Solar Dryers in Response to Poverty and the Changing Climate

ABSTRACT

While trying to preserve the science for effectiveness of solar dryers, the designs has to adapt to local needs, resources, the emerging pool of knowledge and the challenges of the changing climate. From year 2000 to the present, several designs were made to respond to the needs of the families in situations of poverty, lack of space, limited access to construction materials, floods as well as the aftermath of a disaster. The paper also presents a comparative efficiency cost effectiveness of different models of biomass and solar dryers from a socio-technical experiment in 2011. It further presents five models of the solar dryer namely (1) The Solar Dryer in Sorsogon, (2) The Solar Dryer in Wings made of bamboo in Bulacan, (3) The Solar Dryer in Wings with PVC pipes in Daet (4) and the Dryer Tower with rattan poles in Cebu. Lessons, solutions and innovations are presented. The innovations include the heat banks, the hot air compartment in wings, solar dryer in floaters for flooded areas and the use of different construction materials. Field tests and refinements of these models are ongoing in five different locations in the Philippines for drying fish, baskets, fuel briquettes and clay for terra cotta stoves.

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1. Introduction. Sun Drying as a Domestic Imperative. The Philippines is in a typhoon belt zone and is among those at the top of the list for natural calamities. With a tropical climate that is ever changing and intensifying, the weather patterns for a particular season are getting to be unpredictable.

Low income families have to do a much wider range of domestic activities on their own and with much less aid of equipment or hired services. Through their own means, they have to dry clothes, food, fuel, clay, rain soaked books, and all other domestic materials. However, they will always have to be prepared that even in a day of intense sun; there would be a brief rain shower.

For drying fish, the traditional and still the more prevalent method of drying is to soak them in brine water solution and lay them in the drying mats in the open sun. But what more could be disastrous than having hundreds of kilograms of fish that are halfway dry and then a few minutes of brief rain shower. This half dried rain soaked fish would then be a sure loss.

Small scale vegetable farmers on the other hand would also suffer losses in times of harvests when the market prices are on a dip. They would end up having to sell their vegetables simply to recover their expenses. To the worst extent, they may opt not to harvest the vegetables at all and leave it to rot in the fields. For most other enterprises including pottery, arts and crafts or even laundry business, drying as an imperative could be very costly. Furthermore, laundry and gathering fuel for cooking as well as the daily meals are tasked that are culturally expected from the women. Thus, the stress of the laundry or wood fuel or getting soaked in the sudden rains and not having enough meal for the day fall on the women.

2. Objectives of the Project

This project was meant to exhaust all possible options to create technical and social mechanisms to enable the users; particularly the poorer families and women, fully utilize the power of the sun for drying. It works to discover new materials, new designs, new arrangement with the community actors as well as business schemes to enable people in the communities find their own solutions.

Specifically, it wants to

1. Identify technical mechanisms that will improve the performance of the dryers.
2. Identify social mechanisms that will enable people to fully utilize the advantage of the technology.
3. Identify paths and trajectories for creating sustainable livelihood models

3. The Technical Mechanisms of a Solar Dryer

3.1. The Greenhouse Effect. With the use of simple plastic sheets, the heat of the sun may be trapped in a box. The trapped heat then heats up the air inside and creates airflow through natural convection. The hot air causes whatever moisture inside the box to evaporate and thus flows out of the box while at the same time pulling in cool air from below.

While this technical mechanism has been very well understood and already utilized, this project wants to contribute further to discover more mechanisms.

3.2. Heat Banks. While drying cassava chips in the town of Vinzons in 2000, the author learned that drying has a pullback effect at night time or anytime of the day when there is less sunlight. With the lack of better terms, the pull back effect means that the materials that are partly or fully dried would pull in moisture whenever the pressure inside the dryer is reduced. The lowered pressure caused by the drop of temperature inside the dryer will cause the spoilage of the products.

To resolve this, heat banks must be installed in the dryer. It could be any high density material that can absorb the highest amount of heat and release the heat at night time. This dense material must be black to fully effect heat absorption.

The cheapest heat back may be in the form of heavy boulders laid over the base of the dryer. The boulders may be painted black using charcoal that was pulverized and mixed with vegetable oil.

Figure 1. Members of the Self Help Groups (SHGs) of Bacon Sorsogon lay the plastic wrap of the solar dryer unto the bamboo frame. The base of the dryer is made of a concrete box and then filled in with black sand which serves as the heat bank.

Figure 2. The Solar Dryer in use in a community center at Bacon Sorsogon. It was then used to dry *karagumoy* (pandanus simplex) leaves which the local people use for weaving baskets. At the base of the dryer are holey roket stoves at the advanced stage of drying.

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Figure 3. A local basket weaver of Bacon was greatly helped by the project. They were able to get the leaves dry and without the black specks and with much less stress.

3.3. Insulated Platforms. The ground will be very wet after the rains. A solar dryer laid over the wet ground will only be able to dry anything only after the ground has been thoroughly dried. To prevent this delay, the solar dryer must be laid over an insulated platform. It could be in a form of an elevated soil, sand or gravel that was stabilized and then laid over with a plastic sheet or any water insulating material.

Figure 4. The ground as it is being prepared to be the platform of the solar dryer.

3.4. Wire mesh box. Fish laid inside the dryer is a sure feast for cats, dogs and other pests. Wrapping the entire dryer with a wire mesh will be very expensive. Thus it is advised that the fish be dried inside wire mesh boxes.

Figure 5. The wire mesh box is an effective protection for the fish from cats and other stray animals. It is a much cheaper solution than having the entire dryer wrapped in wire mesh.

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Philippines 17 July 2014

4. The Social Mechanisms of a Solar Dryer

4.1. Open access to technology. This presentation argues that for rural development to fully flourish there has to be an open access to technology particularly for the poor families who are the intended users of these projects. Such an open access should promote an open sharing of knowledge in the spirit of cooperation and solidarity. It is only then that the technology may be able to stimulate social inertia and allow local initiatives to prosper.

4.2. Access to materials of local equivalents. The technical designs must allow the use of local material equivalents. For this project, it is encouraged, whenever possible that people use bamboo instead of PVC pipes or rattan poles. Joining the bamboo poles in corners can be very tricky and might require metal or plastic connectors. While UV resistant plastic sheets are ideal, any transparent plastic may be used. Generally, thicker plastic sheets will outlast the thinner plastic sheets.

4.3. Responding to local needs and specific context. The design of the dryer will have to be customized to specific local needs. The need of those engaged in fish drying is entirely different from those engaged in laundry business. While preserving the ideal technical parameters, users are encouraged to create their own customized design freely.

4.4. Providing room for local innovations and inventiveness. With the open access to technology, users would need help from the scientific community to get more access to new pool of knowledge and design systems. Skills training, being among the many mechanisms would be an effective means for them to find their own solutions.

5. The Sorsogon Experiment: Improving the Dryer of Bacon, Sorsogon.

From August 2011 to July 2012, the author was commissioned to undertake a design process and a comparative study of four different models of dryers using biomass and solar energy. It was through the Coastal CORE of Sorsogon with the funds coming from AECID, a Spanish NGO. Through a series of design workshops, four models were created and were soon constructed. Observations were gathered and analyzed using simple mathematical formula. Observations were made using the following parameters: (1) rainfall, (2) fuel consumption, (3) temperature inside and outside the dryers, (4) humidity inside and outside the dryer, (5) moisture reduced, (6) time required for drying.

5.1. Drum Dryer. The dryer tried to capture the traditional methods of the basket weavers of hanging the leaves over a lighted charcoal stove inside the house and then infusing it with the greenhouse effect. The design ended up with a charcoal stove that was encased inside a steel drum and then fitted inside a huge cabinet that was wrapped inside a plastic sheet and then set in the open sun. Thus, the dryer works from two heat sources: the hot charcoal and the sun.

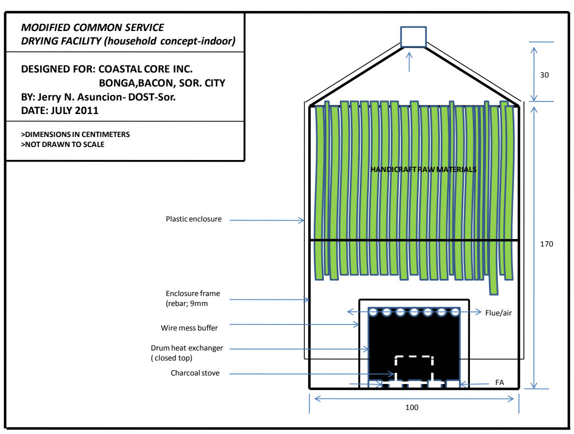

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Figure 6 (top): The drum dryer as designed by Mr. Jerry Asuncion of the DOST Albay. Figure 7 (top left) presents the same design as interpreted by the author. Figure 3 (right photo) the drum dryer being tested by the women of Barangay Salvacion, Bacon, Sorsogon.

On the upside, the drum dryer was found to be simple to construct and can dry the leaves even during rainy days. On the downside, it consumes too much charcoal which competes for their fuel for cooking. Charcoal production is an illegal trade. It is very expensive and the prices would even go up during rainy season.

5.2. Media Talye Wood and Concrete. It is a hot air dryer, a kitchen stove and a fish smoker built as one. While cooking, the hot gases from the flat bed stove will escape through a horizontal tunnel below the drying house. The hot gases still with the smoke will cause the metal tunnel to heat up which would then heat up the surrounding air. The rising hot air will then cause the leaves in the drying compartment to dry. Meanwhile the escaping hot gases from the stove will continue to rise up to the chimney where fish are stacked up for smoking. In the upside, this dryer performs three functions in one unit thus fully utilizes the generated heat. On the downside, there is too much heat loss from leakage in the drying compartment.

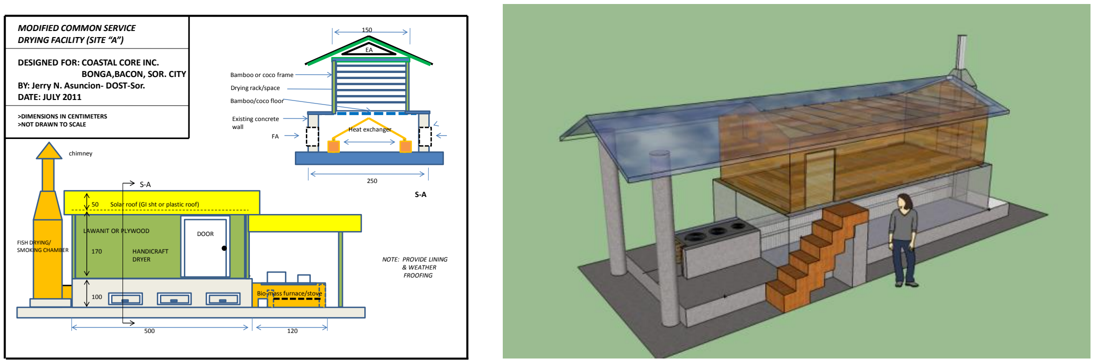

Figure 8. The Media Talye Dryer as designed by Engr. Gerry Asuncion of the Department of Science and Technology and as interpreted by the author.

5.3. Media Talye Slab. It carries the same concept as the previous dryer. The main difference is that it is made of concrete. The project area is prone to storm surges landslides and floods. This dryer being built very strong could then be a refuge for family evacuees. On the upside, the dryer is much more efficient than its wood built counterpart. On the downside it is very expensive.

Both models were able to successfully dry leaves, cook huge meals for a party and dry fish at the same time. The slab dryer consumed about half of the wood fuel compared to its wooden counterpart.

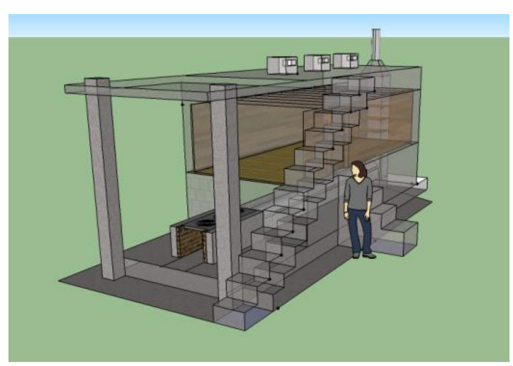

Figure 9. The Slab Dryer as interpreted by the author. Notice the concrete roof platform that may serve as a refuge for the local villagers in case of a tsunami or floods.

5.3.1. Solar Dryer. It is a greenhouse box that was built with a hot air compartment, a drying compartment and a heat bank. The Sorsogon model was built with bamboo poles for the frames, plastic sheets and the base made of concrete and then filled with black sand that serves as the heat bank. It was able to effectively dry any material inside during days with sun but very slow during days of overcast skies and rains. Nevertheless, all the products were safely protected from moist and rains. On the upside, it is very simple to construct and very cheap. On the downside, its performance rests on the available sunlight.

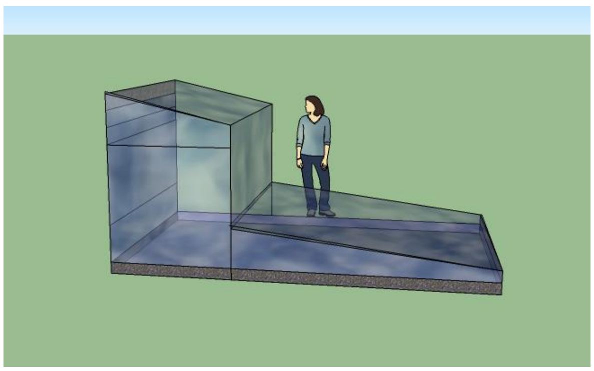

Figure 10. The solar dryer as designed and built by community volunteers in Bacon Sorsogon. The project was through the Coastal CORE of Sorsogon and with the funding support from IPADE and AECID, a Spanish NGO with the author serving as the technical consultant.

5.3.2. Conclusions of the Sorsogon Study. This study prepared mathematical formulas to calculate the technical coefficients of each model as well as their respective cost effectiveness. The following tables are summaries of the results.

Table 1. Comparative Performance of Four Models of the Dryers.

Model	Average Temperature Increment (%)	Average Humidity Increment (%)	Ave Fuel Consumption (kg/load)	Average Cost of Fuel (Php)	Average Reduced Weight of Leaves (%)	Average Maximum Load (number of leaves)	Cost of the Model (Php)	Expected Usable Life (years)
Drum Dryer	**31.42**	**4.65**	**2**	**30**	**40.52**	**322**	**7,458**	**2**
Solar Dryer	**5.40**	**0**	**0**	**0**	**8.53**	**264**	**8,938**	**2**
Media Talye 3n1	**37.93**	**8**	**20**	**30**	**11.42**	**210 –** n.a. will use 646	**76,923**	**5**
Slab 3n1	**36.67**	**4.25**	**20**	**30**	**38.33**	**646**	**150,000**	**15**

Table 2. Comparative Efficiency Coefficients of the Four Models of the Dryers, Bacon, Sorsogon, July 2011.

Model	**Load to Fuel Consumption Ratio**	**Cost/Usable Life Ratio**	**Efficiency Coefficient**
Drum Dryer	**10.73**	**38.84**	**3.77**
Solar Dryer	**264.00**	**46.55**	**3.14**
Media Talye 3n1	**21.55**	**200.32**	**3.59**
Slab Dryer 3n1	**21.55**	**208.33**	**3.79**

Results of this research indicate that the Solar Dryer has the lowest efficiency (3.14) while the Slab 3n1 has the highest efficiency (3.79). The solar dryer passively relies on the available sunlight can only dry during days of good sun and can only extend its drying power until there is available heat coming from the heat banks. Technical observations indicate that the temperature and the humidity inside and outside the dryer have very small increments. One reason could be the heat leakage of the zipper. During the intense use of this dryer, the teeth of the zipper lost its grip eventually could not be closed tightly.

The Slab 3n1 dryer has more power coming from the furnace and can dry anytime when the furnace is fired. The slab concrete can also effectively contain all the available heat from the heat exchanger with a minimal leakage compared to the Media Talye 3n1 Dryer. For this reason, the Drum Dryer has a higher efficiency coefficient (3.77) than the Media Talye 3n1 Dryer (3.59).

Table 3. Comparative Cost Effectiveness of the Four Models of the Dryer, Bacon Sorsogon, July 2011.

Model	Cost Effectiveness Coefficient	Figures Rounded Off
Drum Dryer	**1.04124**	**1.04**
Solar Dryer	**17.806**	**17.80**
Media Talye 3n1	**0.38588**	**0.39**
Slab Dryer 3n1	**0.3917**	**0.39**

The same table presents the cost effectiveness coefficients. It indicates that the Solar Dryer has the highest coefficient (17.80) while the Media Talye has the lowest (0.38558). This coefficient indicates that the Solar

Dryer, although having the lowest efficiency coefficient has the highest cost effectiveness.

Source: Improving the Dryers of Bacon, Sorsogon
Author: Joshua B. Guinto
Commissioned by the Coastal CORE of Sorsogon
With funds from the AECID, IPADE

6. First Phase: The Solar Dryer in Wings Built with Bamboo. In trying to provide a solution to the effects of heavy rains and typhoons, particularly in the flood prone areas of Bulacan, the conventional piano shaped solar dryer was changed to become one with wings. The entire length of the hot air compartment was cut into half and fixed on both sides of the drying compartment like wings of a plane. This configuration improved the balance of the dryer if it will eventually be made to float over flood waters. A skilled carpenter was asked to build this model. Metal connectors had to be fabricated to reinforce the critical joints of the dryer.

Figure 11. Top left photo: the author (in white shirt) as he was giving instructions to the carpenter. Notice the metal joints for the bamboo poles. Top right photo: the bamboo dryer as it was built.

After trying to test the dryer at the urban households, it was realized that it way too big to fit into the house yards of the user families. Poor families in the urban areas have very small or do not have house yards at all.

7. The Solar Dryer in Wings in PVC Pipe Construction. In anticipation of the very wet conditions in the flood prone areas of Bulacan, the author decided to use PVC pipes instead of bamboo poles. To address the issue of the size, the author conceived a model half the size of the previous bamboo dryer. At the same time, the new model intends to test the use of PVC pipes instead of bamboo in anticipation of the very wet conditions at the flood prone areas. Still with the same winged configuration, the half size solar dryer was built.

The dryer was laid over an elevated soil embankment which was then laid over with plastic sheets. This prevented the moisture from the wet ground to enter the dryer. However, if the dryer was meant to float, heat banks will add to the weight and thus reduce its buoyancy. Metal boxes of wire mesh were also prepared. It is where the fish were laid out to dry.

Figure 12. The solar dryer in wings as it was built in the town of Daet. Notice the fish inside the wire mesh box inside the dryer, the cat over it and the dog waiting for her turn to poke into the fish.

Figure 13. The solar dryer in a diversity of services: drying holey briquettes (topmost left photo), drying hot chilli and drying wood fuel and clay (right photo). Ms. Judith Guinto Agnoletto (topmost right photo) now sells her organically grown hot chilli powder in bottles (top left photo) to local restaurants at $1.70 for the larger bottle.

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Philippines 17 July 2014

7.1. Observations.

- On a sunny day of September 3, 2013 at about 8 am, fresh fish was tested to be dried in the solar dryer. The following observations were gathered.
- Drying the fish was done from 8 am to 3 pm. It was realized however, that the fish was dried too much to a point that it was too tough to chew after cooking.
- The fish in the metal box survived two cats and two dogs.
- There were barely any flies inside the dryer.

8. The Solar Dryer in Wings in Bamboo : Second Test

While the size of the dryer remains an issue with the bamboo model, tests were done at Barangay Balungao, Calumpit, Bulacan to determine the its performance in drying fish and at the same time creating a livelihood enterprise with the co-operator family. The tests were conducted during the months of March and April. Fresh fish were bought from the ports of the nearby town of Hagonoy. More than half were sold fresh and the rest were dried in the solar dryer.

Figure 14. The solar dryer in bamboo as it was being cleaned by the children from dust and being prepared for the day's fish drying event.

Figure 15. The freshly dried fish (top left photo) as it is being sold by Cristina to her neighbours. The boys of the family (middle left photo) happily selling their mother's fresh fish on a Sunday morning. The boys got a reward in the form of a shower in the garden afterwards.

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The following are the lessons from this experience:

- Check the weather forecast the day before the decision to buy fresh fish is made.
- Before sunrise, the fish will have to be cleaned and soaked in different spices of choice. It could be barbeque flavour, sweet and hot or plain salty.
- Have a jar of molasses or sugar solution ready. Immediately drop all the fish entrails and gills unto the solution. Keep it in a dark place for two weeks. By then it will be a very powerful nitrogen fertilizer called **fish amino acid** (FAA). To use the FAA, take 10 ml of the liquid or about two table spoons full and mix it with one liter of water. Pour the liquid into the base of the plants twice or thrice per week until the plants demonstrate vigorous growth.

- While the fish is being marinated, wait until about 9 to 10 am or until the dryer have collected enough heat. Otherwise, flies will feast on the fresh fish.

- Set the fish unto wire mesh boxes and lay them inside the dryer. Check the fish after about two hours and flip the box on the other side if all the liquids have dried.

- Take all the dried fish out of the dryer before they get crispy dry. While still warm, put them inside any air sealed containers and seal.

- Drying fish is a very good business with income as much as 300 percent and could even increase if prepared with flavours and improved packaging.

- **Dehydrating vegetables.** The author conducted a test of dehydrating vegetables dipped in citrus juice to preserve their colours. While the vegetables were successfully dehydrated and kept their colours intact, its shelf life will still have to be tested.

Figure 20. A trial was conducted to dehydrate vegetables. After slicing a selection of bitter gourd, string beans, eggplant and squash, it was dipped

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Philippines 17 July 2014

in a diluted *kalamansi* (a local lemon) juice and set on a drying rack. It was then set inside the solar dryer for one and a half days while being covered by a newspaper for shade. The result was a well dehydrated lump of vegetables that did with their original colours. More tests will be conducted.

9. **The Solar Dryer Tower.** The author went further with the tests and created this other imploded model. The tower is a simple cylinder with a big plastic bag covering it. The lower section of the tower was meant to be the hot air producing compartment while the upper part is the drying section. Moist air escapes in the vents of its roof. From the experience of the Solar Dryer Tower in Daet, several improvements were made with the team of artisans in Danao, Cebu.

- The horizontal size was expanded from one square foot to two square feet.
- The model was built with rattan poles and metal connectors.
- Rattan poles were used instead of PVC pipes. At the time of fabrication, the team had an easy access to rattan poles and can be bought very cheaply. While the author did not agree in using rattan poles for reasons of environmental conservation, its use opened up the possibility of using bamboo slats that will be joined with metal or plastic connectors.
- A tailor prepared the plastic sheets by sewing them according to prescribed size of the dryer.
- A tray was made of metal wire mesh was fixed.
- A second layer of plastic sheet was laid over the dryer to overcome the lack of momentum.

- Because of the expanded size of the dryer compared to the Daet model, there was a relative ease in laying out the materials unto the tray.
- On April 2014, news came to the author that it was finally been tested with fish. With the second layer of plastic laid over the dryer, and an outside temperature of 36 degrees Celsius, it only took two hours to dry a kilogram of fish and has been almost cooked.

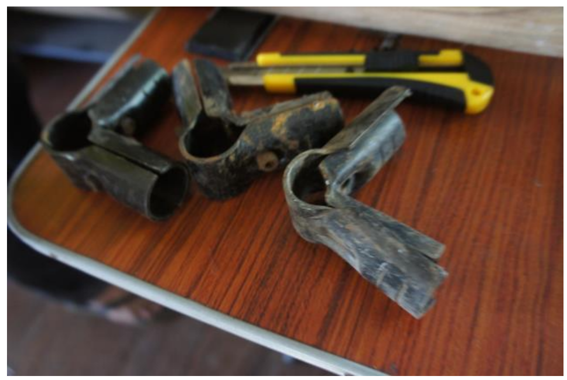

Figure 16. The solar dryer tower as it was being tested in the City of Danao (left photo). It was built with rattan poles that were fixed with metal connectors (top photo). The lower two thirds section of the dryer serves as the hot air generator while the upper one third serves as the drying section.

9.1. Observations

- The dryer was effective in drying fuel but very slow; possibly because of its small size.
- It would topple down easily from strong winds because of its narrow base.
- Setting the materials unto the drying tray could be difficult especially for short persons.

- One important realization came up while writing this paper. While this model may fit unto congested neighbourhoods, such a location will not provide enough sunlight. In a worst case scenario, the dryer may not receive any sunlight at all considering the urban poor communities are very crowded.

10. **Building the Solar Dryer with Community Volunteers.** From June 19 to July 1, 2014, a training series was launched by the Save the Children under its solid waste management program for seven selected villages of the towns of Calumpit and Hagonoy in the province of Bulacan. The author served as the training facilitator and resource persons for the technologies on composting, natural plant ferments, holey briquettes, holey roket stoves and solar dryers. The participants from seven participating villages built one set of each technology which they will promote into their respective villages.

Figure 17. Top photo shows the author teaching a woman volunteer use the electric drill to bore holes into the PVC pipes of the dryer during the skills training on June 2014. The training was part of the campaign of the Save the Children to create

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Philippines 17 July 2014

a pool of village technicians who will help their respective villages create solutions for the pollution caused by poorly managed garbage.

11. **More Conceptual Design.** All the lessons learned during the Sorsogon study was transformed into the following conceptual design called the **3n1 Kitchen Dryer.** It is a stove, a dryer and a fish smoker. It is powered by the excess coming from the stove as well as the heat from the sun. It was meant to allow families to continuously dry their products with or without the sun and as long as something is cooking in the kitchen. The hot gases escape from the stove through a metal pipe and goes through a fish smoking chamber before it finally goes out at the top of the vent in the chimney. The hot pipe heats up the air around it which goes to the drying chamber. As soon as there is sun, the hot pipes are reinforced by the greenhouse effect in the plastic drying chamber.

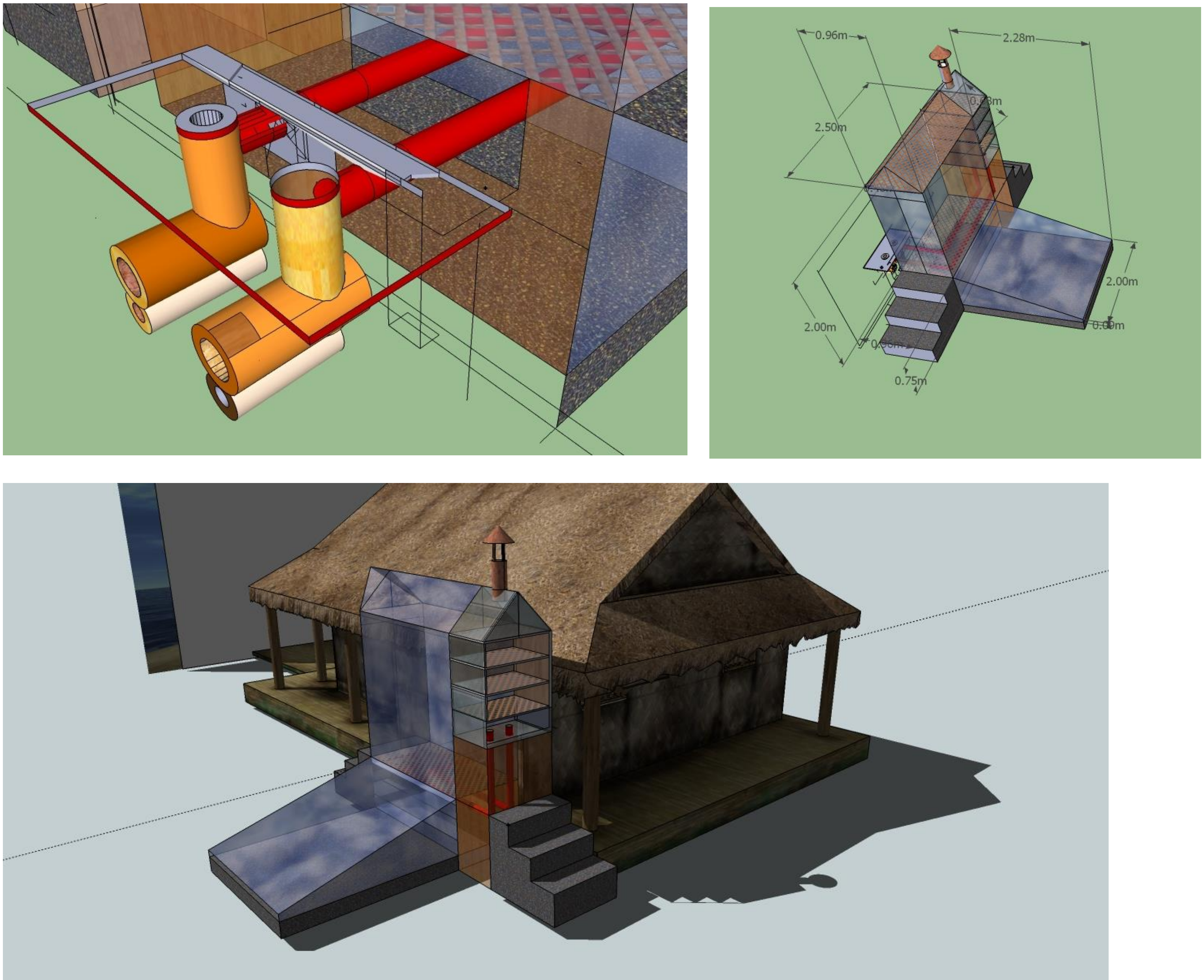

Figure 18. A conceptual design of the 3n1 Kitchen Dryer, Joshua B. Guinto, August 2011. The dryer will serve as a stove, a dryer and a fish smoker and may be used during sunny as well as rainy days.

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Philippines 17 July 2014

Figure 19. The solar dryer tower may further be reinforced with a heat bank. It could be in a form of a gabion, a cylinder of a wire mesh which is filled with boulders and gravel. This will effectively absorb heat during day time and slowly release them at night time or whenever there is less sunlight.

12. Conclusion

Beginning from the year 2000, this project was able to create different models using a wide variety of materials and in different social and bio-physical contexts. It was also able to transcend different sectors of people and their needs. To respond to the challenges that the project earlier faced to respond, the following are the summaries.

Objective 1: Identify technical mechanisms that will improve the performance of the dryers. The project was able to identify and create several technical mechanisms:

- **Installing heat banks using black sand and boulders.** This effectively extended the effectivity of the dryer and reduced the spoilage of the products.

- **Installing double plastic housing.** This will multiply the power of the dryer at a very minimal cost. The challenge however is how to keep the distance between the two plastic sheets consistent in the entire body of the dryer.

- **Transforming the traditional piano shaped dryer to a winged configuration.** The new configuration improved the contact of the dryer to the sunlight by having the hot air generators at both sides of the dryer.

- **The use of bamboo instead of rattan and PVC.** Bamboo is a fast growing plant species and thus will have a very minimal impact to the environment if fully utilized. However, in very wet conditions, bamboo may eventually be overrun with fungus and pests if the plastics would wear off and left un replaced. Joining the bamboo at its ends is very tricky and would require added skills. The use of plastic or metal connectors may help overcome this difficulty. It will be the subject of the next rounds of prototypes.

Objective 2. Identify social mechanisms that will enable people to fully utilize the advantage of the technology.

- **Open source technology**. The project benefitted from the designs and ideas that are freely being shared in the social media. With free access and without any copyright restrictions, the project was able to create new designs which were likewise shared in the same media.

- **Participatory technology development.** Fabrication of the designs solicited the participation of local artisans. New materials and techniques are welcome and were tested. While the dryer technology is very new to most of the communities that were involved, the author very much welcomes any innovation that may evolve as it is being used.

- **Using local resources.** The prototypes used bamboo, pvc pipes and rattan as building materials. It also used plastic and metal connectors.

Objective 3. Identify paths and trajectories for creating sustainable livelihood models. This work is continuing. It will have to co-evolve with the particular user community and its natural resource base. While it is at this ground breaking stage, several challenges were already identified.

During the entire period, the technology was able to support and reinforce other village enterprises namely drying fish, production of holey briquettes, drying wood fuel, production of holey roket stoves, drying and dehydration of vegetables.

- **Dried fish** that were barely touched by flies and those that come in different specialized flavours has a sure market advantage. Constructing dryers that were custom built for a particular client would also be an income generating project.

- **Supporting home gardens.** It can also facilitate activities related to production of bio char and fish amino acids as fertilizers which were then used to create home gardens.

- **Providing cheaper fuel.** Wood sticks, holey briquettes and all other kinds of biomass materials will dry very well inside the solar dryer. Should the family enter into a serious food business using the dryer, a separate dryer will have to be constructed for drying non-food items.

  - **Skills training.** There are enough skills and materials and more than enough needs in the villages for solar dryers. Instead of selling them sophisticated dryers, creating a pool of local artisans will better boost all other related activities from managing biomass wastes, clean cook stoves, processing food and others.

  - **Promoting food security and disaster preparedness.** Dehydrated food would have a strong market in the emergency response sector. Farmers and fisher folks may use this technology as their advantage to process their harvests and sell it to the open market or better yet, to the Disaster Risk Reduction Office. Section 21 of the Republic Act 10121 or The Philippines Disaster Risk Reduction and Management

System , Local Government Units are obliged to prepare a stockpile of supplies in anticipation of emergencies. This will create improved income for the farmers and fisher folks as well as savings on the part of the LGUs. This will also reduce the stress on the part of the affected families by cutting down the response time of the rescue workers. The stress may be reduced to a minimum if families would have the habit of stockpiling their own emergency food supplies by purchasing them early enough from a local food processors in their neighbourhood.

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