. This internship confirmed all my interests and future aspirations for an international career.

Technical Documentation:

Below is a spreadsheet documenting the cost, amount of material purchased and amount used per latrine for the project. One of our objectives for this project was to determine the amount and kind of materials needed to construct a DSL as well as a unit cost estimate.

Item	Type	Description	Unit	Price (PS)	Price (USD)	Quantity	Cost (Ps)	Cost (USD)
Cement	Materials		50 kg	$81.00	$7.62	58	$4,698.00	$442.15
Sand	Materials	fine	m^3	$75.00	$7.06		$0.00	$0.00
Gravel	Materials		m^3	$75.00	$7.06		$0.00	$0.00
Lime	Materials	Bag	25 kg	$26.00	$2.45	10	$260.00	$24.47
Tabicon	Materials	28 x 13 x 10	un	$2.40	$0.23		$0.00	$0.00
Cinderblock	Materials	40 x 20 x 13	un	$3.40	$0.32	770	$2,618.00	$246.39
Burnt Wire	Materials		kg	$13.00	$1.22	9	$117.00	$11.01
Hose	Materials		m	$10.00	$0.94	14	$140.00	$13.18
Nails	Materials	1 "	kg	$24.00	$2.26	0.25	$6.00	$0.56
Nails	Materials	2 "1/2	kg	$14.00	$1.32	1.5	$21.00	$1.98
Nails	Materials	4 "	kg	$16.00	$1.51	8.5	$136.00	$12.80
Nails	Materials	3"	kg	$13.00	$1.22	1	$13.00	$1.22
Umbrella Nails	Materials		kg	$35.00	$3.29	1	$35.00	$3.29
Lead head nails	Materials	4 "	kg	$27.00	$2.54	9.5	$256.50	$24.14
Washers	Materials		un	$0.19	$0.02	18	$3.42	$0.32
Screws	Materials		un	$1.00	$0.09	18	$18.00	$1.69
Hinges	Materials	2 "	un	$5.50	$0.52	18	$99.00	$9.32
PVC pipe	Materials	4"	6 m	$80.00	$7.53	4	$320.00	$30.12
PVC tee	Materials	4"	un	$17.00	$1.60	9	$153.00	$14.40
PVC elbow	Materials	4"	un	$11.00	$1.04	18	$198.00	$18.63
PVC connectors	Materials	4 "	un	$8.00	$0.75	4	$32.00	$3.01
Corrugated metal sheets	Materials	2.45 m x 0.80 m	un	$105.00	$9.88	100	$10,500.00	$988.21
Mosquito netting	Materials		m^2	$30.00	$2.82	6	$180.00	$16.94

Item	Type	Description	Unit	Price (PS)	Price (USD)	Quantity	Cost (Ps)	Cost (USD)
Metal Clamps	Materials	4 "	un	$10.00	$0.94	9	$90.00	$8.47
Plastic hose	Materials	1"	m	$4.00	$0.38	17	$68.00	$6.40
Plastic hose	Materials	1/2 "	m	$1.48	$0.14	14.05	$20.79	$1.96
Hose tee	Materials	1"	un	$10.00	$0.94	1	$10.00	$0.94
Hose elbow 90º	Materials	1 "	un	$9.72	$0.91	4	$38.88	$3.66
Hose elbow 90º	Materials	1 "	un	$15.00	$1.41	32	$480.00	$45.18
Wire Mesh	Materials	1 m x 2.50	m	$40.00	$3.76	13.5	$540.00	$50.82
Transportation	Materials		un	$0.00	$0.00	1	$0.00	$0.00
Drill rental	Tools	rental	day	$50.00	$4.71	1	$50.00	$4.71
Tape Measure	Tools		un	$64.90	$6.11	1	$64.90	$6.11
Hand Level	Tools		un	$55.00	$5.18	1	$55.00	$5.18
Plastic sheet	Tools	0,8 m x 1m	m^2	$4.50	$0.42	15	$67.50	$6.35
Plastic sheet	Tools		m^2	$4.00	$0.38	10	$40.00	$3.76
Paint brush	Tools		un	$12.00	$1.13	1	$12.00	$1.13
Paint brush	Tools		un	$11.10	$1.04	1	$11.10	$1.04
Wooden Form	Materials	2m x 10 cm	un		0	17	$0.00	$0.00
Wood	Materials	2,5 m	dozen	$200.00	$18.82	3.5	$700.00	$65.88
	Materials	2,5 m	un	$25.00	$2.35	1	$25.00	$2.35
	Materials	3 m	dozen	$300.00	$28.23	1	$300.00	$28.23
	Materials	3 m	un	$30.00	$2.82	1	$30.00	$2.82
	Materials	4 m	dozen	$420.00	$39.53	5.5	$2,310.00	$217.41
Wood Transportation	Materials		un	$40.00	$3.76	1	$40.00	$3.76
Paint	Materials	1 l	un	$62.70	$5.90	5	$313.50	$29.51
Paint	Materials	1/2 l	un	$34.70	$3.27	1	$34.70	$3.27
Thinner	Materials	1 l	un	$17.20	$1.62	2	$34.40	$3.24
Gloves	Tools		un	$18.00	$1.69	1	$18.00	$1.69
Glue	Tools	500 g	un	$50.00	$4.71	1	$50.00	$4.71
Pick	Tools		un	$84.50	$7.95			$0.00
Shovel	Tools		un	$49.00	$4.61			$0.00

Item	Type	Description	Unit	Price (PS)	Price (USD)	Quantity	Cost (Ps)	Cost (USD)
Sledge Hammer	Tools		un	$101.00	$9.51			$0.00
Brick Trowel	Tools		un	$27.50	$2.59			$0.00
Hammer	Tools		un	$33.29	$3.13			$0.00
Framing Square	Tools		un	$32.00	$3.01			$0.00
Construction worker	Labor		$/day	$140.00	$13.18	6	$840	$79.06
Construction worker	Labor		$/day	$140.00	$13.18	6	$840	$79.06
Construction worker	Labor		$/day	$140.00	$13.18	5	$700	$65.88
Construction worker	Labor	Shelter	$/day	$225.00	$21.18	9	$2,025	$190.58
Construction worker	Labor	Urinal Installation	$/day	$70.00	$6.59	1	$70	$6.59
						Total	**$30,137.17**	**$2,793.58**

Total Costs (US Dollars)

Materials		$2,373.12
Tools		$34.50
Labor		$419.01
Total		$2,826.63
Total cost per Latrine		$314.07

We also made a work calendar for the construction steps that can be realized each day along with the materials necessary each day and an estimate of the time needed to complete each stage.

Work Calendar

Zone 1

	House 1	House 2	House 3
Day 1	Ground preparation	Ground preparation	Ground preparation
	Stone base	Stone base	
	Cement Base	Cement Base	
Day 2	Blocks		Cement Base
	Stairs		Stone Base
Day 3	Cement Plaster	Blocks	
		Stairs	
Day 4	Cement Polish	Repellado	Blocks
	Prepare frame		Stairs
Day 5	Cement floor	Cement Polish	Cement Plaster
			Cement Polish
Day 6		Prepare frame	Prepare frame
		Cement Floor	Cement Floor
Last Week	Shelter	Shelter	Shelter
	Interior	Interior	Interior

Ground Preparation	± 2 hours

Stone Base	± 1 hours
Stone	3 19 L buckets
Gravel	6 19 L buckets
Wood	4 x 2 m
	1 x 3 m
Nails	3"

Cement Base	± 2 hours
Cement	1.8 sacks
Sand	12 19 L buckets
Gravel	9 19 L buckets

Blocks	± 4 hours
Blocks	80 units
Fine Sand	5 19 L buckets
Cement	0.5 sacks
Lime	0.3 sacks
Gravel	20 19 L buckets
Plastic bottles	2 units
Tee PVC	4 " 1 unit
PVC Tube	4" 50 cm
PVC Glue	5 ml

Shelter	± 5 hours
Corrugated Metal	11 units (2,4 x 0,8 m)
Wood	4 units 2,5 m
	2 units 3 m
	6 units 4 m
Nails	0.5 kg lead head
	4" 0.5 kg
	1" 0.5 kg
Netting	0.3 x 0.3 cm
Burnt Wire	0.5 kg
Sand	3 19 L buckets
Gravel	1.5 19 L buckets
Cement	0.3 sacks

Cement Plaster (Chamber Interior)	± 2 hours
Fine Sand	5 19 L buckets
Cement	0.3 sacks
Lime	0.2 sacks

Cement Polish (Chamber Interior)	± 1 hours
Cement	0.5 sacks

Prepare frames	± 1.5 hours
Wood	4 x 2 m x 10 cm
Boards	3 x 2 m x 30 cm
Wood	8 x 0,8m x 10 cm
Nails	3"

Cement Floor	± 2 hours
Burnt Wire	1/6 kg
Wire Mesh	1,7m x 1,3
Nails	3"
Toilet Mold	1 unit per chamber
Sand	12 19 L buckets
Gravel	5 19 L buckets
Cement	1.5 sacks

Interior	± 2 hours
Toilet	1 unit
PVC Tube	4" 50 cm
PVC Elbow	4 " 2 units
Netting	20 x 20 cm
PVC glue	5 ml
Burnt Wire	0.3 kg
Paint	250 ml
Plastic Hose	1 " 2 m
Elbow	1 " 2 units
Fine Sand	2 19 L buckets
Cement	0.3 sacks
Lime	0.1 sacks
Gravel	4 19 L buckets
Cement lids	3 units