EXPLORATORY STUDY ON HOUSEHOLD ENERGY PRACTICES, INDOOR AIR POLLUTION AND HEALTH PERCEPTIONS IN SOUTHERN PHILIPPINES

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EXECUTIVE SUMMARY

Under cooperative agreement with USAID/Washington, Winrock International undertook an exploratory study on household energy, indoor air pollution, and perceptions of health impacts in Southern Philippines, with two primary objectives: to determine the extent to which indoor air pollution from cooking practices represented a serious problem meriting consideration of a household energy intervention; and to pilot survey and monitoring instruments for use in the design and evaluation of household energy interventions, in the Philippines and/or in other country contexts. The study involved 120 households across three areas in which Winrock is implementing the USAID/Manila-supported Alliance for Mindanao Off-grid Rural Electrification Project (AMORE). This report summarizes the results of the focus groups, household energy practices and health perceptions survey, and indoor air pollution monitoring activities that comprised the study.

Although nearly 75% of the women surveyed cook with biomass over open fires, the study suggests that the pollution caused by cooking does not represent a serious health risk to the women in the study area. The indoor air pollution (IAP) monitoring conducted in a subset of 30 households revealed very low 24-hour average area concentrations of particulate matter (PM4) and carbon monoxide (CO, as a potential proxy for PM): 72 $\mu g/m^3$ and 1 ppm, respectively. Personal exposure monitoring of CO, which is commonly measured as a proxy for PM from biomass smoke, also revealed very low 24-hour averages (1 ppm); however, peaks of acute exposure were evident during cooking times, typically ranging between 20-40 ppm at these times, with instantaneous peaks up to nearly 200 ppm. While less research has been conducted on health outcomes associated with acute exposure to CO, the researchers on this study consider this an issue that should not be overlooked for future monitoring efforts. As a proxy for PM, the results of this study highlight the fact that low 24-hour averages of PM can mask the acute exposure that women have to PM during cooking periods.

In general, the kitchens in the areas monitored are separate from the living space and appear to be well-ventilated. Further, the broader survey and the focus group discussions administered as part of this study indicate that although they are not aware of specific respiratory and other diseases that can result from acute exposure to IAP, women are bothered by both the smoke and the heat of the cooking fire, and believe that these have harmful health effects both for themselves and for their children, reportedly taking measures to keep their children away from cooking fires. Although more detailed observation would be needed to verify this behavior, there is reason to believe that women's and children's exposure to indoor air pollution is not a major health risk. It should be noted, however, that the monitoring was conducted in a relatively small sample of households, and further, that although the season was characterized as rainy, it did not rain during the monitoring activity. It is unclear whether the kitchens would be less-well ventilated during rainy times due to window closure or other practices, such as a shift to indoor cooking for the women who cook outdoors in good weather.

A determination of whether to undertake a household energy intervention should consider not only women's and children's exposure to indoor air pollution, but also the broader health, socio-economic and natural resource impacts of a population's dependence on biomass, and the extent to which the population perceives a need for improved conditions. In this light, both the focus group discussions and the survey confirmed that the primary cooks in the family (women aged 16 to 60) do perceive that smoke and heat from cooking fires cause is detrimental to health or aggravate common symptoms, including excessive coughing and shortness of breath, among others. Fuelwood gathering is common, typically requiring 1-2 trips per week; due to this inconvenience, as well as to the scarcity of fuelwood in some areas, fuelwood is purchased. The study revealed that mangroves are threatened due to pressures for fuelwood. Cleaner fuels, including LPG, were present in a number of homes, but only infrequently used due to the cost and limited availability in some cases. Thus, the introduction of cleaner and more efficient biomass stoves would help to address a perceived health problem, and reduce drudgery, expenditure, and pressures on a tenuous natural resource base.

The focus group discussions, the survey on household energy practices, indoor air pollution and health perceptions, and the IAP monitoring protocols proved to be an effective combination of instruments for assessing both the actual IAP levels in typical households, and the broader conditions and perceptions of the women in relation to their cooking environments. This piloting activity has enabled the identification of several specific ways in which each instrument and its respective application can be improved with modest changes to ensure greater efficiency and accuracy of data collection and processing, which will enable them to be adapted for use in developing and monitoring future household energy and health interventions in the Philippines or other country contexts.

LIST OF ACROYNMS

AMORE – Alliance for Mindanao Off-grid Rural Electrification
BRECDA – Barangay Renewable Energy and Development Association
CDW – Community Development Worker
CO – carbon monoxide
FGD – Focus Group Discussions
IAP – Indoor Air Pollution
LPG – Liquefied Petroleum Gas
NGO – Non governmental organization
PM – particulate matter
PVC – Poly vinyl chloride
REAP-Canada – Resource Efficient Agricultural Production Canada
SES – Socio-economic status
US NISOH – US National Institute of Occupational Safety and Health
USAID – US Agency for International Development

Currency conversion factor: US$1 = 55 Philippine pesos (PhP)

BACKGROUND

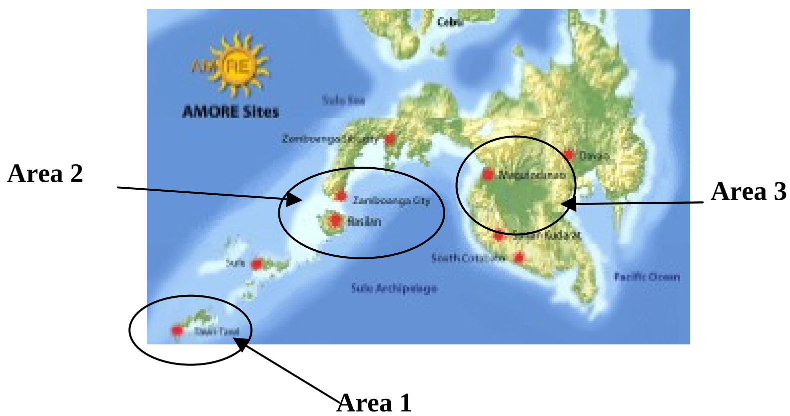
Winrock International undertook an exploratory study on household energy, indoor air pollution, and perceptions of health impacts in Southern Philippines, with two primary objectives: to determine the extent to which indoor air pollution from cooking practices represented a serious problem meriting consideration of a household energy intervention; and to pilot survey and monitoring instruments for use in the design and evaluation of household energy interventions, in the Philippines and/or in other country contexts. This report summarizes the results of the focus groups, household energy practices and health perceptions survey, and indoor air pollution monitoring activities that comprised the study.

The impetus for an exploratory study in Southern Philippines arose through Winrock's involvement in implementing the first phase of the Alliance for Mindanao Off-grid Rural Electrification (AMORE) project supported by USAID/Manila. The major focus of the AMORE project is to facilitate the use of renewable energy technologies for household lighting and entertainment, economically productive/livelihood activities projects, and certain community services. However, Winrock had received anecdotal information that indoor air pollution was considered to be a problem in the project area, and recommended that a preliminary study be done to objectively assess and the severity of the situation, including women's perception of the health impacts and other burdens of household energy.

At the same time, USAID/Washington, through the Environmental Health and Urban Energy teams, had for the first time committed joint funding for household energy and health, through initial activities implemented by Winrock. It was agreed that an exploratory study in the Philippines would be worthwhile both for the potential opportunity to facilitate a comprehensive rural energy project through piggybacking a household energy intervention on a large rural electrification project, and for the value of developing and field testing instruments for establishing baseline information and for monitoring of household energy interventions designed to reduce exposure by women and children to harmful indoor pollutants. It was agreed that the exploratory study would assess general practices and perceptions, as well as include scientific measurements of indoor concentrations and personal exposure to particulate matter and carbon monoxide.

METHODOLOGY

This study covered 120 households located in three different provinces in the southern island of Mindanao, where AMORE is implemented: Zamboanga, Maguindanao and Tawi-tawi. All 120 households (40 per province) participated in a household energy practices, indoor air pollution and health perceptions survey. Indoor air pollution was measured in a subset of 30 households (10 per province). Households were selected for participation in the survey and monitoring through a series of participatory appraisals in 5 villages across the three areas. Focus group discussions were held in 5 villages to gather formative information and to help identify questions that could be eliminated from the survey to reduce the imposition on respondents.



The selection of villages was facilitated by the Area Managers of the AMORE project, with the aim to select communities representative of the area and also accessible for logistical purposes. The chosen areas in Zamboanga and Tawi-tawi were island communities. The houses in these two areas were located along the coast of the islands, some built on stilts on the sea near the beaches. The two selected communities in Maguindanao were inland and in mountainous areas. The municipalities covered were Bongao in Tawi-tawi, and Buluan in Maguindanao, and Tigtabon, Zamboanga City in Zamboanga. The latter is the island-rural area which is still part of Zamboanga City.

Table 1 Villages selected for FGDs, survey and monitoring

	Area 1: Tawi-Tawi Village (Municipality)	**Area 2: Zamboanga** Village (Municipality)	**Area 3: Maguindanao** Village (Municipality)
Focus Group Discussions *7/7/04 – 7/14/04*	Tongsinah (Bongao) Lagasan (Bongao)	Lower Kabenbeng Sumisip (Basilan)	Kalian (Buluan) Tumbao (Buluan)
Survey	Tongsinah (Bongao) Lagasan (Bongao) *9/23—29/04*	Tigtabon (Zamboanga City) *8/10–14/04*	Tumbao (Buluan) Kalumenga (Buluan) *9/6—9/04*
Monitoring	Tongsinah (Bongao) Lagasan (Bongao)	Tigtabon (Zamboanga City)	Tumbao (Buluan) Kalumenga (Buluan)

Local Winrock project staff were hired to implement the survey and IAP monitoring, while an expert was hired from IRG-Philippines to implement the focus group discussions, and consultants from the University of the Philippines and East-West Center were hired to refine the protocols, conduct enumerator training, and complete data processing and analysis. A lab at the Philippine Nuclear Research Institute was hired to pre-condition and weigh the filters for the IAP monitoring.

This field work of this study took place between July and September, 2004. The survey was translated into the most common language, Tagalog, and back-translated for review by local Winrock staff in July. Although distinct dialects are spoken in each of the three study areas, it was expected that most people understand and speak Tagalog, and enumerators would be selected from each of the areas to ensure adequate communication. Participatory appraisals and focus group discussions took place in July, following which minor modifications were made to the survey based on local terminology and conditions. The survey and monitoring was first piloted in “Area 2” (Zamboanga) in August. Data from the CO monitor was downloaded and sent to the expert consultants for review and feedback to the field supervisor. The remaining areas were surveyed and monitored in September. Data cleaning was completed in October, and analysis conducted in November and December.

Winrock staff based in Manila led coordination of the field work, including working with Area Supervisors, the three enumerator teams and the University to select communities, coordinate transportation, data gathering and transmission to Manila, Winrock/Arlington, and East-West Center in Hawai.

The following sections provide details of the activities undertaken, along with the findings and conclusions. General recommendations based on the outcomes of the focus group discussions (FGDs), survey and monitoring, are provided in the main body of the report. Recommendations on improvements for the instruments themselves are included in Appendix 5.

PARTICIPATORY APPRAISALS

Participatory appraisals were conducted in all three study areas over a two week period, between end June and early July 2004. The objectives of these appraisals were: 1) to inform local inhabitants about the purpose of the study and proposed activities; and 2) to select volunteer households for the survey and indoor air pollution monitoring activities. The response in each area was overwhelming and local Community Development Workers (CDWs)[1] were responsible for selecting households according to pre-determined criteria. *See Appendix 1 for household selection criteria.* All three PAs were conducted by an expert who is also the Community Development Supervisor for Area 2

[1] Community Development Workers (CDWs) are professional development workers hired under the AMORE project. They have in-depth knowledge of the areas and are familiar with the communities’ rural energy needs from an electrification and rural productivity standpoint. Winrock and AMORE staff agreed that the CDWs were best positioned to facilitate community selection and meetings pertaining to the household energy and health study.

under the AMORE project. In addition, the BRECDA chairman of each area was also kept abreast of these activities

FOCUS GROUP DISCUSSIONS

Focus group discussions (FGDs) were held in a sample of "barangays" (villages) to obtain qualitative information to complement the findings of the survey. The International Resources Groups – Philippines (IRG-P) was contracted to undertake this activity.

Methodology

The following were the hypotheses of the FGDs:

1. Biomass fuels are most commonly used for cooking in AMORE project areas where anecdotal evidence suggests that smoke generated while cooking adversely affects women and children.
2. Women, as primary food preparers in the household, are aware of the physical discomforts associated with smoke emitted from cooking activities, and may be aware of specific disease impacts on themselves and their children.
3. Young children tend to accompany their mothers while they cook, leading to elevated exposure to smoke.
4. Women are predominantly involved in fuel management (collection, preparation and use), and are exposed to harsh conditions and physical stress that impact negatively on their health and personal safety.
5. Access to cleaner fuels and improved stoves is limited by a number of factors, including most importantly: financial constraints, lack of awareness of the benefits of cleaner fuels and stoves, and lack of availability of cleaner fuels and technologies.

The FGD expert was given a draft questioning guide which was based on the FGD guide developed by ITDG/University of Liverpool for the Shell Foundation pilot project in India. The expert then modified it in order to fit the Philippines context *(See Appendix 2 for the FGD topic guide).* A total of 5 FGD sessions were conducted in five different villages/barangays. Each session had between 8 to 10 participants who were all women. The AMORE community development worker (CDW) coordinated in advance with the BRECDAs (Barangay Renewable Energy and Development Association) in each barangay to select participants and fix the schedules.

Findings

Additional Observations:

- Use of fuelwood from mangroves may indicate that depletion of mangrove forests is an issue in the study areas. (Mindanao has 32% of the country's 150,000 ha of mangrove forests[2]). Some households in the village of Tongsinah use LPG because of its proximity to the mainland and relatively better financial situation of the households. As seen in other parts of the world, LPG is used for cooking tasks that require relatively less time.

- While in Tumbao there are no sanitary toilets and water is taken from dug-wells, in Tongsinah all houses have proper toilet facilities. This may be due to the varying history of these villages. Tumbao has typically been the scene of rebel insurgency while Tongsinah has seen more stability with the majority of its households involved in trading. Government health centers are not commonplace. Similar views were expressed by residents of Lower Kabengbeng who go to nearby Sumisip health center for medicine.
- The clay dapulans are used for cooking with charcoal made from either coconut shell or wood. Coconut charcoal seems to be more expensive selling at about PhP 80 -150 (US$1.50 – 3.00) per sack compared to wood charcoal which sells at PhP 1-10 (US$0.02 – 0.20) per small bag.[3] With earnings ranging from PhP 3000 – 5000 (US$55 – 91) per month, most families are not able to afford LPG.[4]

SURVEY ON HOUSEHOLD ENERGY PRACTICES, INDOOR AIR POLLUTION AND PERCEPTIONS OF HEALTH IMPACTS

Objectives

Winrock developed the survey on 'Household Energy Practices, Indoor Air Pollution and Health in the Philippines' to assess household fuel use and cooking patterns, as well as to gather information on local knowledge, perceptions and attitudes towards indoor air pollution and possible ways to reduce exposure to smoke. The results of the survey were expected to assist with a primary objective of determining the severity of indoor air pollution and associated impacts in order to enable a recommendation to the USAID Mission in Manila on the inclusion of a household energy intervention as part of its large-scale Alliance for Mindanao Off-grid Rural Electrification (AMORE) project in Southern Philippines. Further, this was an opportunity to pilot the survey along with focus groups and indoor air pollution monitoring as complementary protocols to be refined for future application in the design and evaluation of household energy interventions.

Methodology

This survey is heavily based on the Intermediate Technology Development Group's (ITDG) smoke and health study,[5] currently underway in Kenya, Sudan, and Nepal. Winrock aimed to adapt the survey to local conditions, and to update it based on current thinking on household energy and health monitoring. Winrock consulted the World

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[2]'Coastal Resource Management Project: Understanding the Philippines Coastal Environment' accessed on January 19, 2005 http://www.oneocean.org/about_crmp/coastal.html
[5] Follow-up should determine equivalency in standard units (e.g. kg).
[4] GDP per capita in Philippines = US$ 4,600 (Source: CIA World Factbook, 2004)
[5] "Reducing Indoor Air Pollution in Rural Households in Kenya: Working with the Community to Find Solutions." ITDG Smoke and Health Project, 1998-2001.

Health Survey and the Environmental Health Project's Hygiene Improvement Household Questionnaire: Knowledge, Practice and Coverage of Water Supply, Sanitation and Hygiene, for relevant questions and format. Various experts from household energy, indoor air pollution, and health sectors provided comments on the survey.[6] The survey was accompanied by an enumerator's manual which explained key questions, offered guidance on how to record responses, and provided visual illustrations. The structure of the manual was also largely based on ITDG's interviewer's manual which accompanied the household and monitoring questionnaire for the Smoke study.

The survey contains seven main categories: households' socio-economic condition; cooking practices; cooking technologies; fuel use; health perceptions; and a final section for enumerator observations on house and kitchen characteristics. Questionnaires for households which were monitored for indoor air pollution contained an additional section of post-monitoring questions which were asked to validate the results of the monitoring.

The survey was translated to the primary Philippine language, Tagalog, and back translated. While several local dialects are spoken among the three study areas, it was agreed that most of the population speaks or at least understands Tagalog, and thus the survey was not translated into all local dialects.

Forty households in each of the three study areas were selected by Community Development Workers according to two basic stratification criteria. The first pertained to membership with the Barangay Rural Electrification Development Associations (BRECDAs). It was assumed that households that were BRECDA members would either already have received (and be paying for) solar household systems under AMORE or be eligible for one; as such, these households appear more likely to be early adopters of innovations, and may have more disposable resources than non-BRECDA households. Thus, a combination of BRECDA and non-BRECDA households was selected to provide a balanced representation of households. The second criterion was to have a mix of households located on land and on stilts, to represent typical conditions of households in the region and to better understand whether this factor influences fuel use and ventilation patterns and thus indoor air quality. *See Appendix 1 for household selection criteria.*

Fourteen local enumerators with survey experience under AMORE were recruited to administer the survey, with one team for each of the three areas. Enumerators underwent a two-day training in Zamboanga City led by an IAP expert from the University of the Philippines which provided a thorough overview of the survey, provided practice sessions and reviewed the implementation plan. *See Appendix 3 for training guide.*

The primary cook, or in her absence the secondary cook, was chosen as the main respondent for the survey. Consent from the household head and/or the main respondent was obtained with the help of consent forms prior to initiating the survey. The survey took between an one and one-and-a-half hours to complete. As compensation, households

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[6] Prof. Kirk Smith (UC Berkeley), Liz Bates (ITDG, UK), Prof. Nigel Bruce (University of Liverpool, UK), Eckhard Kleinau (John Snow Inc.), and Eva Rehfuess (World Health Organization), among others.

were provided with a small token consisting of rice, sugar, powdered milk, and noodles (for a total value of approximately US$2).

The survey was conducted in the three areas in consecutive periods between August and September, in conjunction with the IAP monitoring activity. AMORE Area Managers assisted with supervising the enumerators. The survey activity had to be carefully coordinated with the monitoring activity, as enumerators returned to the 'monitored' households to ask some post-monitoring questions.

Results

Comments on implementation

The fact that two of the study areas were island communities provided logistical challenges to the survey team, and in some cases delays due to infrequent availability of boat or plane transportation. Other field delays were experienced when one of the area coordinators contracted chicken pox and had to recover beyond the point of contagion before the survey could commence.

Regarding survey language, although Tagalog is supposedly widely spoken in the country, local dialects were still preferred or better understood by respondents. Thus, sometimes, the interviewers had to translate the questions themselves.

Household Profile

An analysis of household assets (furniture/equipment/appliances) reported by the respondents reveals that 78% of the households fall in the lowest category of socio-economic class in the Philippines, with most of these earning less than 5,000 pesos (roughly US$90) per month. This generally applies to all three regions, although it appears that Maguindanao houses have comparatively fewer assets than the other two areas, except for land. In terms of entertainment-related assets, Tawi-Tawi houses seem to have the most.

It is notable that despite the low socio-economic class, a significant percentage of households have multiple entertainment-related appliances. For example, in Tawi-Tawi, 68% have radios, 45% radios with cassettes, 23% color TVs, and 20% VCRs; in Zamboanga, where 80% of the households own fishing boats (compared to 8% and 30% for Maguindanao and Tawi-Tawi, respectively), radios are also very common, 28% have color TVs, and 50% have black and white TVs. While having these entertainment items does not necessarily imply that households would choose to invest in improved cooking appliances, it does suggest that some capacity exists for purchasing items of value.

A very small percentage of households claimed to have kerosene stoves (wick, gravity, or "dibomba" (pump type apparatus) or LPG stoves, with the highest percentage being 5% in Zamboanga with the kerosene dibomba stove. A slightly larger portion own kerosene wick lamps (7.5% in Tawi-Tawi, 5% in the other two areas).

Further discussion of household assets and incomes is included on page 16. *(See Appendix 6 for data tables.)*

Cooking Practices

The age of the respondent ranged from 16-60, with an average of 36 and median of 33 years. Primary and secondary cooks generally begin cooking between the ages 11-15. Nearly all (98%) the households reported that they cook for exactly all the members of the household (not less not more).

It was observed that this is a community that predominantly cooks indoors and that the kitchen/cooking area was for most houses (86% in the dry season and 78% in the rainy season) not the same room as the living room. Kitchens have either one or two windows (54% and 46%, respectively). Outdoor cooking was more common for houses on land compared to those on stilts.

Changes across the seasons are not significant except for those who cook outdoors with no walls (and it is likely that in the rainy season just these houses cook in the same space as the living area). Though the questions about location of cooking allowed for more than one response, we observed that nearly all households mentioned just one location in both seasons. Therefore, there is no need to study the change in stove types in each different location. In future questionnaires this change can be made, simplifying the questionnaire and the data analysis. There is greater likelihood that different meals are cooked with different devices rather than devices varying across locations inside a house. The latter aspect should be probed at length in focus group discussions.

Most women (63 % of the households) indicated that they cook on a raised platform. This has important implications for designing interventions as well designing exposure assessment protocols (for the latter case, implying that breathing zone during cooking should relate to a person who is standing). This was reported by users of kerosene and LPG stoves, but was also reported by a large number of open fire (*dapulan* three stone and rebar) users. In this case, these were households that also used kerosene or LPG occasionally. Of particular relevance to infant exposure to smoke, less than 5% of the houses reported that an infant is present near the fire during cooking. However, observation would be needed to verify behavior with respect to infant and child proximity to fire, and duration of that proximity.

The vast majority (>84%) cook 3 meals a day and the pattern is same across the seasons. It was noted, however, that in the sub-set of houses that were selected for monitoring there was a substantially greater fraction (40%) that cooked four meals on the day of monitoring. A potential explanation may be the fact that some of the houses cooked for the monitors since they were treated as visitors or cooked for selling, hence 4 meals were made.

It was observed that 20% of the households cooked food or drink for sale. As shown in the table below, the dapulan open fire (using three stones or rebar pot support) was the most commonly used for cooking, followed by kerosene wick stoves and Mayon turbo stoves.[7] It should be noted, however, that in absolute numbers, the kerosene and Mayon turbo stoves were very few. We observed that the same device is used to cook all the meals of the day. Those households that prepare food for sale largely use the same device as they use for cooking their own food. Overall, when food is cooked for sale there is a greater tendency to use wood as a fuel (as implied by adding number of users of open fire and biomass stoves). A question for future observation is whether the type of food cooked for sale determining use of wood.

Table 2 Cooking devices used

Type of cooking device	Cooking for self (n = 120) %	Cooking for sale (n=17) %
Open fire (dapulan three stone or rebar)	57.6	64.7
Charcoal stove	6.8	0.0
Biomass stove without chimney	0.0	5.9
Kerosene wick stove	16.1	11.8
Mayon turbo stove	13.6	11.8
Others	5.9	5.8

Generally, a single meal cooking time did not exceed 2 hours. Meals cooked during the latter part of the day were of longer duration, as is common. The current survey design does not permit computing the cumulative time spent cooking in a day.[8] Though the houses that cook food for sale are few, they tend to cook the sale food for long periods of time.

All women reported to use a lid to cover the pots when cooking. A majority of the houses cook rice, vegetables and small fish under 30 minutes. Large fish, root crops and meat was reported to take 30-60 minutes, and sometimes longer, to cook. Fish is commonly cooked for sale, and takes slightly longer to cook than other items, particularly when it is the larger fish used for feeding more people than the average family. When women cook for their own family they usually cook 2-3 dishes; seldom do they cook just a single dish. However, when cooking for sale they typically cook 1-2 dishes.

Cooking Technology

<u>For users of open fire</u>

In the three areas surveyed, many people cook over open fires, using either a 3-stone arrangement, or a pot support made of rebar. The Tagolog word *dapulan* refers to both of these open-fire arrangements, as well as to a mud stove used with charcoal. The survey distinguished between these three uses of *dapulan*.

[7] Mayon turbo stoves were designed to operate with agricultural waste, and are manufactured in the Philippines . See Appendix 4 for photos and descriptions of stoves commonly found in the area.
[8] It is recommended the related questions (B13 on time to cook each meal, and B15 on time to cook each food type) be modified to be treated as continuous variables rather than categorical responses.

The survey found that out of 89 houses that reported cooking over an open fire, 90% use a rebar support and the rest use three stones. About 68% of these *dapulan* users expressed liking to cook over the open fire, although cost of fuel appears to be the most critical factor for this group.

Table 3 Reasons for liking or not liking open fires

View about open fires	% respondents	
	Like to cook over open fire	Do not like to cook over open fire
Food tastes better	40.0	20.7
Cheaper than other alternatives	64.6	20.7
Alternatives not available	15.4	3.4
Not aware of alternatives	4.6	10.3
Good source of heat	7.7	3.4
Produces more smoke and soot	4.6	27.6
Takes longer to cook	1.5	3.4
Uses more fuel	1.5	10.3
Open fire causes accidents	1.5	20.7
Other	6.2	13.8

There also seems to be strong cultural belief that food cooked over an open fire tastes better. Among the negative perceptions about fuels, the smokiness of open fires ranked highest. Those who like to cook over open fire see mainly positive aspects associated with such cooking. We can speculate that a lack of awareness of alternatives contributes to this, but there are no questions that measure the natural awareness of the respondents about alternatives. On the other hand, those who do not like to cook over open fire also admit that there are some positive aspects of cooking with open fire. Longer time taken to cook over open fire was not a consideration for either of the groups. As is to be expected in a warm tropical climate, stoves as a source of space heating is not an important consideration.

Table 4 Among stove users, number of stoves and types used

Stove type *(See Appendix 4 for photos and descriptions)*	**Households with stoves**	
	# HH with 1 stove	# HH with 2 stoves
Anagi Liyab		2
Mayon Turbo		2
Cement charcoal stove	16	4
Pugon	6	2
Other biomass stove	13	
Biomass stove with chimney	2	
Charcoal stove	29	5
Kerosene wick stove		
Kerosene gravity stove	2	
Kerosene dibomba stove	2	
LPG stove	18	
Solar cookers		
Other stoves	44	5

The above table indicates that 152 stoves are owned by 120 households. There are 29 houses that own a single charcoal stove and 5 that own two such stoves. In all, about 25% of the houses own more than one stove. It is noteworthy that even after defining as many as 12 distinct types of stoves, there were 49 cases of stoves of unknown type (other stoves). This area needs further attention in the manual and questionnaire. As shown in the table below, only kerosene and LPG stoves are entirely purchased commercially. About 14-22% of other types of stoves are constructed at home. Charcoal and biomass prices range from 50-500 PhP (approximately US$1 – US$9), with the average charcoal stove being less expensive than the average biomass stove (no chimney), and the kerosene stove and LPG stoves costing more than 500 PhP.

Table 5 Stove types and source of stoves

Stove type	**Source of stove**			
	Constructed at home %	Purchased %	Given by relatives %	Other %
Biomass stove without chimney	14.3	85.7		
Stove with chimney	14.3	71.4	14.3	
Stove without chimney		100		
Kerosene stove		100		
Charcoal stove	17.9	82.1		
LPG stove		100		
Other stove	21.8	34.5		41.8

The vast majority of women (89%) said they are satisfied with their stove and of these, 92% plan to replace the stove with a similar one when the current one wears out. Among those who were not satisfied with their stove, all planned to replace the stove. Respondents were asked about their reasons for not using alternative fuels or cleaner cooking devices. As shown in the table below, in the case of kerosene, women indicated that the unavailability of the fuel was the main reason for not being able to use kerosene stoves. For LPG the cost of the fuel is the main barrier. Due to low level of electrification in the region it is no wonder that many are not aware of electric stoves. Many are also not aware of solar cookers; for these cookers, 31.7% said that fuel is very expensive.[9]

Table 6 Reasons for not using alternatives to open fires

Reasons for not using alternatives	**Kerosene (n = 85) %**	**LPG (n = 90) %**	**Electricity (n= 77) %**	**Solar cooker (n= 60) %**	**Other (n = 2) %**
Stove too expensive	17.6	2.2	6.5	8.3	50.0
Fuel too expensive	22.4	47.8	15.6	31.7	0.0
Stove not available	2.4	3.3	14.3	3.3	0.0
Fuel not available	41.2	32.2	6.5	1.7	0.0
Not aware of options	7.1	8.9	45.5	31.7	0.0
Other	9.4	5.6	11.7	23.3	50.0

[9] Given that solar cookers do not require a purchased fuel, the more appropriate answer to this question would have been the option, "stove/cooker too expensive". It is possible the respondents were not familiar with the nature of a solar cooker. The structure of this question should be revisited, and additional attention paid to training enumerators to ensure proper data recording for this question.

Fuel use, collection and supply

Respondents were asked to indicate which fuels are the most important fuels used for cooking, followed by the second and third-most important. The format of the question appears to have been confusing for either the enumerators or the respondents, or both, as there are some inconsistencies in the responses recorded. In general, firewood appears to be the predominant fuel, for all uses except for fire lighting, for which kerosene and another unidentified fuel(s) are used. In response to this question, nearly 58% of the houses use an undefined type of fuel for lighting. In a follow-up question on lighting fuel, over 25% of the respondents indicated they used rubber slippers for ignition, which is of concern given the toxic fumes emitted.
Charcoal and LPG appear to be the secondary and tertiary fuels of choice, depending on the specific use. Coconut husks and fronds were classified as "other"; while the table below suggests that "other" fuels are primarily used for lighting, coconut husks and fronds were noted in the FGDs as a common fuel source. Some data inconsistencies[10] suggest that this question may need reworking and piloting by enumerators; focus groups can also help to bring clarity to the responses.

Table 7 Types of fuel use by specific activity

Activity	**Wood %**	**Charcoal %**	**Kerosene %**	**LPG %**	**Other %**
Cooking for home (n = 102)	55.9	28.4	2.0	13.7	0.0
Cooking for sale (n= 60)	63.3	15.0	0.0	20.0	1.7
Lighting (n = 69)	2.9	1.4	44.9	2.9	57.9
Heating water (n = 97)	59.8	25.8	2.1	11.3	1.0
Cooking animal food (n= 4)	75.0	0.0	0.0	25.0	0.0

The survey found that a significant percentage of the households purchase fuel, per table below, with no significant variation across the three geographic areas. Among users of wood as the main fuel, 57% rely mainly on gathering, typically once or twice a week regardless of the season. As high as 37% of the respondents collect wood every other day, if not every day. No respondents indicated that children assist with fuelwood gathering. Others buy fuelwood, largely due to scarcity of nearby sources and overall convenience. Among the houses that purchase fuelwood, the amount reported ranged from 1 to 21 bundles per week with an average of 8 bundles, with costs ranging from 10-300 PhP (or US$0.18 - $5.45) per week.

Users of other fuels mainly purchase the fuel. Eight people reported purchasing kerosene, on average 2 liters per week, with the cost ranging from 12-96 PhP per week, while 16 people reported purchasing a ¼ tank of LPG every week, with the cost ranging from 56-415 PhP per week.

[10] For example, there is no information from 18 houses about what the main fuel for home cooking is. Also, results from the previous section indicated that only 24 houses cook for sale, but in this table it is shown to be as high as 60.

Responses to these questions on fuel purchase and gathering revealed an inconsistency in the units reported, highlighting a need to improve how these questions are framed in order to be able to compare expenditures.[11] In addition, further analysis would be needed to explain the large variations in expenditures, for example, whether those households running a food business out of their homes spend significantly more on fuelwood and/or LPG than those that don't.

Table 8 Percentage of households that buy or gather fuel

Fuel gathered or bought	% houses
Mostly gathered	24.1
Mostly bought	17.2
All gathered	15.5
All bought	43.1
Other	0.0

Health Impacts

The objective of the health-related questions was to describe the general health status and perceptions in relation to indoor air pollution and selected socio-economic variables of the sample population surveyed.

METHOD

The variables used to analyze this section are following:

1. Health Outcomes
   a. Respiratory Symptoms and Illness among the respondents: asthma; cough in the morning; cough the rest of the day or frequent cough; cough at night; phlegm production; wheezing in past 14 days; wheezing after exercise in past 14 days; shortness of breath in past 6 months.

   b. Respiratory Symptoms and illness among children in the households:
      i. In the past 14 days: discomfort in the chest; asthma; wheezing; illness with fever; illness with cough; and difficulty of breathing.
      ii. In the past month: chest problems; phlegm production; shortness of breath; noisy breathing; and painful breathing.

2. Socio-economic Variables.
   a. SES class according to furniture/equipment/appliance ownership. Categories:
      Class 1 - highest SES class
      Class 2 – Middle SES class
      Class 3 – Low SES class
      Class 4 – Lowest SES class

[11] It is recommended that future analysis determine the expenditures as a percentage of monthly household income.

a. Monthly Household Income Class. Categories:
   Class 1 – 0-5000 Php (approx. US$90)
   Class 2 - >5000 – 20,000 Php (approx. US$357)
   Class 3 - >20,000 Php
b. Household size. Categories: </= 6 persons per household; > 6 persons per household

3. Indoor air pollution Variables
   a. Type of Cooking Fuel: wood, charcoal, kerosene and LPG
   b. Location of Cooking Facilities for Dry and Wet seasons
      Categories: 1- In a room used for living w/ partition,
      2- In a room living w/o partition,
      3- In a separate room used as kitchen,
      4- In a separate building,
      5- Outdoors with some walls,
      6- Outdoors
   c. Smokers in the Household: presence or absence

The data was analyzed using the Epi-info and stata software. Full description of the data was made with the frequency distribution and calculating for prevalence of the respiratory symptoms and illness. Then a bivariate analysis using the chi square test of significance was performed. Finally, a logistic regression analysis was made to arrive at the risk factors or predictors of the respiratory symptoms.

Results and Discussion of the Health Section with Selected Socio-economic and Indoor Air Pollution Variables

In determining the health status of the study population in terms of their socio-economic profile, certain socio-economic variables are described. For this purpose, these variables are the household size, Socio-economic status (SES) according to monthly income and SES according to furniture/equipment/appliance ownership.

The household size has an average of about 6.74 persons per household with a range of 2 to 11 persons per household. A household size of 6 is typical for the Philippines especially in the rural area. For the monthly income, majority of those surveyed (73%) have a total household income less than or equal to PhP 5,000.[12] Only 5% have income that is more than PhP 20,000 per month. This same pattern is seen when ownership of furniture, equipment and appliances were considered. More than 77% of the study households were in the lowest socio-economic class (class 4). This is followed by 22.5% in class 3, 8.3% in class 2 and only 3.3% in the highest socio-economic class.

Apart from these socio-economic variables, and the indoor air pollution variables of cooking fuel and location of cooking area, another variable which might affect respiratory health outcomes is cigarette smoking of the household members. Among the respondents, only 12.5% smoke regularly. However, about 48% of the other household

[12] At PhP 55/US$1: PhP 5,000 = US$91; PhP 20,000 = US$364.

members also smoke. Overall, a total of 61% of the households have smokers. The smoking rate among the respondents which is presumed to be the mothers and the overall smoking rate are much higher than in other rural areas (5% and 53% respectively) in the Philippines. (Pagbilao Study, 2003).

Perception of Health Effects of Smoke from Cooking by Respondents

Only a few of the respondents believe that smoke from cooking is beneficial (15.8%) and majority of them (84.2%) said that it is detrimental to health. For those respondents indicating they believe smoke is beneficial, they did not specify why. The perceived health effects of smoke by the respondents mentioned were irritation of the eyes, blurring of vision, excessive coughing, asthma, shortness of breath, headache and dizziness. In terms of the respondents' knowledge of the smoke's effect on respiratory diseases in children and adults as well as respiratory deaths in children, about one fourth to one third of the respondents admitted that they have no knowledge of such effects.

Further inquiries were made into specific health symptoms. The majority of the respondents perceived smoke from cooking as harmful for the eyes (81%) and may cause some cough and chest problems (63% and 55% respectively). The perceived eye effects specified ranged from minor irritation including itchiness, redness and tearing, to eye pain and blurring of vision. Those who said that smoke may cause chest problems mentioned tuberculosis and asthma as probable illnesses that one can get from smoke.

Table 9: Respondents who perceive that smoke has specific health effects

Illnesses/Symptoms *(n=120)*	**Frequency**	**Percent**
1. Eye effects	97	80.8%
2. Cough	76	63.3%
3. Chest problems	66	55%
4. Difficulty of breathing	49	40.8%
5. Headache	59	49.1%
6. Back pain	48	40%

Respiratory symptoms and illnesses among respondents

The following two tables summarize the number of respondents who experienced certain respiratory symptoms and illness. In table 10, more than 18% of the respondents had asthma and the most common respiratory symptoms were cough, phlegm production and tightness in the chest. The prevalence of asthma is comparable to other areas in the Philippines. These symptoms are indicative of an obstructive process in the respiratory system which may be of the infectious or allergic type.

Table 10 Respondents with respiratory symptoms and illness

Illnesses/Symptoms	Frequency *n = 120*	Percent
1. Asthma	22	18.3%
2. Cough in the morning	33	27.5%
3. Frequent Cough	65	55.2%
4. Cough at night	42	35%
5. Phlegm production	36	30%
6. Wheezing in past 14 days	18	15%
7. Wheezing after exercise in past 14 days	7	5.8%
8. Wheezing without exercise in past 14 days	6	5%
9.Shortness of breath in past 6 months	37	30.8%

However, not all those who have answered that they experienced the respiratory symptoms enumerated above, sought treatment for their conditions as can be seen in Table 11. For example, of the 22 respondents who claimed to have had asthma, only 5 respondents sought treatment for the said illness. The same pattern is seen among the respondents with the other respiratory symptoms. This occurrence could be due to accessibility of treatment; however, accessibility of treatment facilities for those who did not go for treatment was not explored in the survey. Not seeking treatment may also be due to the socio-economic status including educational background of the respondents.

Table 11 Respondents who sought treatment

Illnesses/Symptoms	Frequency *n = 120*	Percent
1. Asthma	5	4.2%
2. Cough	20	16.7%
3. Wheezing	3	2.5%
4.Wheezing after exercise	0	0
5. Wheezing without exercise	0	0
6. Shortness of breath in past 6 months	15	12.5%

Respiratory symptoms and illness reported among children

In the 120 households, there were a total of 447 children less than 15 years old. As seen from Table 12, the proportion of children who were reported to have experienced respiratory symptoms and illness in the past 14 days was not very large compared to the prevalence among the respondents. The same could be said with the respiratory symptoms experienced by children in the past month as seen in Table 13. However, more household respondents have reported occurrence of cough (45.8%) among the children in the past six months.

Table 12 Children who were reported to have experienced respiratory symptoms/illness in the past 14 days

Illnesses/Symptoms	Frequency *n = 120*	Percent
1. Discomfort in the Chest	11	2.46%
2. Asthma	15	3.35%
3. Wheezing	4	0.9%
4. Illness with Fever	45	10.06%
5. Illness with Cough	34	7.6%
6. Difficulty of Breathing	6	1.34%

Table 13 Households with children who had respiratory symptoms in the past month,

Illnesses/Symptoms	Frequency *n=120*	Percent
1. Chest problems	29	24.2%
2. Phlegm production	5	4.2%
3. Shortness of breath	14	11.7%
4. Noisy breathing	4	3.3%
5. Painful breathing	7	5.8%

Table 14 shows the symptoms and illness of children for which treatment was sought. Generally, the number of cases for which treatment was sought is much smaller than prevalence in the earlier table 11. This occurrence could be due to either of two issues. First, it could be that only cases cited in Table 10 were grave or severe enough to necessitate treatment; second, due to poverty, the other cases cannot afford to consult any health officer; or thirdly, there may be problems with the accessibility of health services.

Table 14 Households with sick children for which treatment was sought

Illnesses/Symptoms	Frequency *n = 120*	Percent
1. Discomfort in the Chest	12	10%
2. Asthma	2	1.7%
3. Wheezing	4	3.3%
4. Illness with Fever	16	13.3
5. Illness with Cough	11	9.2%
6. Difficulty of Breathing	1	0.8%
7. Cough alone	12	10.0%

The majority of those who answered that they sought treatment went to the village doctor (27.7% for the respondents and 33.3% for the children) or the government health center (33.3% for the respondents and 36.1% for the children). Only 12% of the respondents who sought treatment and 5% of the children went or were brought to the religious healer. The rest went to the local pharmacy or the NGO health center, or others which were not specified.

With regard to the most common sources of health information, a majority of the respondents cited personal experience (55%) as the best source, with a significant percentage (35%) citing the radio as a source of information. The following table describes the different sources of health information.

Table 15 Sources of health information

Source of Health Information	Percentage of Respondents (%)
1. Personal Experience	55
2. Family	28.3
3. Neighbors	24.2
4. Village Doctor	25
5. Television	25
6. Radio	35
7. Health Workers	30.8
8. Health Center	25
9. Billboards	11.7
10. Newspapers	15
11. Other sources	4.2

Correlating the health outcomes with socio-economic variables and indoor air pollution indicators.

Bivariate Analysis

To describe the relationship among the health outcomes and the socio-economic and indoor air pollution variables, two by two tables with the chi square test were prepared. Based on the three socio-economic variables namely the socio-economic status (SES) according to monthly income and SES according to furniture/equipment/appliance ownership, and household size, that were considered for this analysis, only the SES according to furniture/equipment/appliance ownership came out significant with the respondents' respiratory symptoms of coughing at night and shortness of breath. More of these respiratory symptoms were significantly experienced by the lowest SES class as compared to the other three SES classes. Household size and SES according to monthly income were not significant.

Table 16 Respiratory Symptoms Among Respondents Which Were Statistically Significant According to Socio-Economic Status According to Furniture/Appliance/Equipment Ownership

Respiratory Symptoms	**Socio-economic status according to furniture/appliance/equipment ownership**				**P value** ***n = 12-***
	1	2	3	4	
Cough at night	0	0	1 (0.8%)	41 (34%)	0.008
Shortness of breath in the past 6 months	1 (0.8%)	0	2 (1.6%)	34 (28%)	0.048

With regard to the three indoor air pollution variables considered, the types of cooking fuel were significant in two of the respiratory symptoms specifically coughing the rest of the day or frequent cough and coughing at night. Significant respiratory symptoms were found among those who use wood and charcoal as compared to those who use LPG and kerosene. This observation is consistent with many studies, both local and international. The use of wood and charcoal is more prevalent in these areas, about 71%, compared to another rural area in Luzon, Philippines, at only 49.7%. (Pagbilao Study, 2003) The 8 hour-indoor PM10 levels in the 240 houses covering 1 to 2 cooking periods that were monitored in this Luzon rural area had a mean level of about 117.6 µg/m3 +/- 64.5 µg/m3. Cooking location during dry or wet season was also found to be significant for frequent cough in the present study. For the smoking variable, significant correlations were found for the respiratory symptoms of frequent cough among the respondents and chest problems of children in the past month.

For the other health outcomes among the children, no other significant correlation with both socio-economic and indoor air pollution variables was noted.

Table 17 Respiratory symptoms among respondents which were statistically significant according to the type of cooking fuel, n=120

Symptoms	Type of Cooking Fuel				Total	P Value
	Wood	Charcoal	Kerosene	LPG		
1. Frequent Cough	31 (88.6%)	21 (32.3%)	2 (3%)	5 (7.7%)	65	0.044
2. Cough at night	32 (76%)	10 (24%)	0	0	42	0.001

Table 18 Respiratory Symptoms Among Respondents Which Were Statistically Significant According to Cooking Location During the Dry and Wet Season

Symptom	**Cooking Location (*n* = *120***						P Value
	1*	2*	3*	4*	5*	6*	
Frequent Cough: dry season	10 (8.3%)	0	28 (23%)	15 (12.5%)	4 (3.3%)	8 (6.6%)	0.029
Frequent Cough: wet season	14 (11.6%)	1 (0.8%)	28 (23%)	14 (11.6%)	3 (2.5%)	3 (2.5%)	0.027

* 1- In a room used for living w/ partition, 2- In a room living w/o partition, 3- In a separate room used as kitchen, 4- In a separate building, 5- Outdoors with some walls, 6- Outdoors

Table 19- Respiratory symptoms which were statistically significant according to households with smokers

Symptoms	**Households with Smokers**	**Households without Smokers**	**P Value *n = 120***
1. Frequent Cough among respondents	41 (34%)	24 (20%)	0,036
2. Chest Problems among children in the past month	20 (16.6%)	9 (7.5%)	0.035

Regression Analysis

For those health outcomes for which correlation with significant independent variables were found on bi-variate analysis, a logistics regression analysis was performed. These are four health outcomes, namely: frequent cough, shortness of breath in the past 6 months, cough at night among the respondents, and chest problems in the past month among children. The relevant data tables can be found in Appendix 6.

For the respiratory symptoms of frequent cough or cough the rest of the day and shortness of breath in the six months among the respondents, the only significant variable was the location of cooking during the dry season. The cooking location during the wet season could not be properly evaluated due to lack of cases in some categories. Locating the cooking area in a separate building from the house seems to be protective of these respiratory symptoms. The other locations were found to be at risk of the said respiratory symptoms. For coughing at night, in addition to the cooking location, the lowest SES class was also found at risk. For categories of some variables not found in the tables, no cases were found for those categories which could be the result of the small sample size or too many categories for each variable.

For the chest problems among children in the past month, several variables came out significant. As in the two other respiratory symptoms among respondents, having a separate building or outside cooking during the dry season was more protective of this respiratory symptom among children than having the cooking area within the living area, whether they have partition or not. However, with the use of kerosene, the risk seems to be higher than the use of wood. This finding seems strange as it is known that kerosene is a "cleaner" fuel. There could be other factors involved or it could be a spurious result. The presence of smokers and a bigger household size increase the risk of having chest problems among the children significantly, odds ratios of 7.68 and 5.38 respectively.

For the respondents, the most important variable in this analysis is the location of the cooking area or facility more than any of the other variables. This occurrence is probably a consequence of better ventilation. Better ventilation clearly better protects the cook or respondent acquiring the respiratory symptoms. For the children, it becomes more complex as other factors like smoking and household size play important roles in the development of chest problems. The risk factors identified in this survey are consistent with other studies.

House and kitchen characteristics: enumerator observations

The survey included a section for enumerator observation of various household characteristics in order to draw a more complete picture of the degree of ventilation enabled through house design and other factors influencing indoor air concentrations and exposure.

About two thirds (65%) of the surveyed houses were on land, with the remaining 35% on stilts. Many of the land-base households were located on or relatively near the shore, where ocean breezes are common. Largely highly permeable materials are used for building walls, primarily wood as well as thatch to a lesser degree. Most roofs are made of corrugated iron sheets, with about a third of the stilts houses using thatch. As is to be expected, there are differences in the materials used in houses on stilts compared to those on land. In a small percentage of houses on land, bricks or other materials are used for the walls and roofs. The houses on stilts are more homogenous, with almost all walls of wood and roofs of either corrugated iron (81%) or thatch (29%). Most kitchens (64%) had one door, and the remainder had two doors (mainly in houses where the kitchen was in a separate building or kitchen was not used for living space).

Though all dimensions of the kitchen are important form a ventilation point of view, the height is the most critical. The table below shows the distribution of responses to this variable. More than 25% of the kitchens have a height of less than 2 m. These houses are likely to have severe ventilation problems. Given the importance of kitchen ventilation, it is recommended that future surveys use an accurate measuring tape instead of a 1-m string.

Table 20 Typical kitchen dimensions

Height	% houses
<1 m	1.9
1-2 m	24.0
2-3 m	37.5
>3 m	35.6

INDOOR AIR POLLUTION MONITORING

Objectives

1. To assess, on an exploratory basis, the level of indoor air pollution due to domestic cooking, and
2. To examine technical and institutional issues associated with developing and implementing a protocol for monitoring, with a view to developing refined protocols for future use.

Survey design and parameters

Air quality was monitored in a sub-set of 30 houses from the larger sample of the 120 houses chosen for the socio-economic, health and perceptions survey. The houses were equally spread across the three project areas. Two criteria were chosen for sample stratification:

1) Membership or lack thereof in the local rural electrification association, BRECDA.[13] It was assumed the membership with respect to BRECDA is an indicator of socio-economic status and "leadership" within the community with respect to willingness and ability to pay for new energy technologies.

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[13] Barangay Rural Electrification and Development Association, community-level organizations established by Winrock to manage renewable energy systems and serve as focal points for planning productive livelihood and social projects under the AMORE program. BRECDAs were established due to the lack of viable cooperatives and other community-based organizations in the rural areas where the program operates.

2) Location of the house on stilts or on land. It was assumed that kitchen characteristics would differ across houses on stilts and those on land.

The air quality indicators chosen for this study were 24-hour continuous measurements of carbon monoxide (CO) and particulate matter with a median size cut off (d50)of 4 μm (PM4) corresponding to the Soderholm respirable dust curve, which is now also the standard in Europe and USA. Area and personal monitoring of the primary cook was done for CO. For PM4, only area monitoring was done due to the logistical difficulties associated with personal monitoring of particulate matter over a long period of time.

Measurements and protocols

In selecting our methods and protocols, we were largely guided by a desire to use those that are similar to the ones being used by other major international groups, thus providing a rational basis for comparing results. Also, using previously established methods is easier for groups such as NGOs that do not have extensive scientific staff and expertise. More specifically, in our case, we based our methodology and protocol on the ITDG study (Doig , Bates, Bruce, *et al*. 2001).

CO was measured using the T82 real-time potentiometric monitor manufactured by the Industrial Scientific Corporation. This measures in the range 0-1500 ppm in 1 ppm increments. A zero-check was done prior to each monitoring. Calibration with a span gas was not required because the instruments were new and used over a short period of time. The alarm levels were set to possibly unachievable high levels (999 ppm) to ensure that at lower levels the sound from the alarm does not disturb members of the household. Data were logged at a frequency of 1 minute and at the end of the 24-hour monitoring period the data were downloaded to a laptop.

PM4 was measured using the gravimetric technique with a Higgins-Dewell type of cyclone (manufactured by BGI Inc.). This cyclone provides a 4 μm median cut off with an air flow rate of 2.2 L min^{-1} (± 5%). The pump used for air flow was the VSS-5 model manufactured A P Buck Inc. Flow rate was calibrated using the automatic M5 Mini Buck calibrator based on the soap bubble technique. PVC (polyvinyl chloride) filters, which are hydrophobic, of 5 μm pore size and 37 mm diameter were used with cellulose support pads. These were weighed at the Philippines Nuclear Research Institute, Manila, using a Mettler MT5 microbalance that has a readability of 1 μg. Exposed and unexposed filters were desiccated for 24 hours before weighing. Also, just before weighing the filters were passed over an alpha-emitting source to eliminate static charges. Filters were weighed repeatedly till a difference of less than 10 μg was observed between consecutive measurements.

All filter handling operations (loading and unloading of filters from cassettes, weighing and equilibration) were carried out inside a laminar flow clean air work bench fitted with HEPA filters. The balance was internally calibrated and checked for performance using calibrated weights of 10 and 20 mg before every weighing session. One control blank filter was used for every 15 filters. The method we used for measuring PM4 conforms to the US NIOSH (National Institute for Occupational Safety and Health) 0600 guideline 'Particulates not otherwise regulated, respirable'.

A CO monitor and the PM4 monitor were collocated at a distance of 1.3 m from the stove and at a height of 1.3 m away from smoke rising directly from the fire to correspond to the ITDG protocol. We avoided locations close to (less than 1 m away from) windows, doors and other openings. For PM4, the filter was changed after approximately12 hours to avoid any possibility of overload. A car battery was used to power the pump. A second CO monitor was attached to the primary cook of the household for a period of 24 hours. The sensor was placed as close to the woman's nose as possible. A fabric case with a broad/soft strap was prepared so that the woman could wear the monitor around her neck. The women were instructed to remove the monitors only when washing, changing or sleeping. During these times the monitor was kept as close to the breathing zone as possible.

Data analysis

The CO data were analyzed by downloading the data through the instrument's software and importing the files into Excel, where the average of approximately 1440 readings (24 hours) was computed. PM4 levels were first calculated, after adjusting for the change in weight of the control blanks, for the two 12-hour sessions separately. The volume sampled in each session was calculated by using the sampling duration and average of the flow rates at the start and end of each session, as indicated on the pump display. The 24-hour PM4 average concentration was computed using volume-weighted averages of the PM4 concentration of the two sessions. The average change in weight of the blanks was 3 μg and the standard deviation was 4 μg. The method detection limit was calculated using three times the standard deviation divided by the volume sampled over 24 hours. Thus, in this case the method detection limit was found to be 4 $\mu g\ m^{-3}$. For CO we were able to do the statistical analysis using data from all 30 houses because of satisfactory data quality. For PM4 we had to exclude from our analysis data pertaining to 11 houses due to data quality issues. These largely related to errors or inconsistencies associated with sampling duration (battery failure problems in most instances).

Data quality was also adversely affected by the following factors: less number of control blank filters used, watches not being synchronized and subjective criteria used to select houses. Though not an important issues in this project (owing to the low particulate loadings on the filters), in future projects care must be taken to carefully store and transport the filters.

It must be noted that ITDG types of protocols tend to produce far more data on CO than on PM, because two CO monitors are used as opposed to one PM monitor and the CO monitors produce real-time data whereas the PM monitors yield only one data point for each measurement. This is by no means implies that the health concerns related to CO are more crucial than those related to PM.

Results

It is evident from Table 21 that the mean levels of CO and PM4 were very low.

Table 21 Descriptive statistics of CO and PM_4 concentration

	CO area (ppm)	CO personal (ppm)	PM4 ($\mu g\ m^{-3}$)
n	30	30	19
Minimum	0	0	4
Maximum	5	5	459
Arithmetic mean	1	1	72
Coefficient of variation (%)	108	190	145
Median	1	0	43

Table 22 shows 24-hour mean levels of CO observed elsewhere in the world in houses using wood. The levels observed in this region are comparable only to those observed in Guatemala, Costa Rica and Pakistan in houses using traditional wood-stoves. The exceedingly high levels of CO observed in Kenya are likely due to the very small kitchen sizes leading to poor ventilation.

Table 22 Comparison of 24-hour mean CO concentration across other studies

Country	Stove	Sampler location	CO (ppm)	Study reference
Guatemala	Improved	Personal	5	Smith, Liu, Rivera, *et al.* 1993
	Traditional	Personal	15	
Guatemala	Improved	Personal	1	Naeher , Smith, Leaderer, *et al*. 2000
	Traditional	Personal	6	
Guatemala	Improved	Personal	1	Naeher, Smith , Leaderer *et al*. 2001
	Traditional	Personal	3	
Nepal	Traditional	*not specified*	14	Hessen, Schei, Yadav, *et al*. 1996
Burundi	Traditional	Area	37	Viau, Hakizimana and Bouchard 2000
Kenya	Traditional	Area	5	
	Traditional	Area	51	Doig , Bates, Bruce, *et al*. 2001
Pakistan		Area	3	Lodhi and Zain-al-Abdin. 1999
Costa Rica	Traditional	Area	1	Park and Lee 2003

Similarly, Table 23 shows the levels of PM observed in other areas. Since there are not many studies that have measured PM4 we have included in the table 3 PM in the size range 2.5 – 5 microns. It was seen that in the project area the levels of PM4 were lesser than even what has been observed elsewhere in houses using improved stoves and possibly less than even typical rural background levels. Only one other study (in Costa Rica , by Park and Lee 2003) had observed comparably low PM levels and they attributed their findings to good ventilation (more specifically the high air exchange rates observed in those kitchens).

Table 23 Comparison of 24-hour Mean PM Concentration Across Other Studies

Country	Stove	Sampler location	PM Size	PM (μg m^{-3})	Study reference
Guatemala	Improved	Personal	PM2.5	97	Smith, Liu, Rivera, *et al.* 1993
	Traditional	Personal	PM2.5	528	
Guatemala	Improved	Personal	PM2.5	152	Naeher, Smith , Leaderer *et al*. 2001
	Traditional	Personal	PM2.5	868	
Guatemala	Improved	Area	PM3.5	330	Albalak, Bruce, McCracken, *et al*.. 2001
	Traditional	Area	PM3.5	1200	
	Traditional	Area	PM3.5	1930	
Guatemala	Improved	Area	PM2.5	180	McCracken, Albalak, Boy, e*t al*. 1999
	Traditional	Area	PM2.5	1102	
Costa Rica	Traditional	Area	PM2.5	44	Park and Lee 2003
India		Personal	PM4	1307	Balakrishnan, Sankar, Parikh, *et al*.. 2002
		Area	PM4	1343	
		Personal	PM4	1359	
Kenya	Traditional	Area	PM5	629	Doig , Bates, Bruce, *et al.* 2001
	Traditional	Area	PM5	3522	

Based on discussions with the field staff it was decided to investigate the possibility of strong coastal breezes playing a role in lowering the concentration levels. In the absence of data on any other appropriate indicator, we used house type (on water stilt or on land) as a surrogate for proximity to the coast.[14] However, a one-way analysis of variance (ANOVA) did not indicate any significant difference in the means of CO and PM4 across house types. However, this does not necessarily imply that coastal breeze has no affect on ventilation. This might only be suggesting that house type, as defined here, is not a good surrogate for proximity to the coast.

We next attempted to determine which other ventilation and emissions related variables and other possible influencing variables might explain this phenomenon and the variation of levels across households. A one-way ANOVA was done using CO-area, CO-personal and PM4 as dependent variables and the following variables as factors:

- Area
- BRECDA membership
- Kitchen location
- Roof type
- Type of walls
- Type of vents in the kitchen
- Number of windows in the kitchen
- Number of doors in the kitchen

[14] Comparison across the three areas revealed no significant difference in most variables, for both the IAP measurements and for the survey.

- Type of cooking fuel
- Number of meals cooked in a day
- Other uses of the stove
- Cooking for sale

It was observed that only the factor related to number of meals cooked in a day (for household consumption) had a significant effect on PM4 ($F = 2.099$, $p < 0.15$). Figure 1 shows that PM4 levels were much higher in houses that cook 4 meals as compared to those that cook only 3 meals. CO area levels were influenced significantly by kitchen location ($F = 4.02$, $p< 0.03$) and number of doors in the kitchen ($F = 3.843$, $p< 0.05$). None of the factors were found to significantly influence personal levels of CO. Figure 2 shows that CO area levels in kitchens that have 2 doors were almost half those in kitchens with just one door. Figure 3 shows that CO area levels are highest in houses where the kitchen is in a separate building.

As was revealed in the focus group discussions, women do have some awareness of the hazards of smoke; therefore, when they cook in the same room where they live, they may undertake actions that reduce the level of smoke. We observed that in those houses where people cook in the same room where they live, 100% of the houses reported keeping the windows open during cooking. In houses where the kitchen was in a separate room in the same building, 54% kept the windows open and in houses where the kitchen was in a separate building only 38% reported open windows. We also observed that in those houses where people cook in the same room where they live, 62% of the houses reported keeping the doors open during cooking. In houses where the kitchen was in a separate room in the same building, 48% kept the doors open and in houses where the kitchen was in a separate building 69% reported open doors.

Figure 1 Concentration of PM4 by Number of Meals Cooked

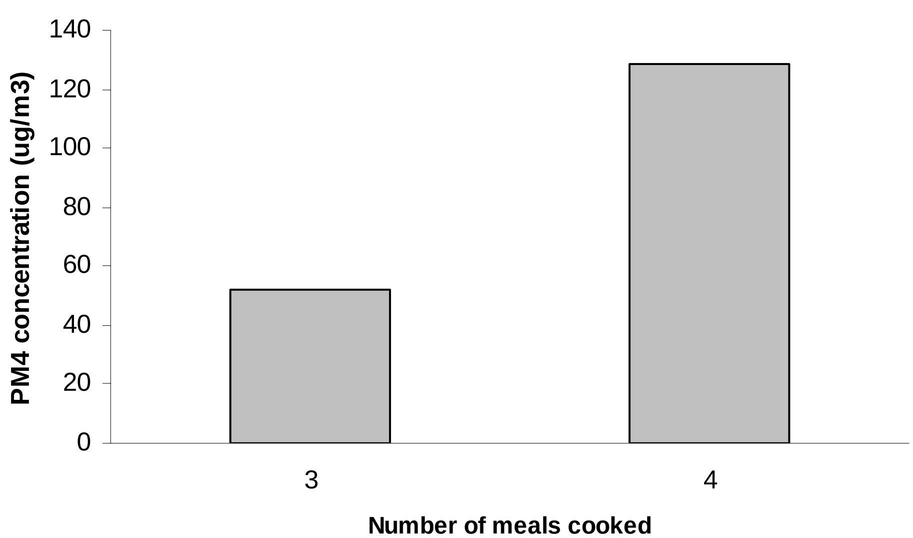


Figure 2 Concentration of CO byNumber of Doors in Kitchen

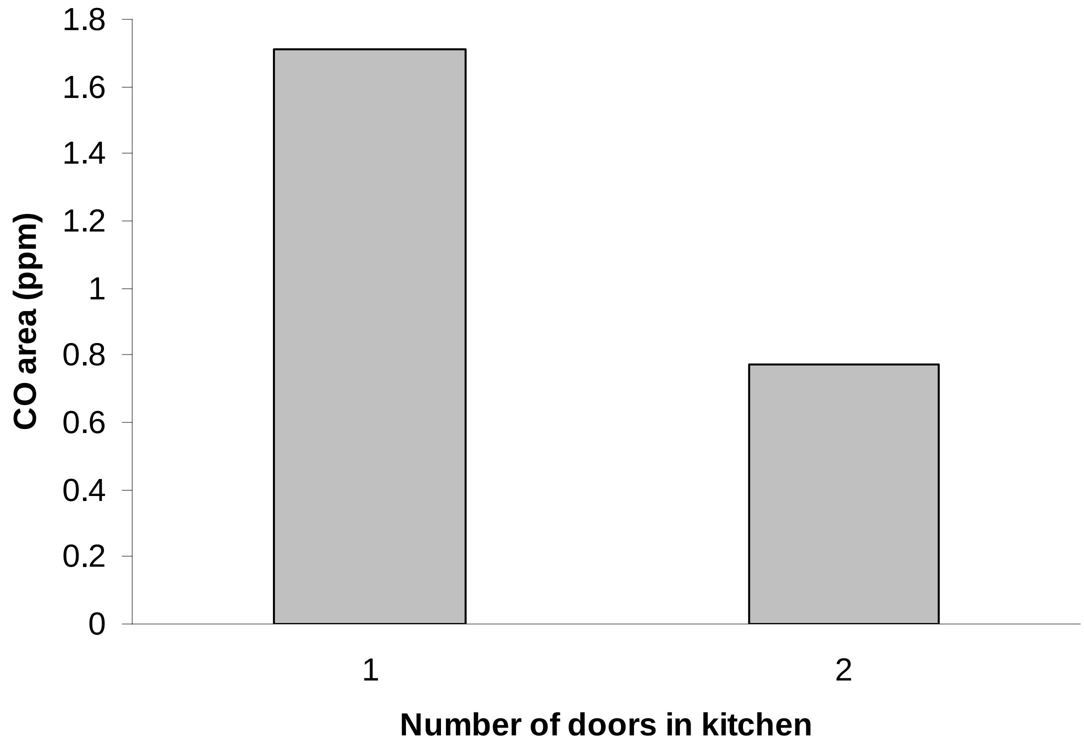


Figure 3 Concentration of CO by Type of Kitchen

The field staff had the following area related insights to offer. During the monitoring of these areas, it rained occasionally but not for long periods of time (less than an hour).

Areas: Tawi-Tawi and Zamboanga

These are coastal areas. Most the houses are on stilts and most houses also have their kitchen outside the house that's why it was hard to find a house with the kitchen inside. Houses that were monitored in this area have their kitchen inside the house and most of their kitchen were facing the shore; this practice is common to all for the reason that it is easy for them to dispose or throw waste in the bodies of water. Houses have big holes in their kitchen designed for the smoke to pass through as they were already aware or experiencing smoke effects on their eyes and health.

Areas: Marvell, Cotabato (Maguindanao province)

This area is in the mountain wherein houses are far away from each other. Most houses also have their kitchen outside the house. But for those monitored houses, with their kitchen inside the house, usually have holes or fence-like style of kitchen made of Bamboo for the smoke to pass through.

The fact that some of the factors seemed to influence area levels of CO but none of the factors affected personal levels of CO is consistent with our observation that the correlation between area and personal CO concentration was very poor. The value of Pearson correlation coefficient, r^2, ranged from 0 to 0.78 across the 30 houses (n = 1440 for each house) with a median value of 0.05. The Spearmann correlation coefficient, R, ranged from –0.006 to 0.807, with a median value of 0.414. PM4 was also found to be poorly correlated with CO-area (r^2 = 0.0001, R = 0.488, n = 19) and CO-personal (r^2 =0.005, R = 0.127, n = 19). All this implies that among the three indicators of indoor air pollution – PM4-area, CO-area and CO-personal – none can be used as a reliable surrogate/proxy for another.

So far, results from other studies have been mixed. While some studies have shown a high degree of correlation between PM and CO (for example Naeher, Smith , Leaderer *et al*. 2001 with PM2.5) other studies have indicated a poor correlation (for example Saksena, Singh, Prasad, *et al*. 2003 with PM5). However, the Naeher, Smith , Leaderer *et al*. (2001) study did also indicate that in situations where the levels of pollution are low, such correlations are weak. There are two main reasons why we believe that future studies should continue to measure CO: a) while the health effects of CO are less serious than those of PM, they are by no means negligible and b) the degree of correlation between CO and PM is dependent on factors such as wood type, wood moisture, cooking practices, stove efficiency (including age induced damage to stove) (Naeher, Smith , Leaderer *et al*. 2001). Since these factors are of vital importance to stove designers, continuing with CO measurements will only improve our knowledge on these aspects. It is to be noted that as compared to only monitoring PM, the additional costs and labor burden associated with monitoring CO are not significant. Results of this study justify the ITDG type of protocols where personal and area measurements of CO are simultaneously made.

We observed that while the 24-hour average CO levels were comparatively low, the averages and peaks during the cooking periods were by no means low. The protocol did not permit us to calculate the average over just the cooking periods (because neither the enumerator nor the respondent were required to maintain accurate records of when each cooking actually began and ended), so this insight has been gained by examining the time series graphs of the CO levels. To illustrate this point, Figure 4 pertains to a house where the 24 hour area average was 5 ppm. It was observed that during cooking periods the levels were typically between 20-40 ppm. Instantaneous peaks are even higher – up to 140 ppm. The weak correlation between area and personal levels is also obvious in this graph. Figure 5 pertains to a house where the 24 hour average was 1 ppm.

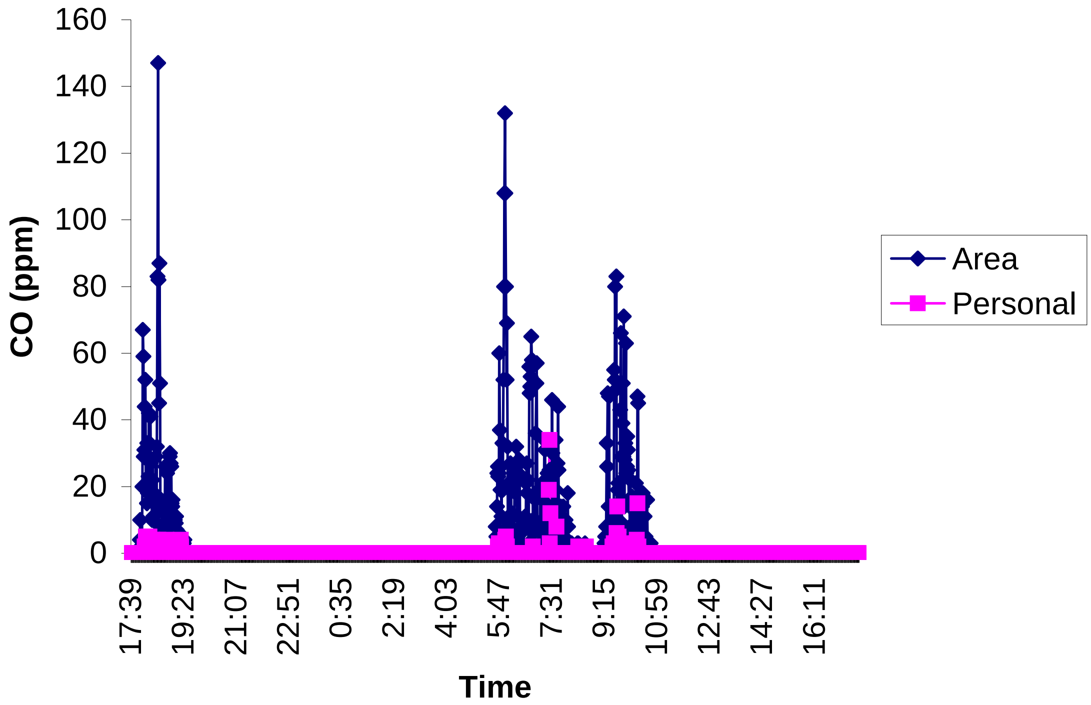


Figure 4 CO 24-hour time series profile (house #53)

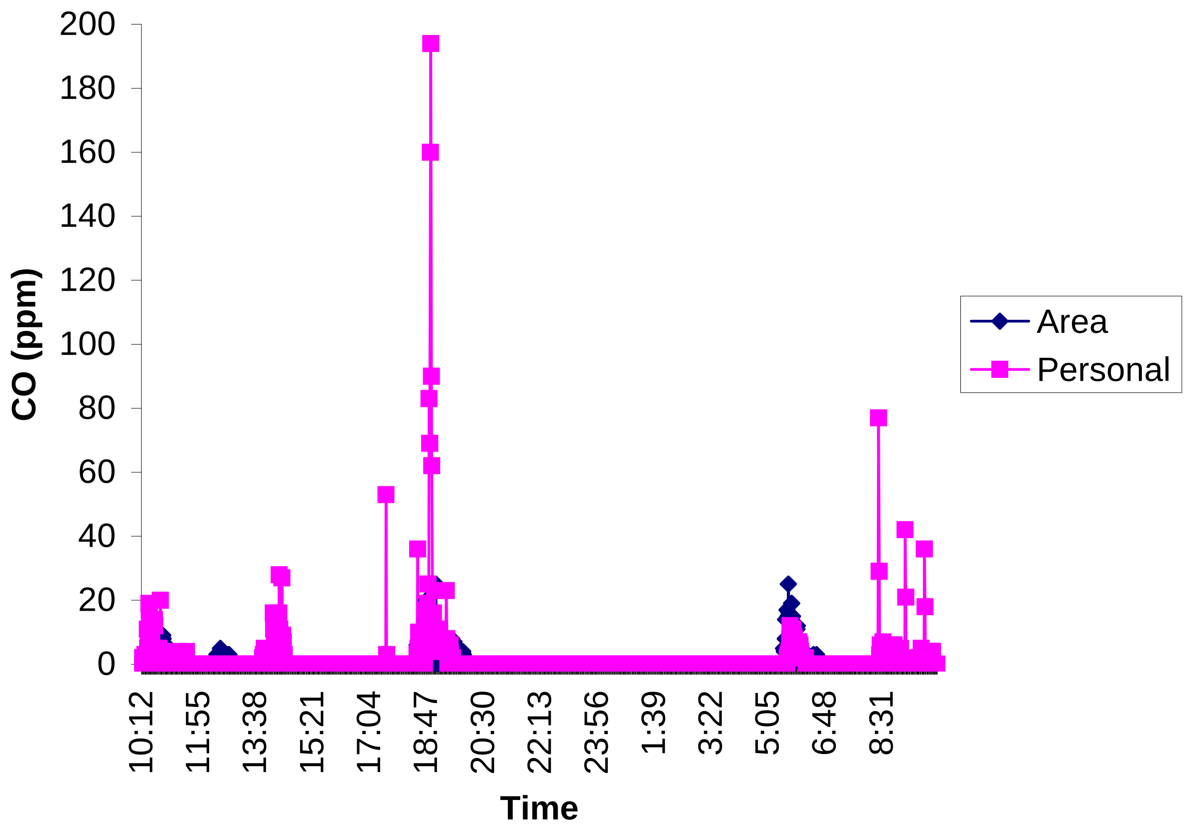


Figure 5 **CO 24-hour time series profile (house #28)**

This temporal pattern implies that though long-term (chronic) exposures may be low the short term (acute) exposures are likely to be very high. This in turn implies different health outcomes than those more commonly researched; there might be, for example, a higher incidence of acute health effects than chronic health effects. It must be remembered that even in the case of ambient air pollution, standards for CO pertain only to short durations such 1-hour or 8-hours and that 24-hour standards are not prescribed. While we do not have real time data for PM4, it is fair to assume that such patterns might be valid for PM4 as well. A study of Acute Lower Respiratory Infections in Kenya also confirmed the importance of examining high-intensity episodes as distinct from longer-term averages (Ezzati and Kammen 2001) for particulate matter (PM10). A study in Costa Rica indicated that peak levels of PM2.5were, in some cases, 40 times higher than the 24-h averages (Park and Lee 2003).

MAJOR FINDINGS AND CONCLUSIONS

This was an exploratory study to assess if household energy and associated health and socio-economic impacts in the AMORE project area in Southern Philippines appears serious and would warrant adding a household energy intervention to existing off-grid rural electrification activities. In addition, it was also an opportunity to field-test the FGD, survey and monitoring instruments adapted by Winrock International in conjunction with household energy, indoor air pollution, and health experts, for future application in the design and evaluation of IAP reductions, health and socio-economic impacts of household energy interventions.

The survey results suggest the following general conclusions about the socio-economic conditions, household energy practices and associated perceptions of health impacts in the study area. These conclusions are complemented by the IAP monitoring results, which follow.

Survey

- This "enhanced" survey proved to be an important tool for assessing household energy practices; awareness, existence and relative affordability of cleaner alternatives; household structure and cooking conditions; and perceptions of the impacts of smoke on adult and child health. This piloting effort enabled the identification of specific aspects of the survey that, with minor modification, can yield even more useful data. Used in combination with the focus groups and the IAP monitoring, the survey enables the identification of knowledge gaps and possible communications channels, and characterization of practices, preferences and constraints that in turn inform the development of effective interventions.
- The majority of households surveyed continue to rely on biomass for cooking, with most of these using open fires for cooking. Charcoal is the most common secondary fuel, used in chimneyless mud or cement stoves. Cooking is typically done indoors in a kitchen that is separate from the living space, and is often well-ventilated. Coconut shells and fronds were also reported as a commonly-used fuel in the FGDs.
- A significant portion of the households prepare food for sale, increasing significantly the women's daily exposure to IAP. Women do, however, appear to take measures to reduce children's exposure to the cooking fire: less than 5% of the respondents reported that an infant is present near the fire during cooking. Modifications to the survey will enable more direct correlation between behavioral patterns and exposure, with additional verification possible through observation.
- The majority of the respondents perceive that smoke due to cooking is detrimental to human health. As perceived by the respondents, there are several health effects that could result from exposure to smoke due to cooking, foremost of which are the effects on the eyes including irritation and blurring of vision, and certain respiratory health effects such as coughing and chest problems. At the same time, nearly a third of the respondents admitted that they have no knowledge of the impact of smoke exposure on specific respiratory diseases in adults and children, including respiratory deaths in children.
- Even with lower overall levels of PM_4 and CO detected through monitoring, the occurrence of the respiratory symptoms were found to be associated with factors commonly known to increase the risk in this study population. The socio-economic

and indoor air pollution variables that correlated with some of the respiratory symptoms and illness in the bivariate analysis were: smoking; type of cooking fuel; SES class according to assets; and location of cooking facility.

- Risk factors of the respiratory symptoms identified in the logistics regression analysis among the respondents were location of cooking facility – facilities located in a separate building or room or outside had lower risk as compared to cooking facilities in the house even with partition – and the lowest SES class according to furniture/equipment/appliance ownership which had a higher risk compared to the higher SES classes. While these results may appear obvious, confirmation of these points through the survey provides a basis for intervention design.
- For chest problems among children, the risk factors identified were location of cooking facility similar to that of the respondents, presence of smokers and bigger household size.
- A large number of households owned stoves of varying types, including 15% with LPG stoves, although it appears that these are infrequently used due to the cost and general lack of availability of the fuel. Kerosene is often used as a lighter fuel, but rarely reported to be used for cooking. However, the presence of purchased stoves in a significant number of homes suggests an interest and awareness (albeit limited) to alternatives to biomass, charcoal, and open fires. In two cases, households owned the Mayon Turbo Stove (a metal stove used with agricultural waste),[15] suggesting that a potential market exists for such a stove. Further insight into women's awareness of improved biomass alternatives can be gained through an additional question on the survey.
- While the population is generally from the lowest socio-economic class, many homes have radios, TVs and other entertainment assets which suggests some ability to pay for items considered to have value.

IAP Monitoring

- The IAP monitoring protocol is basically sound, and provided critical information on average PM4 and CO levels to enable a more objective assessment on the severity of IAP in the surveyed homes. A few modifications to the protocol and the associated training will enable additional information to be gained from the monitoring (recommendations are detailed in the appendix). The existence of local IAP experts and a laboratory equipped to handle the filters enabled cost-effective data processing.
- The levels of CO and PM4 were found to be very low and there is a reason to believe that strong coastal breezes and kitchen characteristics that affect ventilation are the probable causes. Results from the survey indicated that windows and doors are kept open more commonly during cooking in those houses where the kitchen is in the living room and to a lesser extent in houses where the kitchen is separate from the living room. However, it is important to remember that this was an exploratory study

[15] introduced in the Philippines in 2001 by the Canadian organization Resource Efficient Agricultural Production (REAP) and promoted for its cost-effectiveness, efficiency, cleanliness and reduction of greenhouse gases

where the IAP component piggybacked on the rural energy related activities in the region. This placed scientific and logistical constraints in the design and implementation of the IAP monitoring survey. A baseline study designed specifically to assess IAP, with a larger sample size will increase the confidence level in the results. Further, strong local capacity building is needed to ensure data quality.

RECOMMENDATIONS

Intervention Recommendations:

- On purely health grounds, the results of this exploratory study suggest that a household energy and health intervention is not warranted in the three areas of Southern Philippines surveyed. Assuming chronic exposure to particulate matter represents the most common health concern, this risk appears to be low, given the very low 24-hour average personal exposure and area levels of indoor air pollution found. If, however, peak exposure to CO (or PM, by association/proxy) is of concern, there could be a case for intervention, especially if other conditions such as burden on women in collecting an processing fuelwood, contribution to deforestation, high opportunity cost for the time spent, etc. are compelling enough.
- Introduction of improved household energy technologies and practices can bring socio-economic benefits including reduced expenditures on fuelwood, as well as time savings, reduced drudgery and other perceived health impacts. The survey indicated that considerable time is spent collecting biomass fuels; for those who cannot easily access wood, it is purchased, though there are few sources from which fuelwood can be purchased. Meanwhile, cleaner fuels are typically either unavailable or considered too expensive. It is recommended that organizations implementing energy or other development activities involve participatory processes to assess the perceptions of the target population, including women, of these burdens and their interest, and ability and willingness to pay for, alternatives to open fires with solid fuels for cooking.
- While fuelwood collection does not often represent a serious threat of deforestation, as in heavily forested areas of the Philippines, in other areas with less forest coverage, impacts to the natural resource base can become an important driver in determining the need for an intervention. This study revealed that in some of the study areas, mangroves are being harvested for fuelwood. While a detailed study of this dynamic and the health of the mangroves was beyond the scope of the present study, it is recommended that this issue be further investigated to determine whether there are serious environmental concerns that would render an intervention more urgent.
- As evidenced in this exploratory study, future decision making processes regarding whether to have interventions and the choice of interventions will need to distinguish between chronic and acute exposures. Then, a decision will have to be made, depending on the demographic group and health outcome of interest, to target for a reduction in either chronic exposures or acute exposures or both. This is true irrespective of which pollutant is of interest, for as Ezzati and Kammen (2001) and Park and Lee (2003) have shown, even peak concentrations of PM can be much higher than what the averages imply. It must be remembered that acute exposures have a greater impact on infants, elderly, asthmatics, and other vulnerable groups.

- Based on the bivariate analysis, the use of wood and charcoal is a risk factor in the occurrence of selected respiratory symptoms. Hence, there appears to be a need to, where possible, upgrade the type of cooking fuel used amongst these populations to lessen the risk of respiratory symptoms. Given the low socio-economic strata of the target populations, and the fact that many respondents indicated that alternative fuels are either unavailable or too expensive, cleaner fuels may not be an option without improved distribution and/or micro-lending. In the absence of these possibilities, improvements to the way biomass fuels are used can be addressed through the introduction of improved biomass stoves.
- It appears that the households tend to be well-ventilated, and women avoid long periods of exposure to smoke—both among themselves and for their infants—to the extent they can, and also use some efficient cooking techniques such as keeping lids on the pots. However, most women among the surveyed households still use open fires and thus improvements can be made through the use of enclosed stoves, including stoves with chimneys. Because health is seldom a driver for decision-making on household fuels, significant attention should be paid to raising awareness about health impacts to catalyze interest in moving up the "energy ladder".
- Women will likely benefit from information on improved stove options. Several findings suggest that households would be willing and able to make modest purchases for improved stoves. These include: the existence of a range of stoves, from locally-made to those acquired from outside the area; the presence of certain luxury items such as radios, TVs, and sewing machines, despite the generally low socio-economic status of most households surveyed; and the fact that a significant portion of the population either has purchased a fuelwood or cleaner fuel stove, purchases LPG periodically, and/or purchases fuelwood.
- Radio appears to be a useful medium of communication about the health risks of indoor air pollution in at least two of the surveyed areas (Tawi-Tawi and Zamboanga, less so in Maguindanao). Other effective means of communication may include through health clinics and local healers, as well as comics, which have proven to be an effective medium of communication to rural populations covered by the AMORE project. This aspect can be further explored through focus groups.
- Smoking is another important risk factor that must be addressed by intensive information campaign and smoking cessation programs as this affects both the adults and children alike.
- An indoor air pollution and health study that is larger in scope both in terms of sample size and different living conditions, is needed to be more conclusive about the associations or lack thereof, seen in this pilot study.

Training and institutional issues

- One of the key lessons from piloting these instruments and protocols was the need for more thorough and systematic training of enumerators to ensure consistency in data collection. At least a week of training and pre-testing in actual pilot houses in addition to any time spent on training and piloting the questionnaire based survey, is recommended. Project coordinators must remember to account for extra filters (and the time to actually weigh them) that will be need for the training and piloting. It is important that every field staff go through at least two rounds of the complete monitoring cycle and that every one go through most of the steps of calculating the pollution levels. This will convey the importance of measuring every variable carefully to the field staff. In this study we observed that the field staff did an excellent job with respect to highly technical operations such as flow rate calibration but efforts to record simpler parameters such as time, house codes and classification schemes, downloaded file names, etc., were not as satisfactory. Improvements in the supervisor and enumerator manuals would also facilitate better data recording and processing. *(See Appendix 5 for specific recommendations on the instruments.)* This leads to many inconsistencies that often cannot be resolved or if they can be resolved, nevertheless leads to delays and overall inefficiencies in survey management and data analysis.

- Trainers and supervisors must emphasize to their staff that once a consensus has been achieved between the major actors (Principal Investigators consultants, trainers and field staff) on the protocols, manuals and data sheets and these have been approved by all parties in a participatory manner, then deviations from the instructions these imply will not be acceptable. It is to be expected this participatory approach will be time consuming and Principal Investigators must budget for this.
- Training must also emphasize the need to follow household selection criteria suitable to local conditions. Enumerators must not deliberately select those houses which in their perception are likely to have higher levels of pollution.

Scientific issues

- The most important recommendation on the scientific aspects is that future surveys should continue to measure both PM and CO for reasons mentioned above. It is also recommended that surveys be designed such that in addition to measuring 24-hour averages in a larger sample, in a sub-sample acute exposures (cooking time averages and episodes within the cooking session) be measured. It is also possible to measure acute exposures in all houses of the sample and then the chronic exposure profile can be computed by aggregating the acute exposures, but the converse is not true. That is, as this study has shown, acute exposures cannot reliably and precisely be estimated from a knowledge of longer-term averages without having extensive supplementary information (for example, precise data on when cooking began and ended, and similar information for any other activity that leads to pollution. In our study the recall method for obtaining this information was found to yield highly inaccurate data). Measuring acute exposures will certainly entail a greater degree of field observations by the field staff and higher levels of involvement of the respondents. Usually this approach requires more equipment, more visits to the household and staying for longer periods in the household. This implies higher costs and resource needs and more extensive training.
- It should be noted that short-term measurements eliminate the need to ensure long term power supply for the equipment and the problems associated with battery charging (a factor that led us to exclude almost 40% of our PM4 samples). There is

also the issue of whether the longer presence of field investigators alters the respondent's behavior. Any errors due to this can be minimized, if not eliminated, by comprehensive training and adopting participatory methods of inquiry. In some cases these errors, which usually lead to a constant systematic bias in results, cancel out, as in comparative studies. If very short terms measurements cannot be made easily and cheaply then an alternative method could be to monitor the cooking and non-cooking (usually late evening to early morning) sessions separately. Thus, instead of having two sessions of equal duration (12 hours), sessions of unequal duration can be considered. (This had, in fact, been initially recommended for the current project, but the field staff could not follow the suggestion due to logistical difficulties.) Additional specific technical suggestions related to modifications in the protocol, manual and data sheets are mentioned in Appendix 5.

- Regarding the applicability of protocols and manuals for other studies, care needs to be taken in adapting to other situations. For example, as manufacturers upgrade their models, even though the basic functions remain the same, the specific operational instructions might change. It may be easy for trained scientists to rewrite their protocols, manuals and data sheets to accommodate differences in models and makes, but it would be more difficult for NGOs to make these changes on their own.

APPENDIX 1: Household Selection Criteria

Philippines Household Energy and Health Survey and IAP Monitoring

Sample Selection Criteria

General Criteria: Barangay (village) and Household Selection

1. Households will be selected in Barangays with AMORE presence
2. 2 barangays will be selected per region – total of 6 barangays
3. 40 households will be surveyed in each of 3 AMORE regions – total of 120 households
4. 10 households in each region will be monitored for indoor air pollution (IAP) exposure – total of 30 households (a subset of the total 120)
5. For IAP monitoring, households selected should be within close walking distance (max 15 min to go from one household to the next)
6. Households selected in each Barangay will be located in close vicinity of each other (*Ning*)
7. The number of households on stilts selected in Areas 1 and 2 should be proportionate to the actual numbers found on stilts.
8. Households surveyed should have children under 5 years of age

HEH Survey Sample (120 households)

Area managers will select two barangays in each of the three AMORE project areas, such that between the two, a representative number of households on stilts are included. We understand that the proportion of households on stilts is very small, perhaps 10 to 15%; area managers can confirm this and adjust the numbers as appropriate.

Our assumptions regarding this categorization of households:

- The three categories represent three fairly distinct socio-economic conditions. Though the sample size is small, we want to cover the most representative conditions of the population.
- We anticipate that the poorer households may have worse IAP conditions due to use of cheaper and lower-quality fuel.
- At the same time, households which have already been electrified by AMORE or which have been targeted for another phase of AMORE may have less "survey fatigue".
- Until we have greater insights into the household energy practices, we recommend equal numbers of respondents per category.

    a. Area 1 (Tawi-Tawi, Basilan provinces): A total of 40 households from 2 barangays, to be selected by area managers according to guidelines below.

	Inland	Coastal/ Stilts
Households electrified by AMORE (*using PV or rechargeable batteries*)	11	2
Households who have requested electrification by AMORE (*BRECDA and non-BRECDA Hhs - assuming these Hhs do not differ socio-economically)*	11	2
Households that cannot afford electrification	12	2

b. Area 2 (Sulu, Zamboanga City; Zamboanga Sib. Provinces): A total of 40 households from 2 barangays, to be selected by area managers according to guidelines below.

	Inland	Coastal/ Stilts
Households electrified by AMORE (*using PV or rechargeable batteries*)	12	2
Households who have requested electrification by AMORE (*BRECDA and non-BRECDA Hhs - assuming these Hhs do not differ socio-economically)*	11	2
Households that cannot afford electrification	11	2

c. Area 3 (South Cotabato, Sultan Kudarat, Miguindanao and Davao Provinces)

	Inland
Households electrified by AMORE (*using PV or rechargeable batteries*)	13
Households who have requested electrification by AMORE (*BRECDA and non-BRECDA Hhs- assuming these Hhs do not differ socio-economically)*	14
Households that cannot afford electrification	13

IAP Monitoring Sample

Area managers will select a subset of 30 from the 120 households to undergo indoor air pollution monitoring in conjunction with the HEH survey. An approximate distribution of these households within the total 120 is presented below for guidance.

	Inland	Coastal/ Stilts
Area 1		
Households electrified by AMORE (*using PV or rechargeable batteries*)	2	1
Households that have requested but don't have electrification	2	1
Households that cannot afford electrification	3	1
Area 2		
Households electrified by AMORE (*using PV or rechargeable batteries*)	2	1
Households that have requested but don't have electrification	2	1
Households that cannot afford electrification	3	1
Area 3 (*all Hhs on land*)		
Households electrified by AMORE (*using PV or rechargeable batteries*)	3	
Households that have requested but don't have electrification	3	
Households that cannot afford electrification	4	

APPENDIX 2: Focus Group Discussion Topic Guide

Initial Assessment of Cooking Practices, Indoor Air Pollution and Perceptions of Associated Health Impacts In the Alliance for Mindanao Off-Grid Rural Electrification (AMORE) Project Areas

Focus Group Discussion: Topic Guide

Most of the following questions have been extracted from the Household Energy, Indoor Air Pollution and Health Survey. Various experts have identified these questions as appropriate for a focus group setting. It is expected that these questions (along with others suggested by the consultant) will help to further substantiate the responses from the survey.

General Questions

The following questions are asked to obtain general information on households and the health status of the village in general.

- Can you describe your village, and what kinds of people live there?

  (Probe: ethnicity; religion (?); population size; household income; family size and type (extended or what); house descriptions (including ventilation, chimneys, hoods, outdoors cooking, bugs in roof – thatch or other?)
  Nutritional status at a village level
  Any income generating activities and time allocated to this?
  Barriers of enablers to increasing time allocated to this. Would they want more time allocated to this? Why? Why not?)

- General health of the village – perceptions etc.

- Common illness, their causes and treatment/costs

  (Probe: seasonal patterns in illness burden and distribution; what happens if a family member gets sick; do women have financial resources to seek health care; do they access any care – traditional, home remedies? where do people rest when they are ill?)

Daily/Weekly/Seasonal Patterns

The following questions are asked to get information on what a 'normal' day is like for the households concerned. This information will be useful for correlating with information in the time-activity charts as well as data obtained during the monitoring activity.

- Can you describe what you do in a typical day to me?

(Probe: gender; productive and reproductive roles; activities of elderly women; access to resources. Who collects the water? Is it boiled before use?)

- Can you describe what men do in a typical day?
  (Probe: gender roles and access to resources; activities of elderly men)

- Can you describe what children do in a typical day?
  (Probe: gender roles; responsibilities; schools etc. Do any activities keep children out of school? Children's health and well-being and what this means to the community)

Cooking Related Questions

*The following questions focus on cooking practices, particularly: variations in cooking practices during the dry and rainy seasons; presence of children in or near cooking area; and their activities. These questions are asked to assess i) the amount of time the stove is in use, and ii) children's exposure to indoor air pollution. In addition, questions are asked on households' choice of cooking devices; their satisfaction with stov**e performance; and interest and willingness to change devices.***

- Who does the cooking in the household?
  (Probe: one person or shared? Proportion of cooking done by whom?)

- Where do you do most of your cooking? Does this change depending on the seasons? How?
  (Probe: who spends time in the kitchen? mothers; children; elders; sick; others?)

- What is your current method of cooking?
  (Probe: How many meals do you cook everyday during the dry season? The rainy season; how long does it take to cook these meals; how many dishes do you cook, on average, for each meal; how long does it take to cook each type of food, describe the process; how long it takes – prep; cooking, cleaning up afterwards)

- What type of pots do you tend to use?
  (Probe: While cooking, do you use a lid to cover the pots? At what point do you cover the pot(s)?)

- Do you have small children (1 yr or younger)?

- Do your children accompany you while you are cooking?

(Probe: On average how much time (per day) does your infant spend near the stove (within 5 feet radius) when it is in use; what is s/he doing during this time)

- Perceptions of cooking methods
  What are the advantages and disadvantage of using the current method of cooking?
  (Probe: cooking devices: open fire, dapulan/rebar, stoves; fuels; biomass collection; time implications; do they find smoke a problem; how do they get rid of it?

  Do you like to cook over an open fire? Why or why not;

  Do you cook over any stoves? What types? Do they serve different functions (explain)? How many different types of stoves do you use? Do you ever use more than one at a time?

- Access to cooking devices

If you are using a dapulan/rebar, where did you obtain it?

(Probe: Did you have to pay for it? How much?)

If you are using a stove, how did you obtain it?

(Probe: If you purchased your stove(s). How much did it/they cost (Php)? Did you pay in a single lump sum, or were you able to pay over time? Who decides the type of stove to use? Who purchases/purchased the stove(s)? Does he/she decide on all major purchases in the household? Explain)

- User satisfaction
  Are you satisfied with the performance of your stove(s)?
  (Probe: Why or why not? Have you ever had to replace a stove? Why? E.g. stove wore out in some way? New designs are attractive or better match cooking needs?
  If you needed to replace a stove, how would you pay for it? What type of stove would you like to obtain and why?)

- Perceptions of improved stove
  What do you expect from an improved stove?
  (Probe: why is that important to you?)
  What do you need from an improved stove?
  (Probe: why is that important to you?)

What are the most important factors regarding design, quality and performance of an improved stove?

(Probe: chimney; side/front firing; accommodates various pot sizes; less smoke; less soot and dust; health considerations; versatility of different types of biomass fuels; fuel saving feature; shorter cooking time; needs less tending; safety etc.)

Fuel Use Questions

The following questions are aimed at getting information on the extent to which households buy and collect fuel for cooking and the time burden this places on household members, particularly women and children. We are specifically interested to know whether time and effort varies for collecting and/or purchasing particular types of fuels. For example, collecting coconut fronds from the backyard may be less time consuming than going to the market to buy fuelwood. It is important to keep in mind that the availability and price of fuels vary by season. A list of commonly available cooking fuels is attached.

- Does collecting fuel (esp. wood) confer any power or status?

- What type of fuel do you most often use for cooking?
  (Probe: Does this vary by season? How? Is there fuel scarcity? Does this affect your choice of fuel? Who decides what type of fuel to use?)

- Gathering and/or buying fuel
  Is your main fuel gathered or bought?
  (Probe: If gathered, is fuel gathered every day? How long does this typically take? Who helps with gathering fuel for cooking?
  If children help with gathering fuel, at what time of the day do the children gather the fuel? Do these children attend school? If any of your children do not attend school why not?
  If fuel is purchased, what are the reasons for buying fuel? How easy/difficult is it to access the fuel? Is it expensive? How much do you typically spend per week? Does this vary by season? How?)

- Fuel drying
  Do you ever have to dry out the fuel before using it?
  (Probe: Explain (e.g. under what circumstances, how often, how long does this take, etc.). Is it difficult to dry? Do you ever burn it before it is fully dry? Explain)

- Does collecting fuel have any impact on your health?
  (Probe: both procuring and carrying points of view, chest; eyes; ears; backache; headache; chest pain; exhaustion; pest attacks; snakebites; skin irritations; pesticide poisoning; psychological deterioration; injuries; rape;

beatings; and any other ill health perceived as caused by collecting wood – head-loading?

Chronic morbidity – physical discomfort; back problems; skin diseases; cough; repetitive strain – do these increase with age? Effect on pregnant women?)

Health Related Questions

The following questions address health related issues: presence of children in the cooking area while stove/fire is in use; level of awareness, knowledge and beliefs about adverse health impacts of exposure to indoor air pollution; women's perceptions about access, quality and cost of health care; and perceived benefits of kitchen smoke.

- Perceptions of health effects from exposure to IAP
  In what way do you feel that the smoke from the fire affects (a) your health and (b) the health of your children, if at all?
  Respondents' perceptions on specific health problems.
  (Probe: chest, eyes, ears, vector borne diseases, chest pains, and dizziness)

- Treatment
  Where do you usually go for treatment?
  (Probe: please specify where you seek treatment for the conditions you have mentioned, costs of diagnosis and treatment, satisfaction with services received – why or why not? Are you satisfied with the services you receive? Why or why not?)

- Health related information
  Source of health related information
  (Probe: Have you received information on detecting symptoms of pneumonia? Explain, Do you believe you receive adequate information on children's health?)

- Other than the health benefits, what do you feel are the most valuable ways in which smoke reduction could benefit / has benefited you?

List of Commonly used Household Cooking Fuels

Note: This is not a complete list. The FGDs may reveal other locally used fuels.

- Wood
- Coconut husk
- Coconut shell
- Coconut fronds/midribs
- Rice husk
- Sawdust
- Dry leaves
- Crop residue

- Cane toppings
- Dung
- LPG
- Kerosene
- Charcoal
- Coal

APPENDIX 4: Enumerator Training Agenda

Training: Indoor Air Pollution, Household Energy Practices and Health Survey

Participants: 12 enumerators/field workers

Date and Time: July 7 – 9, 2004, 9:00am – 5:00pm

Objectives: At the end of the workshop, the participant will be able to:

1. conduct interviews using the household questionnaire
2. perform monitoring of indoor air pollutants particularly Particulate Matter, 4 microns (PM4) and Carbon monoxide (CO) using the proper equipment

Methodologies: Lecture discussions, equipment demonstration and hands-on sessions, role-playing and field testing of the tools

Evaluation: Return Demo

Training Outline

Objectives and Tasks	Teaching Strategy	Content	Resources	Evaluation
1. conduct interviews - a. orientation to the project b. review of the questionnaire c. practice interview d. field testing	Lecture and Discussion Demonstration	Background of the project including objectives and sampling, Survey questionnaire, Enumerator's manual	Materials: Survey forms and 2 HH for each enumerator for pre testing of questionnaires/ Time :1 and half days (1 day for the tasks a-c and ½ for field test)	Return demonstration Feedback from field testing
2. Perform monitoring – a. general orientation on the instruments b. operate the instruments c. use the instruments in the field	Lecture and Demonstration	Instructions on the parts of and how to operates the T82 single gas monitor with its accessories, the dust sampler and the calibrator. Enumerator's manual	Materials: T82 single gas monitor with accessories, computer, dust monitor, filters and cassettes, and gas flow calibrator Households to be pre tested Time: 1 and half days (similar to above)	Return Demonstration Feedback for the field test

Program of Activities:

First Day

9:00 – 9:30	Introduction of Trainers and Participants
9:30 – 10:00	General Background of the Project – Objectives, areas etc
10:00 – 11:30	Sampling Strategy, Review of the Survey Questionnaire and the Enumerator's Manual
11:30 – 12NN	Q and A
12NN – 13:30	Lunch Break
13:30 – 14:30	Practice Interview
14:30 – 17:30	Field Pre Testing

Second Day

9:00 – 9:30	Recap and Feedback re Field Testing
9:30-10:30	Discussion of Recommendations on the Survey Form
10:30 -11:00	BREAK
11:00 – 12:30	Orientation and Demonstration of the Equipment to be used Discussion of the Enumerator's Manual
12:30 – 14:00	Lunch Break
14:00 – 16:00	Practice Monitoring within premises
16:00 – 17:00	Discussion of difficulties and issues, assignment of households for monitoring

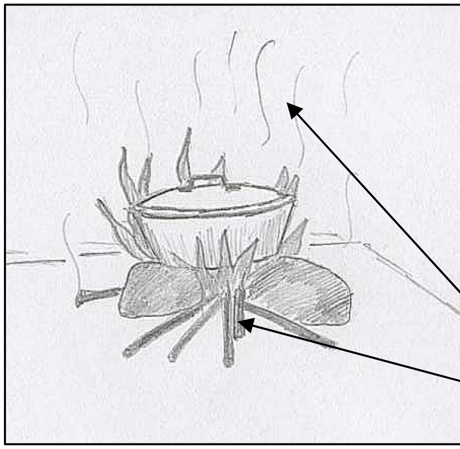
Third Day

All Morning until after lunch – Field Testing

14:00 – 16:00	Feedback re Field testing and discussion of recommendations in the conduct of the monitoring
16:00 – 17:00	Recap of the whole Workshop and further clarification of Issues, Assignment of areas

APPENDIX 5: Common Stove Models in Study Area

The following are some sample illustrations of cooking methods commonly found in the survey areas. <u>Please note that this is not a complete list and has been provided to aid the enumerators with stove classification. The enumerators may encounter other types of stoves not included here.</u>



The Dapulan – three stone or open fire will typically have three stones on which the pot is placed for cooking. The fire will be clearly visible along with the ***<u>smoke emissions</u>***.

Smoke

Firewood

Fig 1 Dapulan-three stone

The Dapulan-Rebar is a structure used to cook on open fires. It is made of iron bars and the fire is clearly visible.

Iron bars

Fig 2 Dapulan-Rebar

Fig 3. Cement Stove I

These stoves are constructed with cement and used to cook with biomass fuels and/or charcoal. The stoves are available in various dimensions as seen in Figs 3 and 4 respectively.

Fuel Magazine

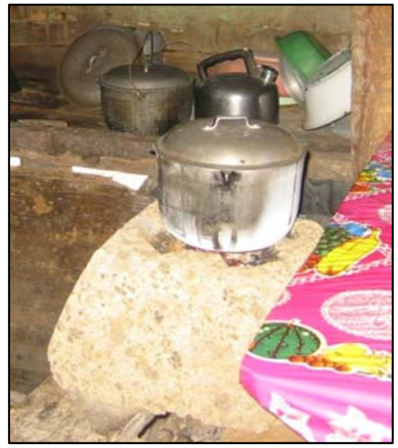
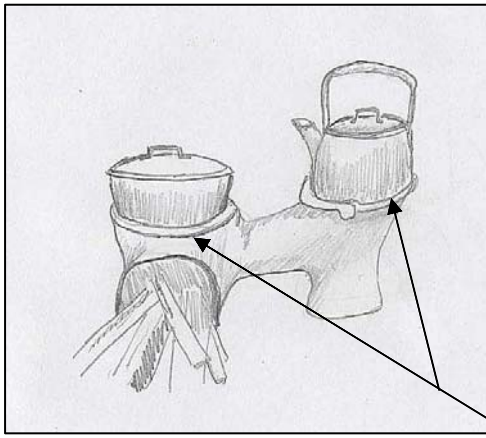


Fig 4. Cement Stove II

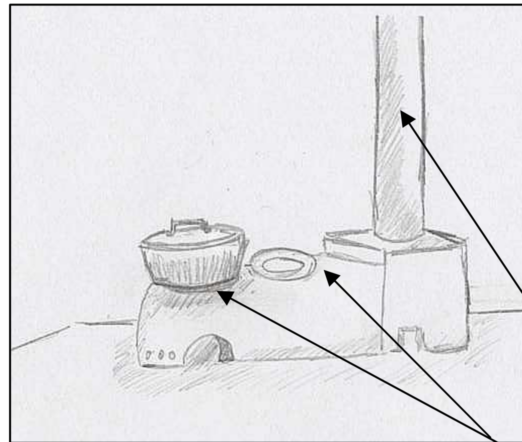
Slightly larger cement stove with the fuel magazine facing away the photograph.



The modified Anagi 'Liyab' is a chimney-less improved stove with two potholes. This stove is usually found in the Mindanao region. There will likely be some visible ***smoke emissions.***

Two Potholes

Fig. 5 Modified Anagi 'Liyab'



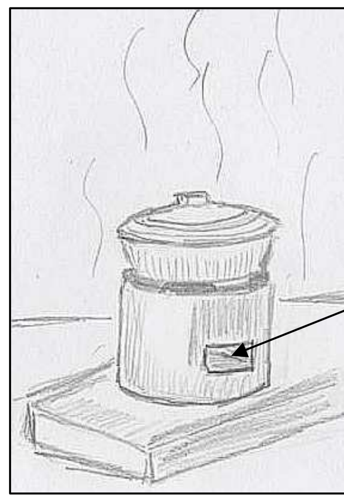
The Improved Stove is typically a wood stove with two or three potholes. There is usually ***no visible smoke emission*** indoors since the chimney expels the smoke out of the cooking area.

Chimney

Two Potholes

Fig. 6 Improved Stove

Fig 7. Clay Stove



The Charcoal Stove will usually have an opening for placing the fuel and will often have visible ***smoke emissions***.

Fuel (Charcoal) Magazine

Fig 8. Charcoal Stove (Dapulan – mud)

Fig 9. LGP Stove I
(Two-burner)

Fig 10. LPG Stove II
(Single burner)

Both single and two burner LPG stoves will have a blue flame and *no smoke emissions.*

Fig 11. Kerosene 'Gravity' Stove

Fig 12. Kerosene 'Wick' Stove

APPENDIX 6: Suggested modifications to the protocols, manuals and data sheets pertaining to indoor air pollution monitoring

Recommendations on survey:

1. The survey questionnaire must be shortened for more accurate and consistent responses. Currently, the questionnaire is far too long, causing respondents to get bored after a while and the answers given may have been not well considered.
2. Translating the survey to the specific dialect of the respondent will facilitate better understanding and more accurate responses. In this study, the interviewer had to translate the questions him/herself to the specific dialect of the respondent, leaving the possibility of inconsistent or inaccurate and thus responses.
3. In shortening the questionnaire, some questions may not be relevant or may be redundant. For example, in the health section, the question on attacks of sweating does not mean much medically in terms of the respiratory health outcomes that are being studied. There are also too many open ended questions especially in the health section. Respondents are impatient with such types of questions. In addition, most of the cooking fuels used by the respondents are wood, charcoal, kerosene and LPG, hence, the other choices may be eliminated for future application in the Philippines, as the four primary choices of cooking fuel are true in most of the country. Perhaps coconut husks/fronds may also be explored as a fifth fuel source since they are common in a great majority of the country. It is recommended that an “other/specify” category be structured so as to capture specific biomass fuels common to particular areas.
4. Though the questions about location (B6 and B7) of cooking allowed for more than one response, we observed that nearly all households mentioned just one location in both seasons. Therefore, there is no need to study the change in stove types in each different location (B6.2 – B6.7 and B7.2 – B7.7). In future questionnaires this change can be made, simplifying the questionnaire and the data analysis. This will also avoid duplication with question B12. It is recommended that B12 be retained as there is greater likelihood that different meals are cooked with different devices rather than devices varying across locations inside a house. The latter aspect can be probed at length in focus group discussions.

Location of kitchen: Question F3 is repetitive and can be deleted because in an earlier section the same question has been asked seasonally.

5. A question for future observation is whether the type of food cooked for sale determining use of wood.
6. Future questionnaires should have a question linked to this one about which stove they would like to replace their old stove with.

Given the importance of kitchen ventilation, it is recommended that future surveys use an accurate measuring tape instead of a 1-m string.

Number of windows: This question appears twice in the questionnaire (B24 and F9). Survey should be modified to eliminate F9.

Future questionnaires need to achieve greater clarity about location of kitchen, type of kitchen and kitchen architecture. There is a danger in being too prescriptive because these variables are very region specific. However, it is recommended that finalization of the questionnaire should be preceded by focus groups and intense pretesting.

11. It is recommended in the future surveys, questions B13 and B15 not have categorical responses but be treated as continuous variables to enable computation of cumulative time spent cooking during the day.

Supervisor's manual

1. The Appendix to Supervisor's manual: 'Planning the monitoring time in a house**'** should be included in the main part of the manual as well as in the enumerator's manual.
2. The first part of the manual should mention that all studies use four types of filters, which can be color coded using colored tape. These types are 1) actual filters that are exposed in the household, b) filters used for calibration (along with support pad). Such filters do not need to be weighed either before or after use, c) Field blanks and d) laboratory blanks.
3. The supervisor should regularly check that all watches (even personal watches), clocks and clock settings in the equipment are synchronized.
4. Part E of the manual should stress that the used cassettes (even blanks) should be carefully transported from the field to the weighing laboratory in hard cases, with adequate foam packing and ensuring that the exposed face is always up. The specific types of materials used will depend on what is locally available. Some commercial agencies (such as SKC) provide ready-made storage and transportation boxes. If the cassettes are jostled there is a danger of the filters losing some of the collected PM. This is especially critical in situations where extremely high levels of PM concentration are likely. It should also be ensured that when monitoring is not being done the cassettes should be sealed with the red and blue plugs to ensure that moisture and other dust do not contaminate the filters.
5. The supervisor should maintain a log of battery usage. When it becomes clear that the battery has been used for a long time, and allowing for a safety margin, the battery should be replaced/recharged. During trial sessions the supervisor must determine the discharge rate and plan accordingly.

Enumerator's manual

1. Section F: Based on the experience we have gained regarding the importance of ventilation , we suggest that kitchen dimensions be measured exactly with a measuring tape rather than with a 1 m string.
2. Section H: in this section and all other sections it is necessary to define the 'duration of cooking'. The issue here is whether preparation of food before fire is lit is to be considered as cooking time or not. And similarly if there any activities just after the fire is exhausted. From an exposure point of view precise information is needed on duration of fire. But in the context of interventions and social issues, total cooking time is also important.
3. The supervision must also ensure that subjective criteria are not used in selecting samples. The sample selection must be truly random. Any tendency to select only

those houses where there is a prior perception that pollution levels will be high should be avoided (example: choosing only houses that cook indoors). Also, respondents must be discouraged from making any modifications to their stove or kitchen during the project, if the respondent's sole motivation in doing so is to portray a different from normal exposure situation in his or her house.

Enumerator's data sheet

1. Section F: Related to the above point the questions and responses must be modified to accommodate actual measurement of kitchen dimensions.
2. Section H: It is a recommended that all fuel related questions be compared with similar questions in Section B. If the responses are not comparable, then the supervisor must probe for the reason, but he or she must keep in mind that even though people may prefer a certain fuel as their main fuel generally, this may be different from what was actually used on the day of the monitoring. This is an acceptable situation, but the supervisor needs to cross-check.
3. Section H: the question related to the ID# of the people cooked for can be deleted
4. Section H: can add a question on location of cooking for all the four meals and other uses of fire. This is to determine if there is any variation in location across a day.

APPENDIX 7: Data Tables

Household Profile

Asset ownership

Asset type	Province (% houses owing the asset)		
	Maguindanao	Tawi-Tawi	Zamboanga
Car or jitney		2.5	
Motorcycle	12.5		
Bicycle	25.0	2.5	2.5
Fishing boat	7.5	30.0	80.0
Kulibo		2.5	
Passenger boat	2.5	20.0	2.5
Power tiller			2.5
Radio	25.0	67.5	45.0
Radio with cassette	17.5	45.0	32.5
Color TV	5.0	22.5	27.5
BW TV	17.5	2.5	50.0
Karaoke	2.5	17.5	22.5
VHS		20.0	2.5
Stereo		7.5	10.0
Computer		2.5	
Other electrical		7.5	2.5
Sewing machine	5.0	30.0	10.0
Fridge		5.0	2.5
Rice cooker		15.0	
Kerosene wick stove			2.5
Kerosene gravity stove		2.5	2.5
Kerosene dbomba stove	2.5		5.0
Gas cooker		2.5	2.5
Kerosene wick lamp	5.0	7.5	5.0
Large livestock			2.5
Small livestock			22.5
Land for subsistence	50.0	25.0	
Land for cash crop	17.5	5.0	
Beds	17.5	62.5	52.5
Shelves	25.0	75.0	50.0
Wooden chairs	60.0	65.0	70.0
Wooden tables	67.5	72.5	72.5
Gas generator or solar		25.0	35.0
Flat iron	5.0	52.5	17.5
Other	7.5	7.5	5.0

Section B: Cooking Practices

Age cooking began

Age group (years)	Primary cook (n = 120) %	Secondary cook (n= 97) %
5-10	35.0	25.8
11-15	51.7	49.5
16-19	10.8	20.6
20-24	1.7	3.1
25-29	0.8	0.0
30-34	0.0	1.0

Location of cooking

Location	Dry season (%)		Rainy season (%)	
	House on land	House on stilt	House on land	House on stilt
In a room used for living or sleeping (with partition)	11.7	17.1	21.3	17.1
In a room used for living or sleeping (without partition)	1.3	0.0	1.3	2.4
In a separate room used as kitchen	35.1	29.3	37.3	29.3
In a separate building used as kitchen	29.9	48.8	28.0	48.8
Outdoors (with one or two makeshift walls and roof)	7.8	2.4	6.7	2.4
Outdoors (open air with no structural support)	14.3	2.4	5.3	0.0

Number of times cooked in a day

Number	Dry season (%)	Rainy season (%)
2	9.2	11.7
3	87.5	84.2
4	3.3	4.2

Time spent cooking a meal

Meal	< 1 hour % houses	1-2 hours % houses

Meal 1 (n = 120)	80.0	20.0
Meal 2 (n = 119)	61.3	38.7
Meal 3 (n= 110)	68.2	31.8
Meal 4 (n = 5)	40.0	60.0
Food sale 1 (n= 20)	35.0	65.0
Food sale 2 (n = 3)	33.3	66.7

Time to taken to cook each type of food

Type of food	Time (minutes) as reported by % houses			
	<30	30-60	60-90	90-120
Rice	84.0	13.4	1.7	0.8
Large fish	40.7	53.7	3.7	1.9
Small fish	87.1	10.9	2.0	
Root crops	37.8	59.5	2.7	
Meat	9.1	66.7	24.2	
Vegetable	91.3	5.2	2.6	0.9
Beans	69.2	26.9	3.8	

Number of dishes cooked in a meal

Meal	Number of dishes cooked (% houses)			
	1	2	3	4 or more
Meal 1 (n = 120)	3.3	61.7	34.2	0.8
Meal 2 (n = 119)	1.7	26.9	64.7	6.7
Meal 3 (n= 109)	1.8	36.7	56.0	5.5
Meal 4 (n = 3)	0.0	66.7	33.3	0
Food sale 1 (n= 19)	42.1	36.8	10.5	10.6
Food sale 2 (n = 2)	50.0	50.0	0.0	0.0

Number of Windows

Number of windows	According to B24 (n = 111) % houses
0	0.0
1	54.1
2	45.9
3	0.0
4	0.0

Fuel to ignite fire

Fuel	% houses
Scrap paper	9.0
Kerosene	75.7

Rubber slippers	26.3
Cloth	0.9
Other	7.0

Reasons for buying fuel

Reason	% houses
Fuel source is not within walking distance	39.5
Scarcity of wood	53.9
Fuel source is situated on rough terrain	0.0
Scarcity of other biomass fuels	0.0
The fuel I buy is of better quality	3.9
Buying fuel is faster than gathering	52.6
Fuel source is situated on private lands	3.9
The fuel I buy produces less smoke	25.0
Other	5.3

How often main fuel is gathered

Frequency	Dry season % houses	Rainy season % houses
Every day	15.8	10.9
Every second day	21.2	20.0
Once or twice weekly	49.1	49.1
Less often	14.0	16.4
Other	0.0	3.6

HEALTH SECTION

Socioeconomic data

Table 1- Socio-economic status according to monthly income, n =120

Monthly Income Class (in pesos)	**Frequency**	**Percent**
0-5000	88	73.3%
5001-20,000	26	21.7%
>20,000	6	5%

Table 2 - Socio-economic status according to furniture/equipment/appliance ownership, n = 120

SES Class	Frequency	Percent
1	4	3.3%
2	6	8.3%
3	17	22.5%
4	93	77.5%

Regression Analysis

Table 13: Logistics regression of respiratory symptoms among respondents: Frequent Cough

Variable	Odds Ratio	Confidence Interval	P Value
Income Class: 1*			
2	1.48	0.44 - 5.01	0.522
3	1.36	0.07 – 23.65	0.820
Cooking Location – dry season:			
1-2*			0.000
3	2.65e+16	5.04e+15 - 1.39e+17	0.000
4	3.97e-09	9.08e-10 - 1.74e-08	0.000
5	3.23e+23	3.05e+22 - 3.42e+24	0.000
6	3.55e+07	2341289 5.38e+08	
Presence of Smokers: Absent*			
Present	2.86	0.95 - 8.58	0.060
Cooking Fuel:			
Wood*			
Charcoal	1.22	0.30 - 4.90	0.770
LPG	0.75	0.11 - 4.79	0.765
SES Class: 1-2*			
3	0.36	0.02 - 6.05	0.482
4	0.72	0.04 - 10.79	0.818
Household Size			
</= 6 persons*			
> 6 persons	0.70	0.23 - 2.07	0.523

*reference group

Table 14: Logistics regression of Respiratory Symptom among respondents: Cough at night

Variable	Odds Ratio	Confidence Interval	P Value
Income Class: 1*			
2	0.55	0.13 - 2.18	0.397
Cooking Location – dry season: 1-2*			
3	7.07e+07	1.37e+07 - 3.64e+08	0.000
4	3.39e-09	6.10e-10 - 1.88e-08	0.000
5	1.57e+15	9.73e+13 - 2.53e+16	0.000
6	1.038455	.064 - 16.73	0.979
Presence of			

Smokers: Absent* Present	1.07	0.33 - 3.47	0.899
Cooking Fuel: Wood* Charcoal	0.22	0.04 - 1.02	0.053
SES Class: 1-2* 4	7.64e+07	6168479 - 9.46e+08	0.000
Household Size </= 6 persons* > 6 persons	0.66	0.21- 2.12	0.492

*reference group

Table 15: Logistics regression of Respiratory Symptom among respondents: Shortness of Breath in the past six months

Variable	Odds Ratio	Confidence Interval	P Value
Income Class: 1* 2	0.98	0.25 - 3.81	0.984
Cooking Location – dry season: 1-2* 3 4 6	6.98e+08 4.24e-08 2.33	1.40e+08 3.47e+09 8.55e-09 2.10e-07 0.18 - 30.08	0.000 0.000 0.516
Presence of Smokers: Absent* Present	1.22	0.38 - 3.90	0.730
Cooking Fuel: Wood* Charcoal	1.87	0.45 - 7.76	0.385
SES Class: 1-2* 3 4	0.28 1.09	0.01 - 10.06 0.05 - 22.35	0.489 0.952
Household Size </= 6 persons* > 6 persons	2.55	0.77 - 8.41	0.122

*reference group

Table 16: Logistics regression of Respiratory Symptom among children: Chest Problems in the past six months

Variable	Odds Ratio	Confidence Interval	P Value
Income Class: 1* 2	 1.89	 0.35 - 10.16	 0.458
Cooking Location – dry season: 1-2* 3 4 6	 1.79 2.10e-08 2.80e-09	0.23 - 13.81 3.15e-09 1.40e-07 1.46e-10 5.38e-08	 0.576 0.000 0.000
Presence of Smokers: Absent* Present	 7.68	 1.56 - 37.62	 0.012
Cooking Fuel: Wood* Charcoal Kerosene LPG	 0.21 1.60e+08 0.18	0.03 - 1.44 426847 - 5.98e+10 0.01 - 4.24	 0.113 0.000 0.292
SES Class: 1-2* 4	 0.29	 0.01 - 6.15	 0.429
Household Size </= 6 persons* > 6 persons	 5.38	 1.27 - 22.72	 0.022

*reference group

House characteristics: enumerator observations

Building materials

Material	Roof %		Walls %	
	House on land	House on stilt	House on land	House on stilt
Thatch	9.1	29.3	15.6	2.4
Wood			40.3	80.5
Corrugated iron sheet	74.1	68.3		
Bricks	2.6		6.5	7.3
Stones			6.5	
Other	14.3		31.2	9.8

APPENDIX 8: References

Albalak R, Bruce N, McCracken J P, Smith K R, de Gallardo T. 2001. "Indoor respirable particulate matter concentrations from an open fire, improved cookstove, and LPG/open fire combination in a rural Guatemalan community." Environmental Science and Technology 35: 2650-2655.

Balakrishnan K, Sankar S, Parikh J, Padmavathi R, Srividya K, Venugopal V, Prasad S, Pandey V L. 2002. "Daily average exposures to respirable particulate matter from combustion of biomass fuels in rural households of southern India." Environmental Health Perspectives 110(11): 1069-75.

Doig A, Bates L, Bruce N, Kithinji J. 2001. "Reducing indoor air pollution in rural households in Kenya: working with communities to find solutions. Final Report of the ITDG Smoke and Health Project."

Ezzati M and Kammen D M. 2001. Indoor air pollution from biomass combustion and acute respiratory infections in Kenya: an exposure-response study. The Lancet 358: 619-624.

Hessen J O, Schei M, Yadav B, Snelligen T, Pandey M R. 1996. "Evaluation of methods for monitoring domestic smoke exposures in rural Nepal." In Proceedings of the 7th International Conference on Indoor Air Quality and Climate. [Nagoya, Japan]

Lodhi M A and Zain-al-Abdin A. 1999. "Indoor air pollutants produced from fossil fuel and biomass." Energy Conservation and Management 40: 243-248.

McCracken J, Albalak R, Boy E, Bruce N, Hessen J, Schei M, Smith KR. 1999. "Improved stove or inter-fuel substitution for decreasing indoor air pollution from cooking with biomass fuels in highland Guatemala?" Indoor Air 3: 118-123.

Naeher L P, Smith K R, Leaderer B P, Mage D, Grajeda R. 2000. "Indoor and outdoor PM2.5 and CO in high and low density Guatemalan villages." Journal of Exposure Assessment and Environmental Epidemiology 10: 544-551.

Naeher L P, Smith K R, Leaderer B P, Neufeld L, and Mage D T. 2001. "Carbon monoxide as a tracer for assessing exposures to particulate matter in wood and gas cookstove households of highland Guatemala." Environmental Science and Technology 35(3): 575-581.

Park E and Lee K. 2003. "Particulate exposure and size distribution from wood burning stoves in Costa Rica." *Indoor Air* **13**: 253-259.

Saksena S, Singh P B, Prasad R K, Prasad R, Malhotra P, Joshi V, Patil R S. 2003. "Exposure of Infants to Outdoor and Indoor Air Pollution in Low-Income Urban Areas-A

Case Study of Delhi." Journal of Exposure Analysis and Environmental Epidemiology 13(3): 219-230.

Smith K R, Liu Y, Rivera J et al. 1993. "Indoor air quality and child exposures in highland Guatemala," pp. 441-446 (vol.1). In Proceedings of the 6th International Conference on Indoor Air Quality and Climate, University of Technology, Helsinki

Torres E., Subida R., Gapas J., Quizon R., Rebullida M. Report on the Environmental Health Monitoring of Pagbilao Grande island and adjacent areas, 2003. Mirant Corporation.

Viau C, Hakizimana G, and Bouchard M. 2000. "Indoor exposure to polycyclic aromatic hydrocarbons and carbon monoxide in traditional houses in Burundi." International Archives of Occupational and Environmental Health 73(5): 331-338.