Ghana 2012 Group Project Report

Ghana's Regional Development in Economics, Education and Natural Resources, with a Case Study on Customers' Preferences for Household Water Treatment & Safe Storage Products

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Master of Science Degree

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Note: W. Qiu's contribution to the 2012 Ghana Group Report was prepared one term later than the rest of her Ghana teammates. It is therefore presented as a stand-alone document.

Supervisor: Susan Murcott

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ABSTRACT

Ghana is one of the few countries that was re---classified from low---income country to low---middle income country in 2011 by the World Bank (World Bank, 2011a). At the same time, Ghana is still in the process of achieving the Millennium Development Goals (MDGs). This thesis uses the MDGs as a guide and backdrop against which to analyze the relationships between economics, education and natural resources. The analysis helps provide recommendation for regional development in economics, education and natural resources for 10 regions in Ghana. The second part of the thesis uses a case study in the water sector to explore the relationship between the MDG targets for poverty, water accessibility and water quality. The case study is a market survey on Household Water Treatment and Safe Storage products, which seeks to understand customers' preferences for safe water in the home and to find out economic opportunities in this sectors.

The author found that each of the economics, education and natural resources indicators: proportion of the population under the poverty line, percentage of population completed primary and secondary schools, selected natural resources (mean time to drinking water source, annual precipitation, oil palm and cocoa) are moderately to strongly correlated with each other. Each region has its own distinct advantages and disadvantages that can help direct priorities for regional development. Among the six HWTS products (*Aquatab, CrystalPur™/Tulip Siphon Water Filter, Kosim Classic, Kosim Deluxe, PUR and LifeStraw® Family*), *Kosim Deluxe* received the highest total preference score with and without the impact of the price. In general, particle removal products are more popular than the chemical products. Interviewees are concerned about the size (either too big or too small) of the particle removal product and are aware of the side effects of chemical products. MDG Target 7.C is likely to be achieved in urban Tamale shown in this data. The market research shows that HWTS products can contribute to potential post---2015 MDG for water as well as the current MDGs Target 1.A for poverty. Market recommendations are also provided for the six HWTS products.

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1. INTRODUCTION

1.1. Focus and Particular Interest of the Thesis

In order to limit the scope of the thesis, the author has selected four targets of three MDGs. These targets overlap and are closely related to the other frameworks *three pillars* of sustainable development, HDI, Sustainable Livelihood Framework and Inclusive Wealth Index/Framework. After the macro study in economics, education and natural resources, a case study in water sector was conducted for further better understanding of the problem.

The MDGs' targets as the focus of this thesis are:

- Goal 1 Target 1.A: Halve, between 1990 and 2015, the proportion of people whose income is less than $1 a day;
- Goal 2 Target 2.A: Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling;
- Goal 7 Target 7.A: Integrate principles of sustainable development into country policies and programmes and reverse the loss of environmental resources;
- Goal 7 Target 7.C: Halve, by 2015, the proportion of the population without sustainable access to safe drinking water[1].

2. OBJECTIVES

This thesis has two major sections, one is a marco-scale correlation study in Ghana, and the other is micro-scale case study in urban Tamale. Part I of the thesis proposes first objective and part II of the thesis is to achieve the second objective:

1. To collect, review and analyze the most updated data for Ghana at both a national level and in Ghana's ten regions (Western, Central, Greater Accra, Volta, Eastern, Ashanti, Brong Ahafo, Northern, Upper East, Upper West of Ghana) in terms of economy, education and natural resources[2], the three components of the MDGs Goal 1, 2 and 7 and important indicators of the development frameworks mentioned;

[1] Note: *Sanitation* is not included in the thesis because the author would like to focus on natural resources, which is one of the key components of the environment.
[2] Due to the closer relationship between economics, basic needs of human being such as food and water, natural resources will be used for analysis of the thesis instead of the large environmental pictures.

2. To conduct market survey on Household Water Treatment and Safe Storage (HWTS) products and customers' preferences in Tamale, a city in the Northern Region of Ghana. We expect that the market research case study help us better understand the existing problems in MDGs Target 7.C and potential problem in the post-2015 MDGs. Additionally, we hope that, if the market for HWTS exist, HWTS products can create economic development opportunities in Northern Sector of Ghana to reduce the economic disparities with other regions in Ghana.

3. METHODOLOGY

3.1 Methodology for the Part I Macro Study in Ghana

3.1.1 Data Gathering and Rationale

For each MDG, there are thousands of data available. For the purpose of this thesis and based on the author's interest, we selected three broad components: Economics, Education and Natural Resources. **Regional** indicators in economics, education and natural resources are collected and as follow:

Economics indicators: % of population under the poverty line;
Education indicators: % of population that has completed primary and secondary schools; % of population that has more than secondary school.
Natural resources indicators: water resources (annual precipitation, mean time to drinking water), oil palm and cocoa.

3.1.2 Data Analysis Methodology

3.1.2.1 Correlation Analysis

The primary foci of first part of this thesis are economics, education and natural resources indicators. Correlation between economics, education and natural resources will first be analyzed by measures using statistical dependence. Pearson correlation coefficient analysis will be used to determine the linear dependence of two variables. The Pearson correlation coefficient can also be generated in Excel® using linear regression function.

3.1.2.2 Combination Analysis

The purpose of this analysis is to help better understand the correlations on a regional and national scale in Ghana. The combination analysis is only used for natural resources indicators when finding the correlations with economics and education, since natural resources have more indicators.

The method is to consider economics (X), education (Y) and natural resources (Z) as three sets of data. Each set of data has its own indicator(s).

- Economics has one indicator: Proportion of population under poverty line (X1);
- Education has two indicators:
    - Percentage of population completed primary school (Y1),
    - Percentage of population completed secondary school (Y2);
- Natural resources (Z) has four indicators:
    - mean time to source of drinking water (Z1),
    - average annual precipitation (Z2),
    - percentage of area for oil palm plantation over the total area of oil palm in Ghana (Z3) and,
    - production of cocoa (Z4).

Each set of (X, Y, Z)'s indicators will be compared with all other indicators to find the Pearson correlation coefficient (R) of every paired indicator set. At the same time, each indicator will be scored (Score 1-10 [the author defined this score as performance score (iScore)], 10 is the highest score) based on their ranking compared to other regions, highest ranking receive 10 and the score descends as the ranking goes down. The iScore then multiplies by the corresponding correlation coefficient square R^2 and this is the final score [the author defines this score as fScore] of two related indicators.

3.1.2.3 Correlation Scale

To better define the how closely each set of indicators are correlated, the author has defined scales for Pearson's correlation coefficient (R) and *combination analysis*:

- No correlation: $R^2 = 0$;
- Weak correlation: the correlation square $R^2 \in (0,0.25]$
- Moderate correlation: $R^2 \in (0.25,0.55]$
- Strong correlation: $R^2 \in (0.55, 1]$

3.2 Methodology for Part II Water Sector Survey

3.2.1 Product Testing

Six HWTS products were preselected and tested for bacteria removal in the lab at PHW: *Aquatabs*, *CrystalPur™/Tulip Siphon Water Filter*, *Kosim Classic & Kosim Deluxe*, *PUR™*, *Life Straw® and Life Straw® Family* (among which, two of them are *Kosim Classic and Kosim Deluxe* which the author considered as two different products with same interior ceramic filter). The author collected Taha dugout water

in Tamale, and tested the initial total coliform and *E.coli* using IDEXX Quanti-Tray®[3]. For instruction of how to use Quanti-Tray® can be found at: http://www.idexx.com/view/xhtml/en_us/water/quanti-tray.jsf. Data presented regarding the number of bacteria per 100 mL is recorded using Most Probable Number (MPN). Instruction on counting the MPN using IDEXX Quanti Tray® can be found at: http://oe.oregonexplorer.info/umpquabasin/MPNCalculator/Default.aspx MPN in the Taha dugout and effluent from the six HWTS products were recorded. Experiences the author encountered with the HWTS products were also recorded.

3.2.2 Question Design

The survey included both open & closed questions, and direct & indirect questions, where interviewees could choose answers directly from answers listed, rank Top 3 choices and explain the reasons for their choices. The types of questions included behavioral, attitudinal and classification questions. Types of questions asked include: customer profile, source of water, product choices and reasons of choices and products preferred distribution point. The survey itself is shown on Appendix I.

The location of market research conducted was at Tridewa Co. Ltd, an Indian family owned business operated at the junction between the taxi station and the marketplace in the center of Tamale. The time to conduct the survey is from Monday to Saturday from 10:00am to 6:00pm.

3.2.3 Total Preference Score Calculation

The methodology of the total preference score calculation is based on the total numbers of Top 3 ranking of the potential customers choice. For each product, assume the total numbers of top choices No.1, No.2 and No.3 are X, Y, Z, then the total preference score (S) calculation will be: S = X*3+Y*2+Z*1, where each vote for No.1, No.2 and No.3 will score 3, 2 and 1 point, respectively.

3.2.4 Actual Sales of HWTS Products

During the survey the author found that some respondents were interested in purchasing HWTS products. Therefore, the author asked for cell phone numbers of respondents who were interested in buying. Daniel would be continued contacting these respondents after the author left Ghana. Additionally, the author also held a market research pilot study for three days (January 25 to January 27 of 2012), to see which HWTS products would be sold during the sale period; and if possible, to compare the actual sales results with the market survey to see if these results on product preference are congruent.

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[3] IDEXX Quanti Tray is used by researcher to provide easy, rapid and accurate counts of coliforms, *E.coli* and enterococci. Information can be found at: http://www.idexx.com/view/xhtml/en_us/water/quanti-tray.jsf?SSOTOKEN=0

4. RESULTS AND ANALYSIS

4.1 Part I Data Presentation and Analysis for Macro Study

4.1.1 Map Generation

4.1.1.1 Regional Economics Data

The concern of the MDGs Goal 1 is whether countries can eradicate extreme poverty by 2015. Although both GNI and GDP per capita in Ghana have increased in the past years, poverty at the regional scale is an obstacle to achieving the MDGs in various countries, including Ghana (Harsch, 2008). Therefore, Figure 4-1-1 looks at economics in Ghana, especially those living under the poverty line of $1.25 a day on a regional scale.

Figure 4-1-1. Proportion of population below the poverty line in 10 different regions of Ghana in 2005/06 (most updated available data obtained from GhanaInfo 6.0, owned by the Government of Ghana[4]).

[4] Data can be assessed by typing in "Under Poverty" on database website: http://www.ghanainfo.gov.gh/

4.1.1.2 Regional Education Data

Maps for percentage of men completed primary school, secondary school and have more than secondary school[5] are generated from ArcGIS to compare the proportion of the population completed primary school, secondary school and tertiary school across 10 regions in Figure 4-1-2 and Figure 4-1-3:

[5] More than secondary school here can be assumed as tertiary education, as the tertiary education in Ghana is defined in the Report of the President's Committee on Review of Education Reforms in Ghana (2002:xxxvi) as the education offered AFTER SECONDARY level at university, polytechnic, specialized institutions, open university and any other institutions to provide training that lead to the award of diploma and degree qualifications

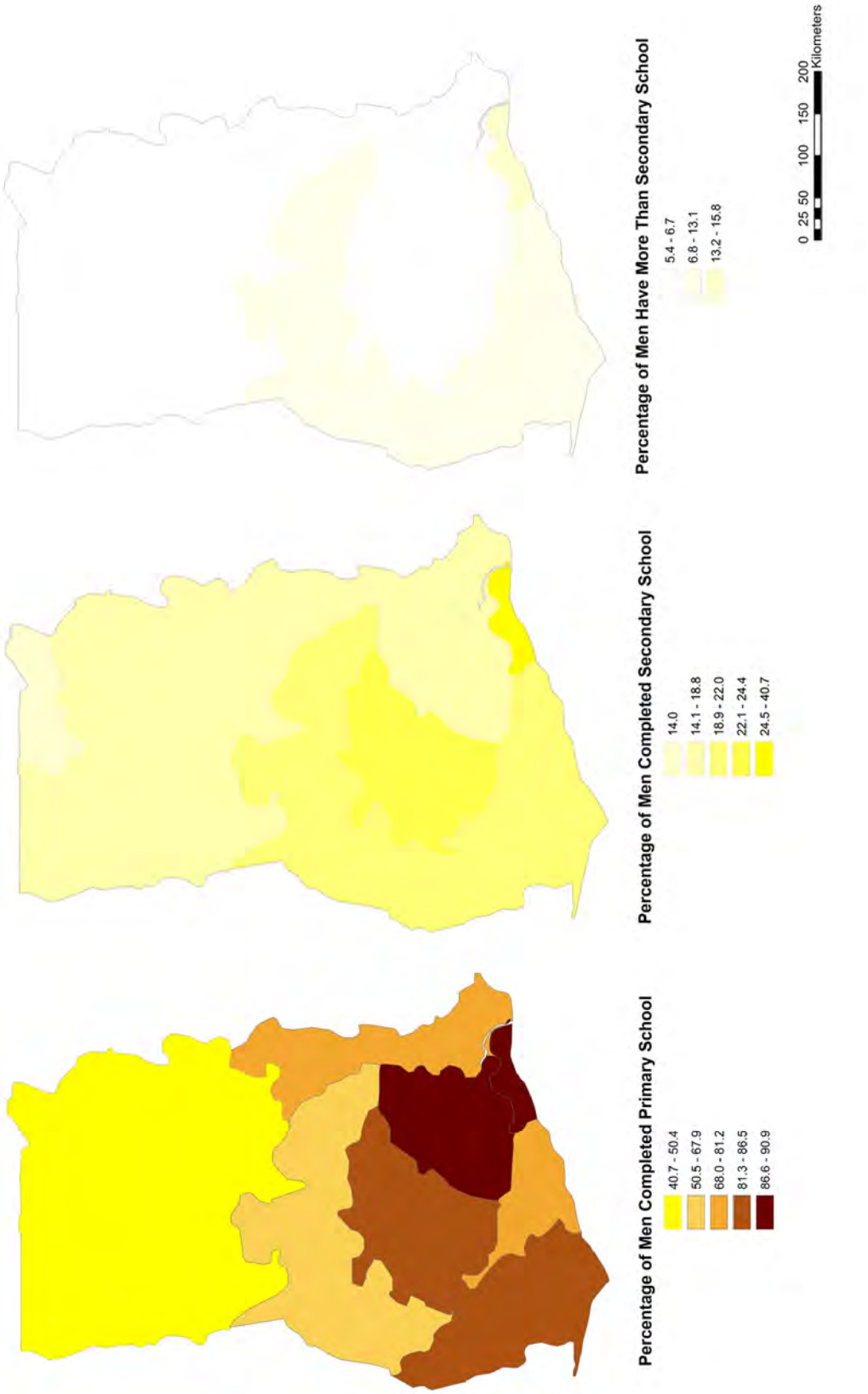

Figure 4-1-2. Percentage of men (aged 15-49) completed primary, secondary school and more than secondary school education in Ghana (Data from GSS demographic and health survey, 2009)

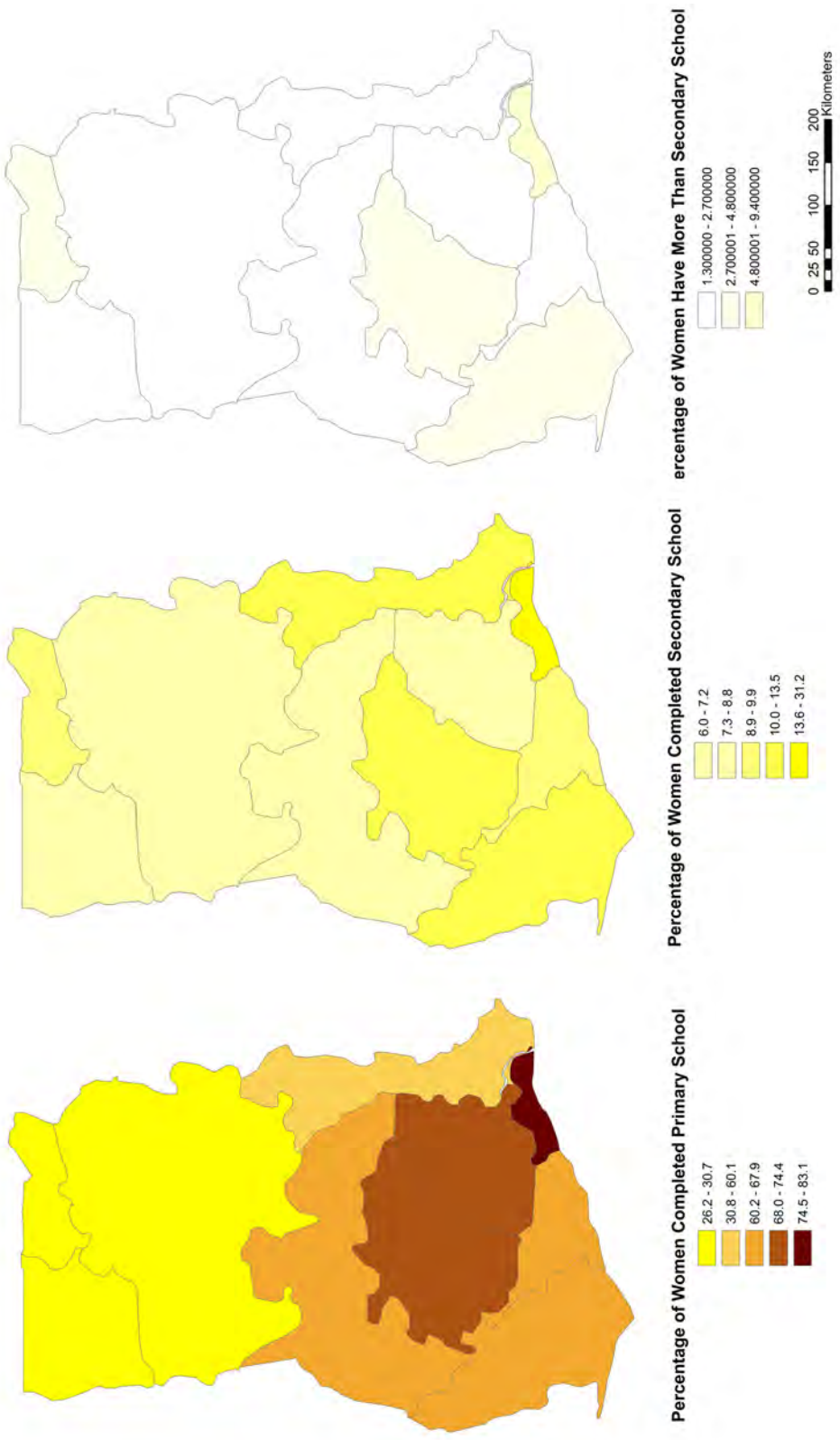

Figure 4-1-3. Percentage of women (aged 15-49) completed primary, secondary school and more than secondary school education in Ghana (Data from GSS demographic and health survey, 2009)

Both Figure 4-1-2 and 4-1-3 show that education, regardless of primary, secondary or tertiary education is more widespread in Greater Accra and Ashanti Regions (areas where the colors are darker); while northern regions are always lighter than the southern regions in all education levels.

When compared with primary school education, there are far fewer people who have completed secondary school, and less than 16% and 8% of men and women respectively who have attained education greater than secondary school. And the highest completion of secondary education rate for both men and women come from Greater Accra Region.

Gender disparity in education is severe in all regions as the scale of Figure 4-1-2 (male education) is always higher than that in Figure 4-1-3 (female education). However, since the MDG Goal 3 *Gender Parity* is not one of the scopes of this thesis, the analysis of difference in female and male education is not included in the analysis.

Although Ghana is rapidly approaching the goal to provide primary education universally and both men and women in Ghana completed primary school, the scale of the Figure 4-1-2 and 4-1-3 indicate that Northern, Upper East and Upper West Regions have almost half of the population from age 15-49, including over 2/3 of the women not being able to finish primary school or never been to primary school at all.

4.1.1.3 Regional Natural Resources Data

4.1.1.3.1 Water Accessibility

Figure 4-1-4 and 4-1-5 show the average mean time to get to the drinking water source and annual precipitation in 10 regions.

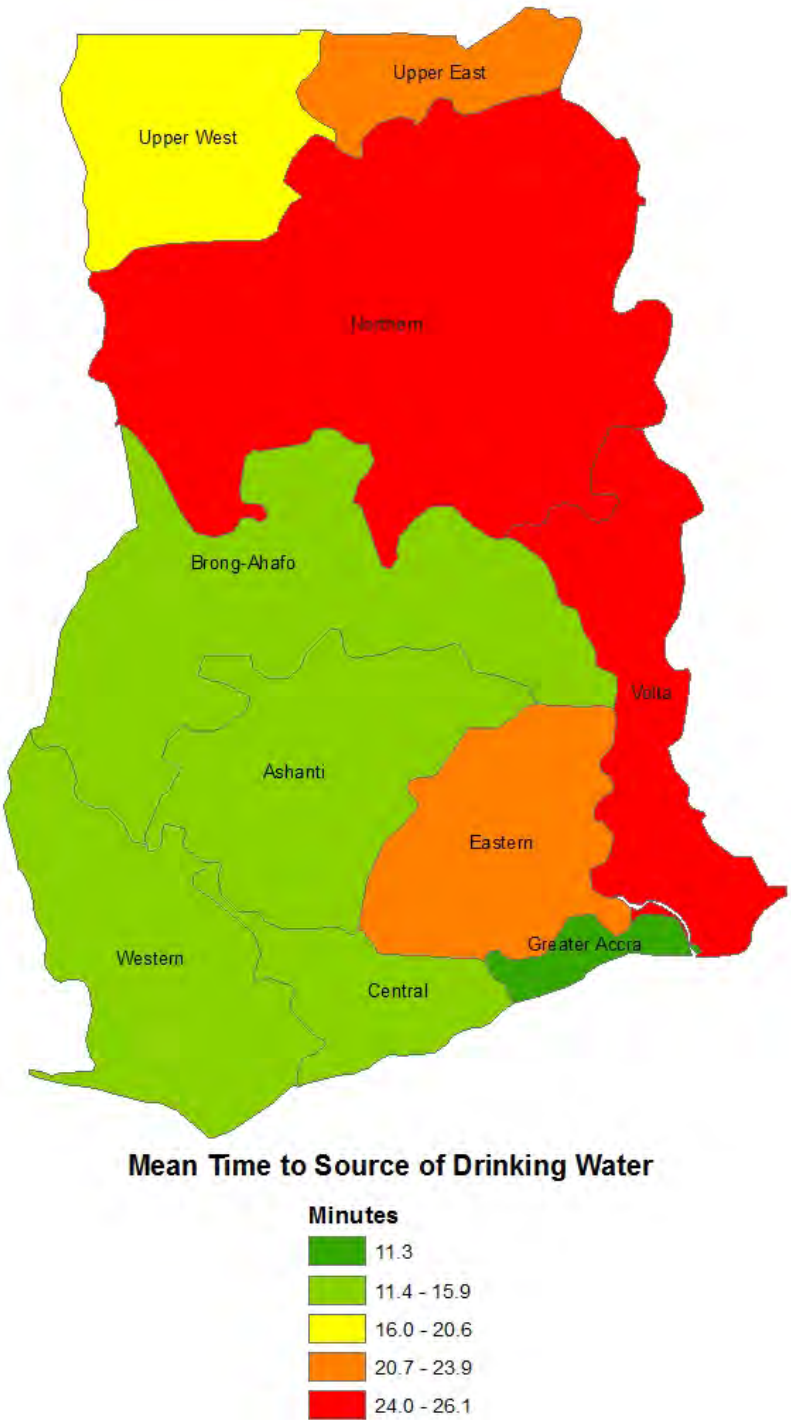

Figure 4-1-4. Average time in minutes to get to the source of drinking water in 10 different regions in Ghana in 2006 (data obtained from GhanaInfo[6])

[6] Data obtained from GhanaInfo, typed in indicator: drinking water, choose "Mean Time to Source of Drinking Water". Online available at: http://www.ghanainfo.gov.gh/. Assessed on July 10th, 2012

Figure 4-1-4 shows that people in Greater Accra Region use the least mean time (11.3 minutes) to access drinking water compared to other regions. People in the Northern and Volta Regions take the longest time to the drinking water source (24-26 minutes respectively). Regions such as Western, Central, Ashanti and Brong Ahafo Regions, although close to the coast or Volta Lake, also take 12-15 minutes to access drinking water.

According to WHO report by Howard and Bartram, household's water service level can be measured by the time it takes to get access to drinking water (Howard and Bartram, 2003).

Table 4-1-1. Summary of access measure (Howard and Bartram, 2003)

Service level	**Access measure**	*Needs met*	**Level of health concern**
No access (quantity collected often below 5 l/c/d)	More than 1000m or 30 minutes total collection time	Consumption – cannot be assured Hygiene – not possible (unless practised at source)	Very high
Basic access (average quantity unlikely to exceed 20 l/c/d)	Between 100 and 1000m or 5 to 30 minutes total collection time	Consumption – should be assured Hygiene – handwashing and basic food hygiene possible; laundry/ bathing difficult to assure unless carried out at source	High
Intermediate access (average quantity about 50 l/c/d)	Water delivered through one tap on-plot (or within 100m or 5 minutes total collection time	Consumption – assured Hygiene – all basic personal and food hygiene assured; laundry and bathing should also be assured	Low
Optimal access (average quantity 100 l/c/d and above)	Water supplied through multiple taps continuously	Consumption – all needs met Hygiene – all needs should be met	Very low

Table 4-1-1 suggests that one is considered not to have access to drinking water if it takes more than 30 minutes to collect water. Taking 5-30 minutes to collect water is under the category of *basic access* to drinking water. With the data shown in Figure 4-1-4, although mean time to get to the source of drinking water varies, ALL regions, on average,, only reached the *basic access* service level based on these Table 4-1-1.

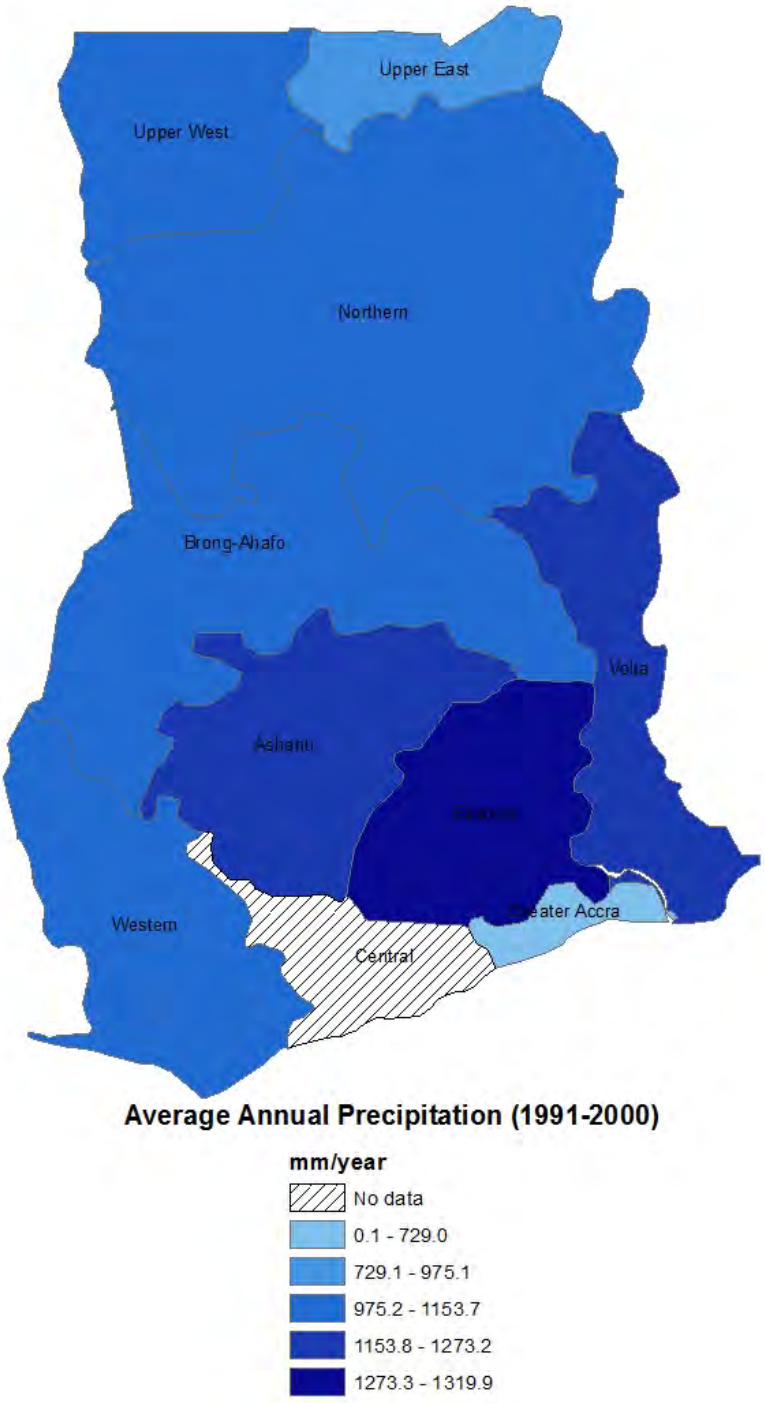

Figure 4-1-5. Annual precipitation in millimeter in 10 regions in Ghana during 1991 to 2000 period (Note: Central Region data is not available). Data source from Meteorological Service Agency[7]

[7] Data collected from GhanaSTAT. Online available at: http://countrystat.org/gha/cont/pxwebquery/ma/081swa011/en. Assessed on July 5th, 2012

In Figure 4-1-5, annual average precipitation is fairly balanced in its distribution. The least annual precipitation is in Greater Accra and the most is in Eastern Region, which borders of Greater Accra. Other regions Western, Brong Ahafo, Norterhn and Upper West regions all have relatively similar annual precipitation levels.

According to the WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation 2012 report, piped drinking water covered 33% and 3% of the population in urban and rural areas respectively in 2010 (JMP, 2012a). Table 4-1-1 suggests that *water supplied through multiple taps continuously* is considered as *optimal access* to drinking water. Figure 4-1-4 suggests that it is likely that, in both urban and rural areas, public water facilities, such as piped water, has not benefited the majority of the population, since the mean time to get access to source of drinking water range from 11.3 to 26.1 minutes, even in relatively prosperous area such as Greater Accra. When compared with different regions (Figure 4-1-5), Volta Region, for example, has relatively abundant precipitation; yet, people take the longest average time to get to the drinking water source. This suggests that water abundance does not necessarily translate into having a water service level.

4.1.1.3.2 Regional Oil Palm Data

Data on percentage of areas under oil palm cultivation by region is collected to estimate the production of palm oil in different regions.

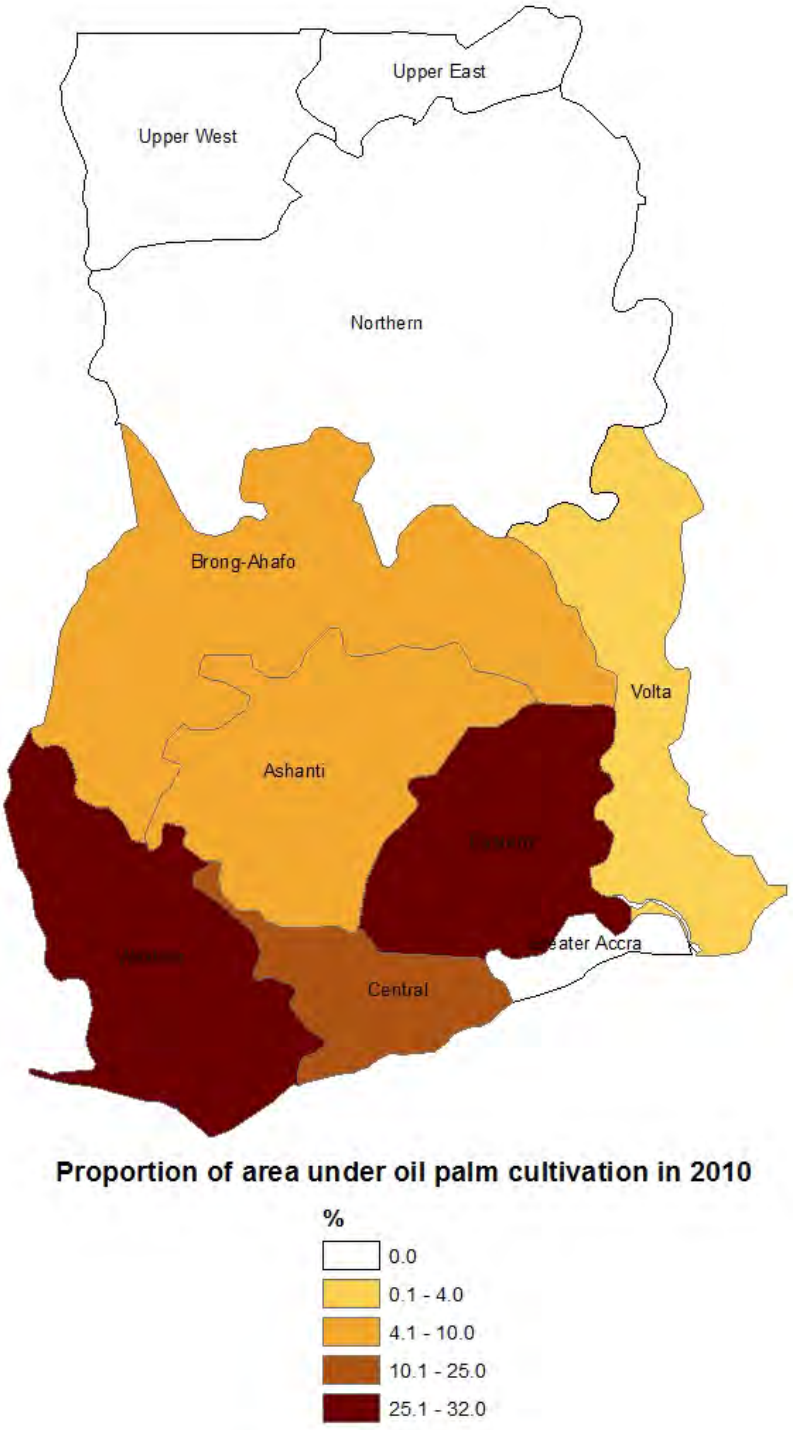

Figure 4-1-6. Proportion of area under oil palm cultivation by region in 2010. Data from MASDAR, 2011 Final report[8].

[8] Data collected from the final report of master plan study on the oil palm industry in Ghana, MASDAR Consulting Team 2011. Online available at: http://mofa.gov.gh/site/?page_id=10244. Accessed on July 1st, 2012

Figure 4-1-6 shows that the Western and Eastern Regions are the sites of the major oil palm cultivation plants. The total areas for oil palm cultivation in these two regions accounts for over ½ of the total area in Ghana, which is 168,000 ha and can potentially produce over 2.5 million metric tonnes of fresh palm oil brunches. The Central Region is the location of one-third of oil palm area by percentage. Greater Accra and the Northern Sector (Northern, Upper West and Upper East) do not have oil palm cultivation areas.

4.1.1.3.3 Regional Cocoa Data

Production and number of cocoa yield from 2005 to 2006 in 10 regions are presented.

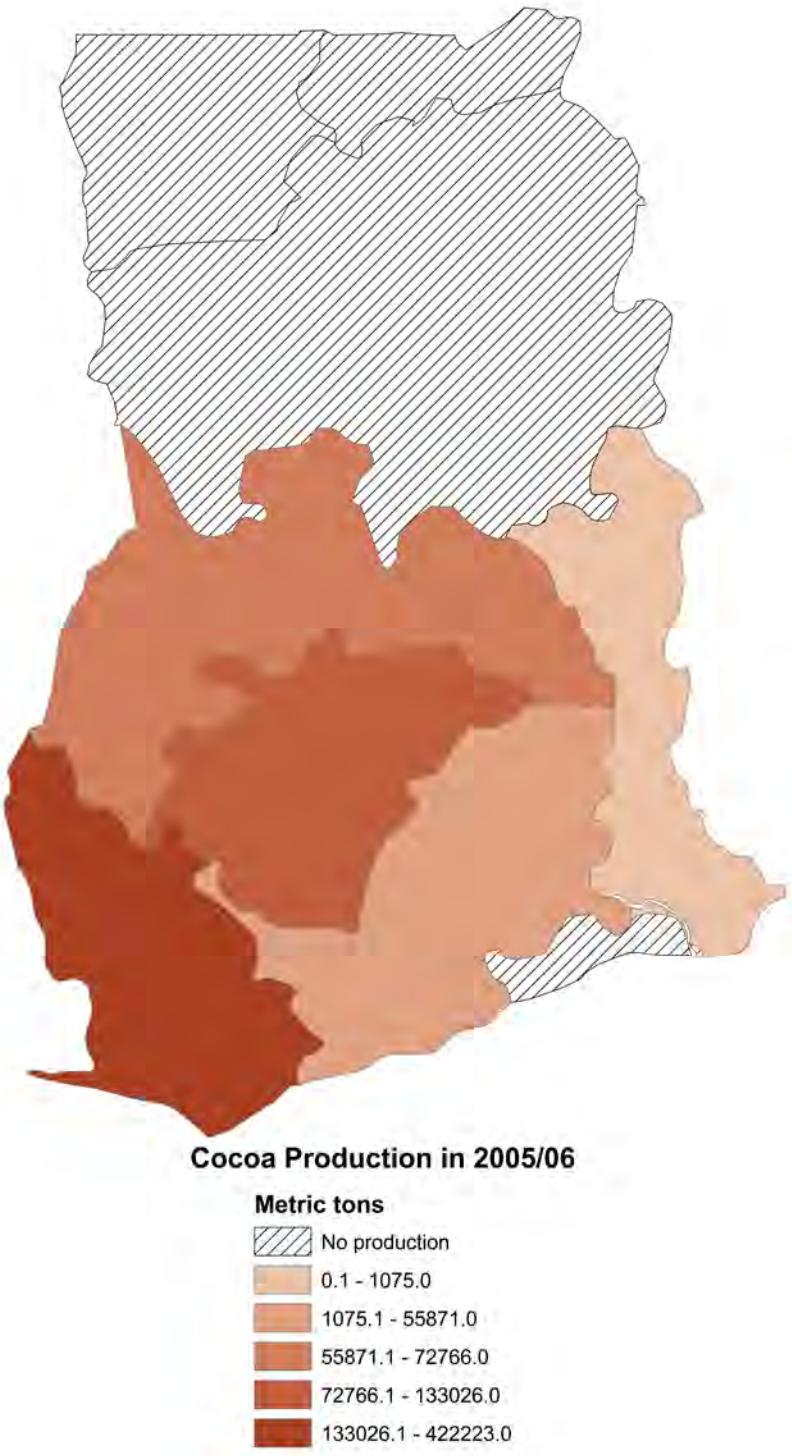

Figure 4-1-7. Cocoa production and yields from 2005 to 2006 in six regions in Ghana. Data from the Ghana Cocoa Board: Economic Activities

Figure 4-1-7 shows that only Greater Accra and the Northern Sector (Northern, Upper West and Upper East) do not have any production of cocoa. The Western Region has the highest cocoa production in 2005-2006.

4.1.2. Data Analysis

Besides generating maps, data is also used for numerical analysis including correlation analysis and combination analysis mentioned in the Methodology section. The analysis shows that correlation between economics, education and natural resources ranges from weak to strong.

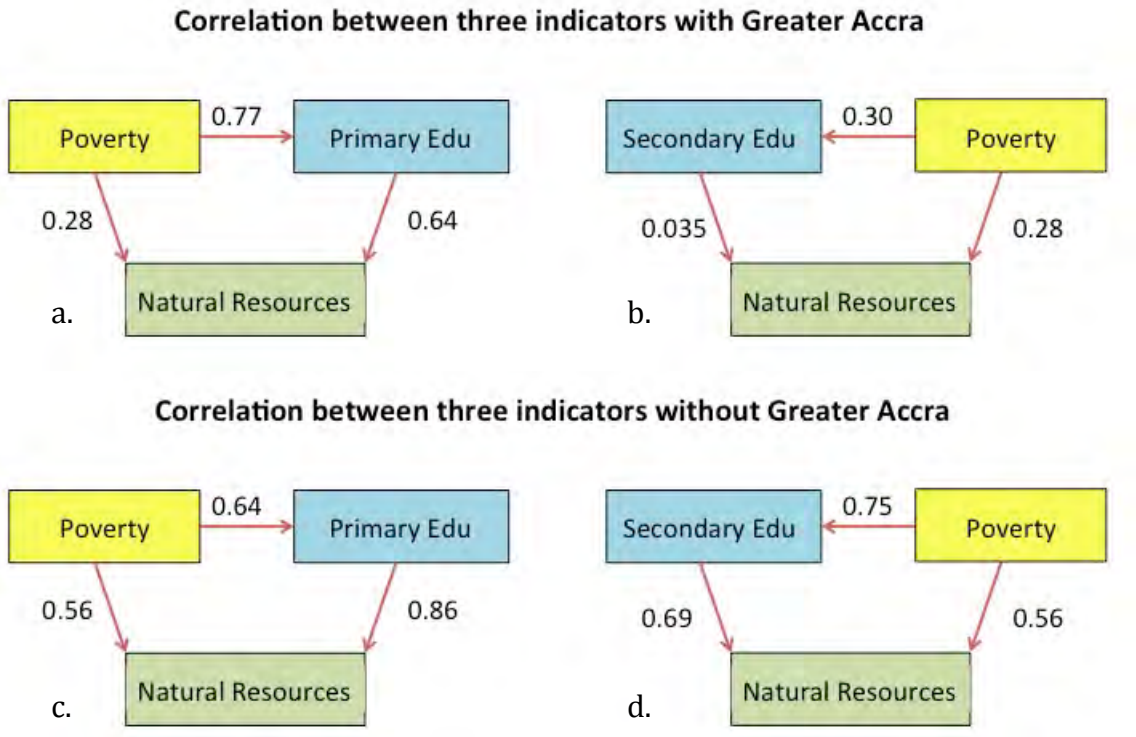

Figure 4-1-8 a-d. Correlation between three sets of MDGs indicators with and without Greater Accra.

In Figure 4-1-8 a and c, the setup of the schematics is based on two primary MDGs, which is ending poverty and achieving universal primary education, with an environmental sustainability key component natural resources. When compared with all the correlation coefficient, the Figures show that after eliminating Greater Accra from the analysis, all coefficients become higher, except the coefficient for the proportion of population under the poverty line and completed primary school (0.64) in Figure 4-1-8 a and c. Correlation between poverty and selected natural resources stay the weakest in analysis with and without Greater Accra (0.56 and 0.28 respectively).

Figure 4-1-8 b and d is a comparison for such correlations with secondary education. The idea is to take a step further to analyze the relationships between secondary educations and other economic and natural indicators. Figure 4-1-8 b and d show that, correlations between secondary education completion and natural

resources, proportion of population under the poverty line and natural resources, as well as secondary education completion rate are higher when analyses do not consider Greater Accra. Figure 4-1-8 a - d show that all coefficients related to secondary education are lower than those to primary education, except correlation between poverty and secondary education for analysis without Greater Accra (0.75).

4.2. Analysis on Case study in the water sector

We have shown that in the Northern Sector, poverty has little correlation with selected natural resources, especially water resources. It might imply that in order to achieve the two MDGs Target 1.A and Target 7.C, different strategies might be required for different regions due to the lack of linkage. At the same time, the analysis shown is unclear as to how these two MDGs Targets affect each other. In order to understand the empirical link between the two, the author conducted a market research in water sector in Tamale, capital of Northern Region, which we will discuss in the second half of the thesis.

4.2.1 Product Testing

Data shown in Table 6-2-1 and Table 6-2-2 are used as background information on water quality, bacteria removal tests of the six HWTS products and author's experience while handling these products. Table 6-4 shows that water in Taha dugout (water source for Taha village adjacent to PHW Filter Factory) is very contaminated with bacteria and has total coliform over 2419 MPN per 100 mL and *E.coli* of 122 MPN per 100 mL. Table 6-2-2 shows that MPN per 100 mL for *CrystalPur™/Tulip Siphon Water Filter*, *Life Straw® Family* and *Aquatabs* are all less than one per 100 mL having been fed with dugout water and then left to filter for an hour. In the case of the *PUR* product, the treated water result was two total coliforms per 100 mL of water after sitting for an hour without using cloth filter to strain the treated water.

Table 4-2-1. Total coliform, *E.coli* and pH in raw water collected from Taha dugout.

Raw water MPN per 100 mL	Total Coliform MPN per 100mL	*E.coli* MPN/100mL	pH
Taha dugout (1/7/2012)	>2419.6 (49 L, 48 S)	122.2 (33 L, 28 S)	8.94

*Note: L means the large wells in one sample of Quanti Tray® and S stands for the number of small wells in the same sample of Quanti Tray®.

Table 4-2-2. MPN and author's experience with six HWTS products

After filtering Taha water	Immediately		After 1 hour		Author's Experience	
MPN per 100 mL	Total Coliform	*E.coli*	Total Coliform	*E.coli*	Handling	*Reasons of rating*
Kosim Ceramic (Comp: 20kg Gbalhi, 6.7kg wayemba, 3.3kg rice husk. Majority of the filters were in this composition)	-	-	*<1*	<1	Easy	Require only one step: pouring water
CrystalPur™/Tulip Siphon Water Filter	<1	<1	<1	<1	Hard	Require extra force to squeeze water, installment is long
Life Straw® Family	<1	<1	<1	<1	Hard	Take time to install, and the design takes time to understand how to use it
Aquatabs	<1	<1	<1	<1	Easy	Dissolve easily
PUR[9]	<1	<1	2 (2 L, 0 S)	<1	Medium	Require extra cloth filters

**Note: Kosim Ceramic* bacterial removal (immediately) is not available due to the oversight found after the trip. However, more information on the new *Kosim* ceramic filter produced by PHW can be found in Millers thesis (Miller, 2012).

4.2.2 Product Final Score

The six HWTS products were set up and displayed at the household product shop (Tridewa Co. Ltd.), so interviewees could see them visually and interact with the products. The highest number of people picked the *Kosim Deluxe* as their first choice, with and without consideration of the price. The least number of people picked *CrystalPur™/ Tulip Siphon Water Filter* as their first choice, with and without the impact of price. The following graphs show the number of top three choices among each product when all six products were offered for consideration.

The top three choices of different products have a unique pattern that reflects customers' preference due to the influence of price. *Kosim Classic* and *Life Straw®*

[9] When testing bacterial removal performance of *PUR*, cloth filters were not used for understanding whether cloth filter is necessary for *PUR*.

Family had increasing supports on all three ranking tiers when the price was announced. At prices that Diagio and Jim Niquette determined, both *Kosim Classic* (GHC 45) and *Life Straw® Family* (GHC 60) are among higher range, which *Kosim Deluxe* is the highest among all. The product *PUR* had the largest fall at the customers 1st choice before versus after the price was announced. The major reason for the change in ranking, according to the respondents, was due to the high price (GHC 30 per 6 packets).

Interviewees have been told that the interior, which is the filter itself, of *Kosim Classic* and *Kosim Deluxe* have no difference. Yet, more interviewees picked *Kosim Deluxe* as their first choice (34 [*Kosim Deluxe*] vs. 21 [*Kosim Classic*]). More interestingly, the number of customers picked *Kosim Deluxe* after the price announced increased.

In order to better compare the impact of price, total scores based on number of Top 3 tiers were generated (Top 1st : 3 points, Top 2nd : 2 points, Top 3rd, 1 point).

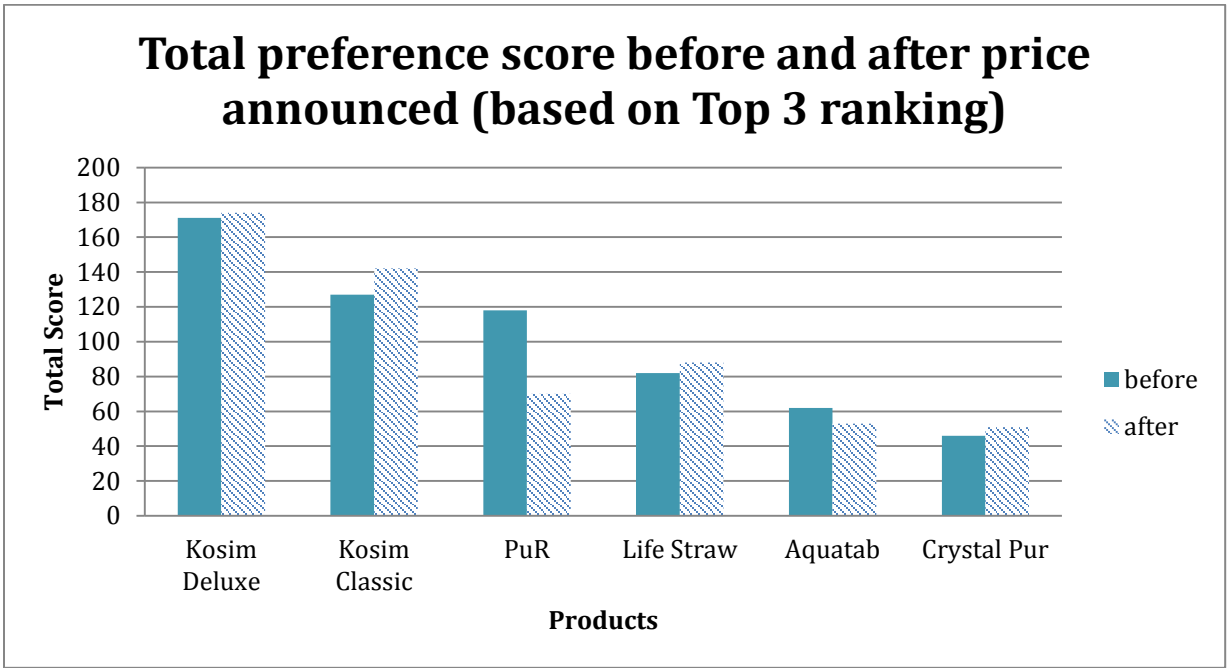

Figure 4-2-1 Total score comparison within six products before and after price was announced

From Figure 4-2-1, it is obvious that the *Kosim Series* (both *Classic and Deluxe*) received the highest score (127:142 and 171:174 for before vs. after price announced, respectively). In fact, though the price of *Kosim Classic* and *Kosim Deluxe* are relatively high (*Kosim Deluxe* is the highest and its price was set at GHC 75), the total score of both products increased after price was announced. *"The higher the price, the better the quality"* has been mentioned several times during the interview, and it is believed to be one of the driving forces for such a change for *Kosim Deluxe*.

The lowest score received before and after is *CrystalPur™/Tulip Siphon Water Filter* (46:51) and *Aquatabs* (62: 53). It is apparent that the reasons behind such low scores differ. Yet, these two products were the least expensive among all (*CrystalPur™/Tulip Siphon Water Filter* for GHC 20 and *Aquatabs* for GHC 5 per 10 tablets). Customers reviewed that the size of *CrystalPur™/Tulip Siphon Water Filter* is small, though they were introduced the way of using it. Another major concern is that *CrystalPur™/Tulip Siphon Water Filter* does not have cover like other products. It is understandable that having a cover for water source is very important for city like Tamale, where in dry season it is windy and dusty, to prevent recontamination.

4.2.3. Feedback from Interviewees

The feedback on different products coming from the interviewees varies. In general, the concern of products include: size, appearance, flow rate, safety (within reach by children, etc.), necessity to use, chemicals affecting health, price, convenience, durability, user-friendliness, time consuming, ability to remove dirt, etc. The major concerns among all products are size, user-friendliness, removing dirt and time consuming to use.

Except *Kosim Deluxe,* all other products have two dominant concerns (as listed above); though science/technology behind each product and brief instruction of how to use them were introduced. Interviewees were asked why they had not considered the other three products as their Top three choices. *Kosim Deluxe* and *Life Straw® Family* received the least complaints (12 and 27, respectively), while *CrystalPur™/Tulip Siphon Water Filter and Aquatabs* were pointed out with most concerns (51 and 52). However, when answering these questions, they were not only considering their family's circumstances, but also considered other end users. Data reflected include both family-based end users as well as their opinions on other users. Figures (4-2-2 a-f) are also presented to summarize the major concerns of each product.

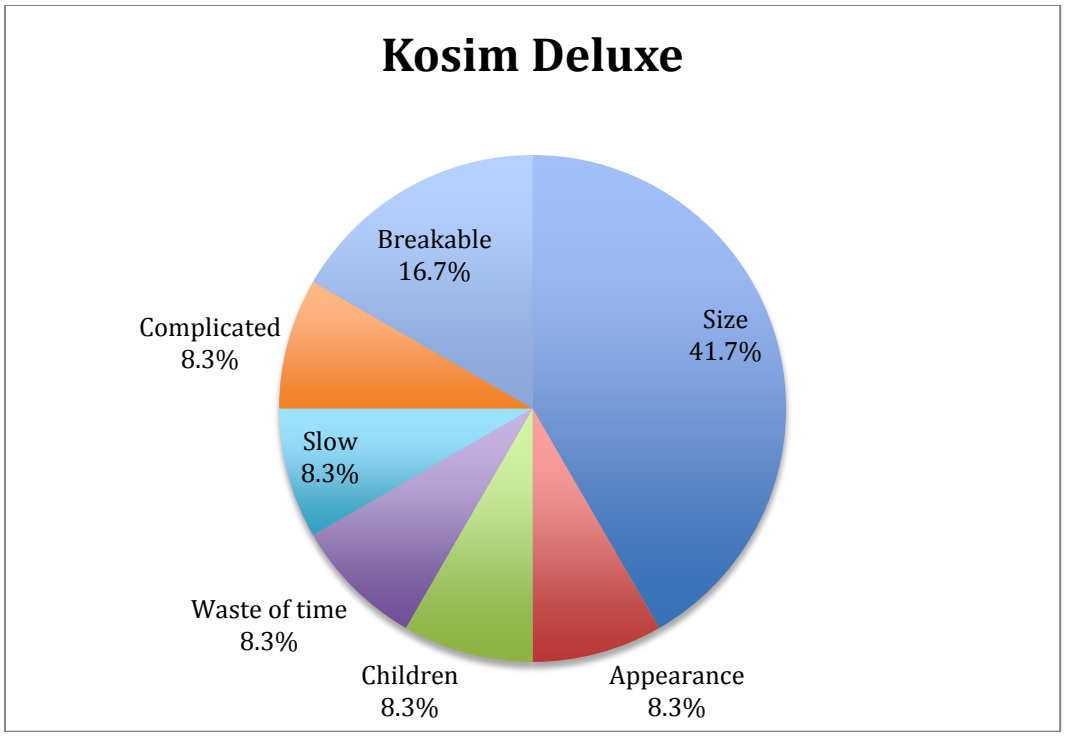

Figure 4-2-2 a. Percentage of major concerns of *Kosim Deluxe* (N=12)

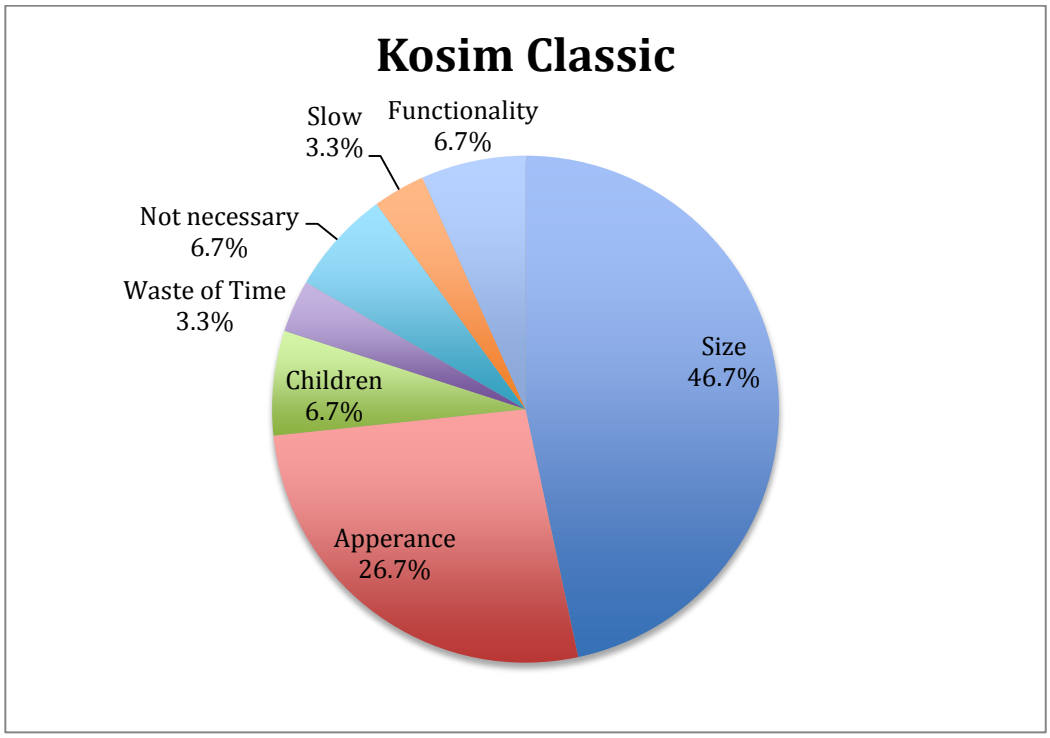

Figure 4-2-2 b. Percentage of major concerns of *Kosim Classic* (N=30)

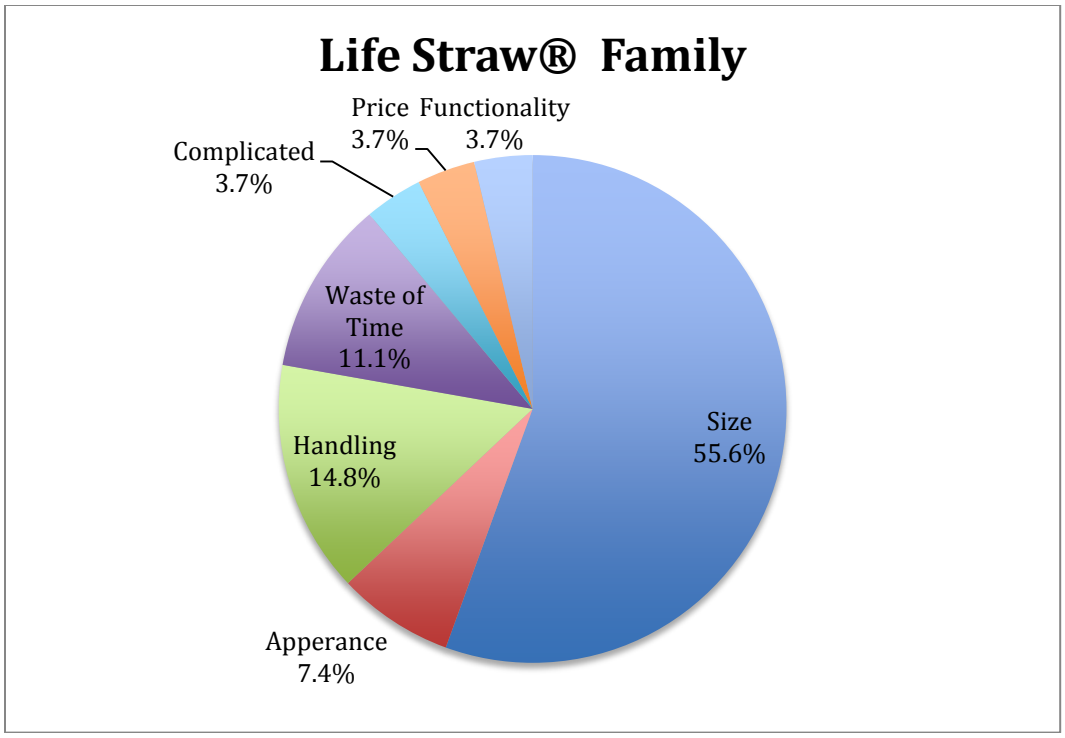

Figure 4-2-2 c. Percentage of major concerns of *LifeStraw® Family* (N=27)

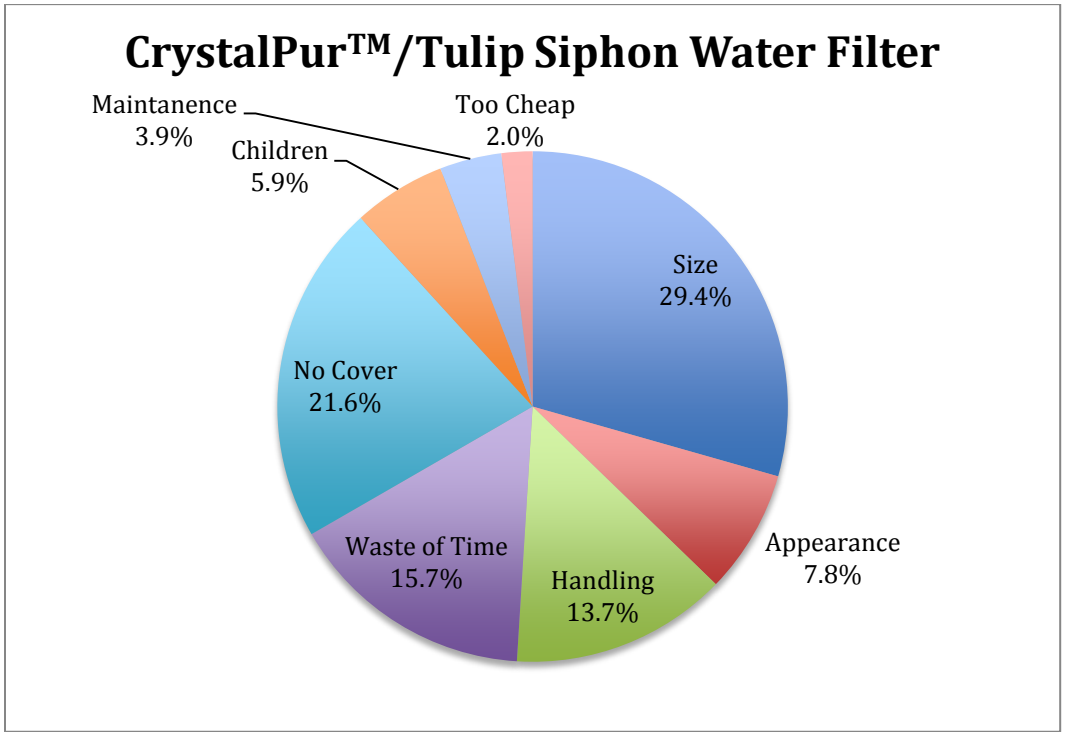

Figure 4-2-2 d. Percentage of major concerns of *CrystalPur™/Tulip Siphon Water Filter* (N=51)

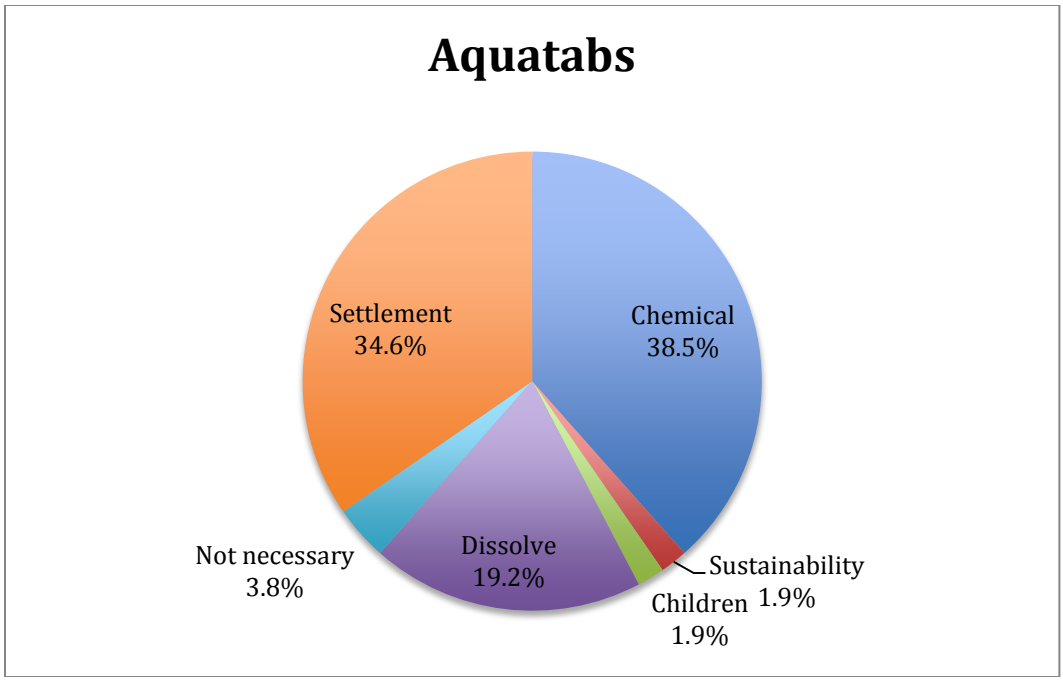

Figure 4-2-2 e. Percentage of major concerns of *Aquatabs* (N=52)

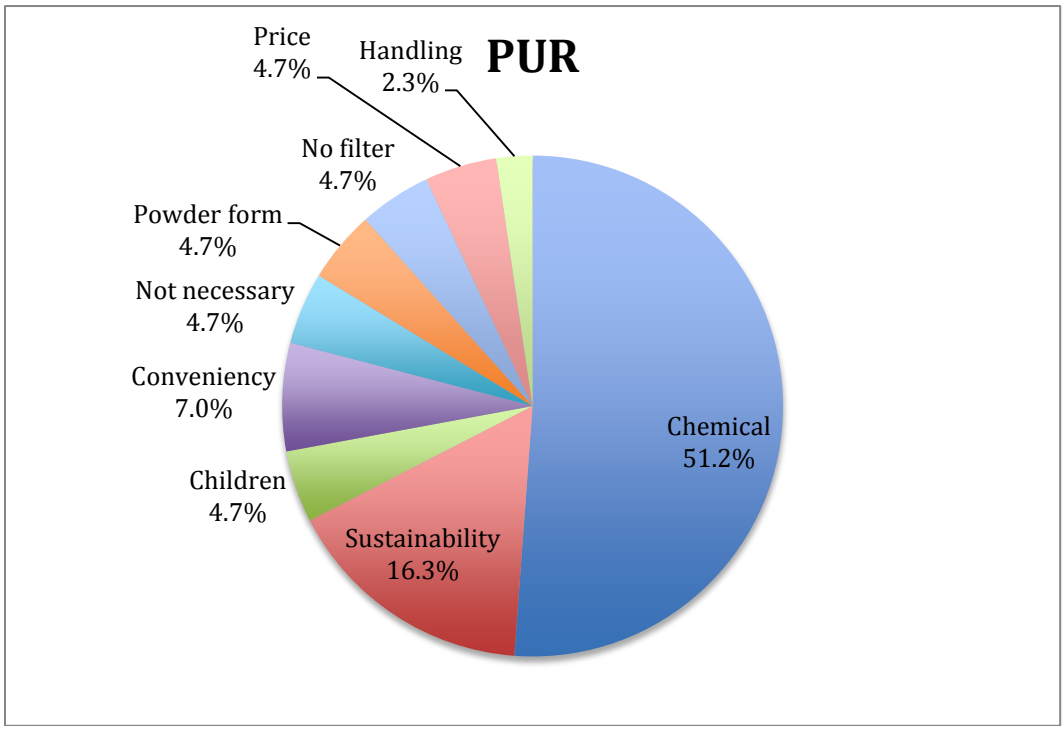

Figure 4-2-2 f. Percentage of major concerns of *PUR* (N=43)

4.2.4 Recommendation

4.2.4.1. HWTS Products Market Recommendation

Product, price, promotion and place (distribution) are the 4 P's described in the *Producer-oriented Model*[10] that has been used by marketers widely throughout the world (McCarthy, 1960). The author is aware of the 8 P's (product, price, promotion, place, publics, partnerships, policy and purse strings) for social marketing pioneered by Shaklee Corp. (Shaklee Corp., 1956). However, due to the time limitation of the market survey, the author was only able to focus on product, price promotion and place survey during the research.

4.2.4.1.1 Aquatabs

Our interviewees mentioned that, using *Aquatabs* on a daily basis, product will be finished and it is not applicable for a large family. Recommendation given could be making *Aquatabs* larger for communities that share same water source. In Tamale Ghana, there are rural communities that share dugout water and due to the effort made by international development organization such as Community Water Solution (CWS[11]), a storage tank is built and water is brought from dugout and treated prior to supply. Using larger *Aquatabs* tablet to treat water for the whole community might help provide more safe water and lower the cost of treatment. In addition, such a model will require less people to deal with technical information about *Aquatabs*, such that people will not need to worry about issues such as making measurement mistake, dissolving tablet, etc. in a daily basis.

4.2.4.1.2 CrystalPur™/Tulip Siphon Water Filter

CrystalPur™/Tulip Siphon Water Filter is the only product that was successfully sold during the market sales pilot study period. The customer considered *CrystalPur™/Tulip Siphon Water Filter* to be convenient as it can be put into the water tank directly (which is one of the common water storage methods wealthier, middle class people in Tamale use). However, the size is considered by the customers to be too small and customers' reviews said that it is a waste of time, since it sometimes requires mechanical force to get the water out. Additionally, interviewees also mentioned that they would like to have a bucket, most importantly a cover to protect the filter from windy and dusty environment in Tamale. It would be a good idea to sell this product with a covered storage bucket as an option. *CrystalPur™/Tulip Siphon Water Filter* should target its market in small households because the flow rate might not be fast enough to satisfy the need for a large family or school.

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[10] Producer-oriented model is four functions (product, price, promotion and place) that marketing has to perform before planning and movement of a product from the supplier of that offering to end-users (Fine, 1981; McCarthy, 1960).
[11] Approach of Community Water Solutions can be found at http://www.communitywatersolutions.org/approach.html. Online accessed: August 7th, 2012.

4.2.4.1.3 Kosim Classic

The size of the *Kosim Classic* received compliments from the majority of the interviewees, which will be a perfect product for family and/or schools. However, the appearance of *Kosim Classic* is not appealing and in fact, it has become one of the major reasons that interviewees did not choose *Kosim Classic,* once *Kosim Deluxe* was presented. In addition, the flow rate of the ceramic filter has slow flow rate due to the design and size of the filter was an obstacle. Improving flow rate without lowering the quality of bacterial removal should be a priority of ceramic filter.

4.2.4.1.4 Kosim Deluxe

Interviewees have given a lot of compliments to *Kosim Deluxe* due to its appearance. However, because of its outstanding look, some interviewees were relevant to consider it among the Top 3 choices, as appearance seems like an indicator for price in the customer's opinions. When displayed at the shop as part of the consumer survey, the *Kosim Deluxe* was always touched because they would like to see what is inside, and because of its design (two separate plastic parts), the two layers are detached easily. While the upper plastic part has to support the filter, that was a concern for family that have children. Similar to *Kosim Classic*, flow rate should be increased in order to encourage people to use the filter rather than drinking tap water. The current filter that can fit into the receptacle of *Kosim Deluxe* ("Super Tunsai") is the coned-shaped ceramic filter element. Since PHW is producing a new hemispheric-shaped filter element, the receptacle should also be re-designed to fit the newly designed hemispheric filter element as well as to make it less fragile.

4.2.4.1.5 PUR

One of the advantages that *PUR* has over *Aquatabs* is that *PUR* settles down particles, whereas *Aquatabs* is only a chlorine disinfectant. In the lab, we tested whether the supernatant layer of water was initially safe to drink but after an hour of settling, bacteria started to go back up to the upper supernatant. Therefore, it is recommended that cloth filter is sold together with *PUR*, and to provide clear instruction for customers on how to use *PUR* properly. The price of *PUR* is higher yet *PUR* powder seemed to be more acceptable than tablet, but the windy weather has made powder form into a disadvantage if the treatment tank is outdoors. It is not recommended to sell such product to a large community. Instead, *PUR* should be targeted at families whose water has a quite high turbidity.

4.2.4.1.6 Life Straw® Family

To create a pressure difference, *Life Straw® Family* must be hung high up on the wall. Based on user's response, such a design is an inconvenience to customers, which requires users to climb up and down to fill the water container. Such a design also causes potential hazards as *Life Straw® Family* might fall off, being pulled off by children at home. In addition, the size of *Life Straw® Family* is relatively small and

people who considered *Life Straw® Family* for their Top 3 choices are usually one-person households. The two tubes design, one for drinking water another for cleaning (backwash) purposes, is somewhat confusing to customers. Users might drink dirty water by mistake since the tube for cleaning purpose is more obvious and easy to use. Customers are not fond of the design in general, as it is not compatible with their house, or they consider it look like a hospital device. Although the price indicates that *Life Straw® Family* is the second most expensive product among the six, the general performance score had not changed much before and after the price was announced. Unlike *Kosim Deluxe* which customers think *the higher the price, the better the quality*, Life *Straw® Family* should be re-designed to be more acceptable by the end-users, because its higher price did not seem to attract interest among customers.

4.2.4.2 HWTS Market Recommendation

4.2.4.2.1 Price

According to the market research conducted in the urban area of Tamale, although respondents consider *high price is equal to high quality*, it does not mean that the price should be so high that local people cannot afford it. For example, respondents consider *Kosim Deluxe* sold at GHC 75 as expensive. From the result difference in before and after price of each HWTS product, this indicates that price might potentially affect the sale of HWTS products. However, more research should be conducted for how exactly price will affect the sale of HWTS products. In terms of subsidy, the author did not find strong evidence to prove that people in urban area would need subsidies. From the successful sale of *CrystalPur™/Tulip Siphon Water Filter* as well as sale of four *Kosim Classics*, the price set for these two products (GHC 20 for *CrystalPur™/Tulip Siphon Water Filter* and GHC 45 for *Kosim Classic*) might be acceptable for local people. Again, more research should be done to support these findings.

4.2.4.2.2 Promotion

One HWTS product (*CrystalPur™/Tulip Siphon Water Filter*) was sold during the market sales pilot study period, during which the author lowered the prices for all products by 10% and handed out brochures for advertising purpose. It turned out that people paid attention to the products. The other four *Kosim Classic* filters (GHC 45) were sold without price reduced after the market sales pilot study period. The successful sales of these two products are due to (1). Limited time price reduction and (2). Periodic phone calls to potential respondents. Promotion efforts should be continued in order to understand the benefits of HWTS products.

4.2.4.2.3 Place

It is recommended that HWTS products should be sold in a well known or fixed location shop (such as supermarket, large household product merchants, etc.) in

urban Tamale, because more than 90% of the respondents prefer to purchase the products in a trustworthy shop. However, the author considered that the market for HWTS products in the urban areas of Tamale is not large, since the majority of the population in urban areas of Tamale are already drinking piped water and they do not seem to like the idea of further filtering piped water. Therefore, the author does not recommend HWTS to be sold by individuals, or small shops in the urban area of Tamale.

As the author mentioned earlier, respondents are aware of their water "having dirt". Additionally, respondents were introduced to HWTS products, e.g. *PUR* or filters that can remove particles in the water. If the demand for high drinking water quality comes from customers drinking unimproved water supplies, can ones utilize the opportunity of poor water quality to develop a business for the population living under or at the edge of the poverty line? Can the poor distribute the HWTS products in urban areas to gain extra income? The survey shows that in urban area, 86% of the interviewees prefer to see displayed water products in a fixed shop which they have heard of or seen, such as Tridewa, Co. Ltd, or quality guaranteed shops such as a supermarket (7%) or drug store (3%) in urban area (Figure 6-2-3). It is not likely that the poor in the urban area will benefit from the sales of water products such as HWTS, as the majority of the people will prefer to buy water products from shops that are family-owned or large and well known locally.

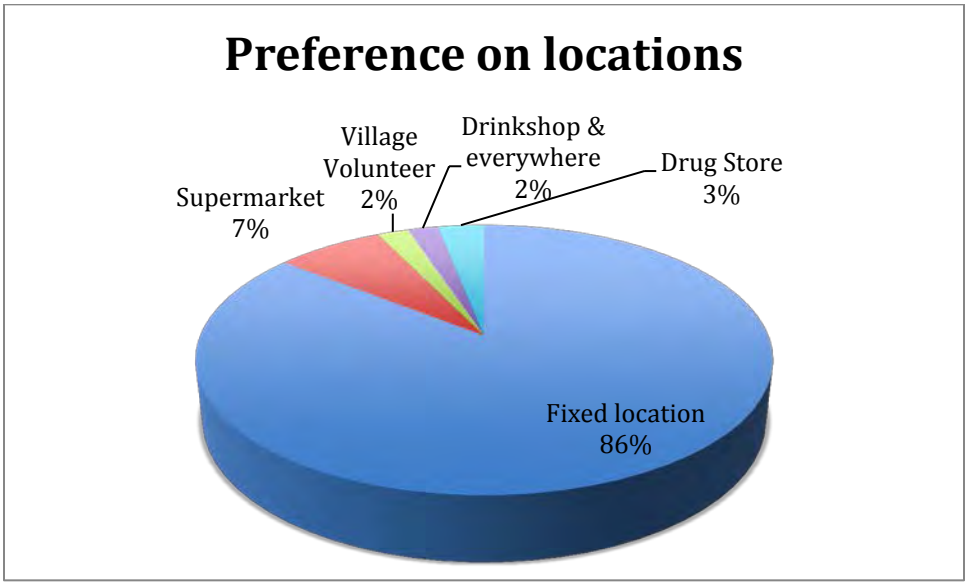

Figure 6-2-3. Preference on water production distribution location in Tamale

From the actual sale of HWTS products, there are two people coming from outside of Tamale who subsequently picked up filters in PHW directly (instead of the fixed shop in the center of Tamale where the survey was conducted. This indicates that if the customers are willing to buy, it might not matter to them where they need to pick up the product. Rather, where they have heard of the products is more likely to

be important. Therefore, places where HWTS products should be promoted seem more important.

5. FROM CASE STUDY TO CORRELATION OF MARCO SCALE

5.1 What Found in the Case Study to What Shown in the Analysis

Majority of the interviewees do not have a plan to purchase the product in the near future and only 8 out of 103 left their phone numbers with us having expressed interest in purchasing one of the six products. From the survey on source of water (Figure 6-2-4), approximately 86% of the interviewees claim that they drink piped water without further treatment. This percentage is much higher than the national average percentage of urban population (33%) having water piped into premises in 2010 (WHO/UNICEF, 2012b). At least 89% of the interviewees are currently drinking improved safe water, because a. piped water (86%) and boreholes (3%) are considered as *improved drinking water* from the JMP definition (JMP, 2012b) and; b. another 8% of drinking source is sachet water and according to Okiga, one out of 15 factory-produced and one out of 15 hand-tied sachet water was found to have *E.coli* (Okioga, 2007). However, according to the owner of Tridewa Co. Ltd Prakesh Ramchandani, there are 60 sachet water companies present up to 2011[12]. Therefore, the author is not sure whether the sachet water sold in the market, or those drunk by the respondents are "safe to drink". Overall, the majority of the respondents surveyed have at least "intermediate access" (access measure: *water delivered through one tap on-plot (or within 100 m or 5 minute total collection time*) (Table 4-1) (Howard and Bartram, 2003). If all people who live in urban Tamale have at least "intermediate access" to drinking water, as the respondents did, then on average, people who live in rural areas might take an even longer time to get access to drinking water than 26.1 minutes (presented in the previous section).

[12] Personal communication.

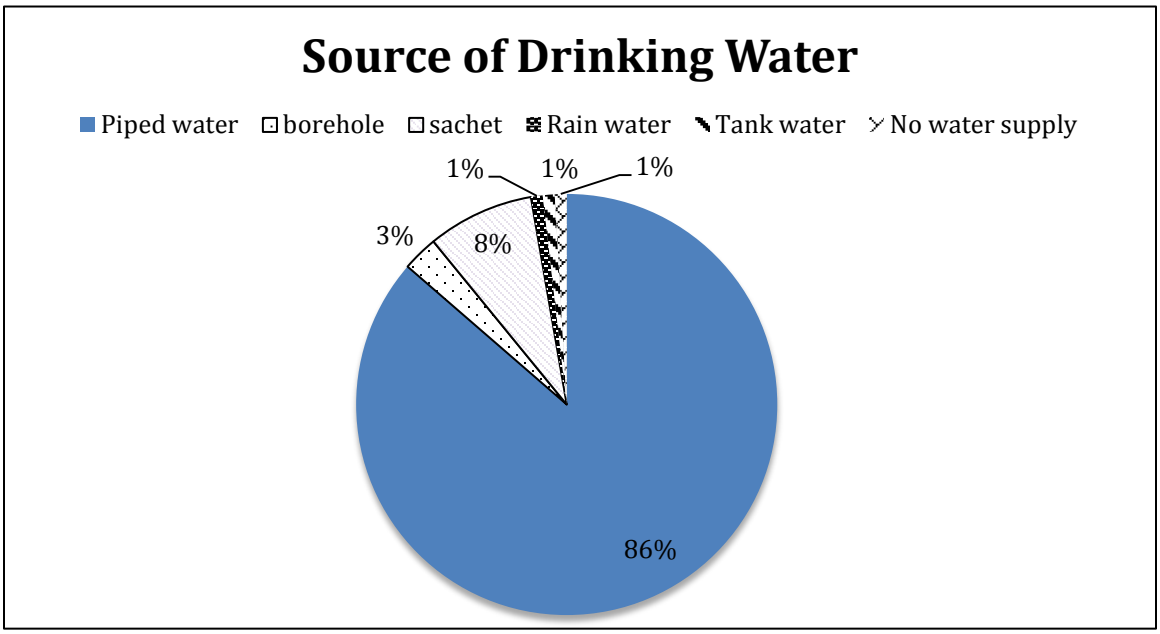

Figure 6-2-4 Source of drinking water distribution in Tamale, Ghana. Data collected from 103 surveys in urban area of Tamale in 2012.

5.2 From Water Accessibility & Quality to Economics Development

A few interviewees told the author that they do not further filter the water from the pipe, even though dirt was present. The high percentage of population using piped water in urban areas (Figure 6-2-4) suggests that the people in Tamale are highly relying on public facilities for water delivery. Only five out of 19 interviewees who live in rural area around Tamale do not use piped water; as an alternative, four households use sachet and one out of these five interviewees uses a borehole. According to an interview with drink shop owner in the outskirt of Tamale, however, only rich families or tourists could afford sachet water (a bag of sachet water costs 5 Ghana pesewas, which is approximately US 3.3 cent). It is very likely that the people that the author interviewed, including those come from rural, semi-urban and urban, are coming from the middle class and for wealthy tier of the society, which are not from population under the poverty line.

The market research indicates that safe water accessibility is very likely to relate to the income of household. Households with higher incomes will be likely to have safe drinking water, and they are likely to have public facility such as piped water, or tank truck water delivered to their house regardless of living in rural or urban area. Those with middle or high income will rather rely on public facility for clean drinking water.

One customer who bought *CrystalPur™/Tulip Siphon Water Filter* during the market sales pilot study said that he purchased the product because he wanted to remove

dirt from the water. It might be an indication that some middle class customers would buy a HWTS product in order to drink high quality water. The other two customers, who purchased *Kosim Classic* after Daniel follow-up with them, live outside of Tamale and they came to PHW for picking up the filter. In other words, there are some interests in HWTS products and those people are willing to pay full price for the HWTS products when they have a need for the products.

6. CONCLUSION

This thesis has collected several data in economics, education and natural resources indicators, with the main focus of analysis on: proportion of population under the poverty line, completion of primary school and secondary school, mean time to source of drinking water, annual average precipitation, oil palm and cocoa.

The author found that there is moderate to strong correlations between each indicator. Among all correlations, the strongest relationships are proportion of population completed primary education and selected natural resources (water resources, oil palm and cocoa combined) as well as proportion of population under the poverty line. The weakest among all is proportion of population below poverty and selected natural resources. Mean time to source of drinking water as an individual natural resources indicator, has the least to do with proportion of population under the poverty line, which correlation coefficients square R^2 are 0.0018 and 0.0019 with and without Greater Accra respectively. Such a weak correlations is confirmed by analysis on correlation of mean time to drinking water source and ranking in poverty in different regions. The correlation is 0.052 and 0.0046 with and without Greater Accra in the analysis.

The issues targeting at economics, education and natural resources are complex. With the weak correlation between water accessibility and proportion of population under the poverty line, the author conducted a market survey to:

a. Introduce HWTS products (*Auqatabs, CrystalPuR, Kosim Classic, Kosim Deluxe, PUR* and *Life Straw® Family*) and find out customers product preferences;
b. Identify economic opportunities in HWTS products in rural and urban areas as potential solutions for achieving the MDGs and post-2015 MDGs.

Among all six products, *Kosim Deluxe* received the highest preference scores both before and after the price is announced. Those performance scores ranks are in Table 6-1 and Table 6-2.

Table 6-1. Total preference score before price is announced.

Rank	Product	Score
1	*Kosim Deluxe*	171
2	*Kosim Classic*	127
3	*PUR*	118
4	*Life Straw® Family*	82
5	*Aquatab*	62
6	*CrystalPur™/Tulip Siphon Water Filter*	46

Table 7-2. Total preference score after price is announced.

Rank	Product	Score
1	*Kosim Deluxe*	174
2	*Kosim Classic*	142
3	*Life Straw® Family*	88
4	*PUR*	70
5	*Aquatab*	53
6	*CrystalPur™/Tulip Siphon Water Filter*	51

Size becomes the most common concerns among physical removal products (*Kosim Deluxe* (42%)*, Kosim Classic* (46%), *CrystalPur™/Tulip Siphon Water Filter* (29%) and *Life Straw® Family* (55%)), followed by appearance/design of the products. Between two chemical products *Aquatab and PUR*, the most concern is use of chemicals (38% for *Aquatab* and 51% for *PUR*), followed by settlement issue. In general, interviewees prefer physical removal products to the chemical removal products.

The author summarized several key results on customers' opinions towards products from the survey:

- Higher the price, better the quality
- Chemicals have side effect
- Product design reflects complexity of the product

For recommendations:

1. Among our respondents, 87% claim that piped water is their major drinking water, and the second major drinking source is boreholes. None of the interviewees we interviewed drank dugout water.

2. According to the market sale pilot study, HWTS products were sold or ordered by local people in Tamale and therefore, the acceptable price of HWTS products should be between GHC 18 to GHC 45.

3. About 86% of the interviewees prefer to buy HWTS products in a fixed shop; while other options such as supermarket and drug store, places where quality is guaranteed are also peoples' choices.

4. Household Water Treatment and Safe Storage products should not advertise as "providing safe water" (potential post-2015 MDG) in urban Tamale, because according to the respondents, people in urban Tamale consider piped water safe to drink. However, HWTS can be advertised as "providing luxury water". Additional value related to health and better appearance might help increase the sales of HWTS products in the urban area. Such a market strategy might help bring economic development and provide extra barrier of protection of water for people (i.e., those who would like luxury water) in Tamale.

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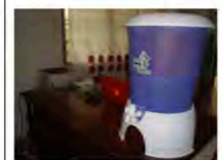
8. APPENDIX

Appendix I. Survey questions handout

1. Where do you live in Tamale?	2. What water source do you drink at home?	3. Are you the purchasing decision maker at home?
1. Rural 2. Peri-urban 3. Urban 4. Others _____	1. Tap Water 2. Dugout Water 3. Others____________ 4. Sachet & Bottled Water 5. Do not have water supply	1. Always 2. Often but not always 3. Sometimes 4. Never, then who_____?

Thank you very much for doing the survey! **Please answer these following questions. And we have prepared a <u>small gift</u> for you at the end.** **Don't forget to ask me!**	 ***Kosim Classic*** can improve drinking water quality and treat 4-6 Liter of water per hour. It has its safe storage bucket equipped and great for rural family.	 ***CrystalPur*** is a water filter device removes most of the bad bacteria. It is small and does not require a lot of maintenance. It filters 4-5 liter per hour.	 ***PuR*** is chemical powder that disinfects water. Each packet treats 10 liters of water. It is perfect for treating water with less dirt.	 ***Life Straw*** filters 10 liter of dirty water per hour and does not occupy land space at home. It removes bacteria fast without chemical. It is easy for children to use.	 ***Aquatabs*** is a tablet that removes bad bacteria with mixed alum and chlorine. One tablet treats 10 liters of water and is convenient to carry around for treating various type of water.	 ***Kosim Deluxe*** is designed for people require high quality of water and life style. It removes almost 100% dirt and bad bacteria in tap water. It is a great device for offices.
Which one would you prefer to buy? (Please rank Top 1, 2 & 3)						
What concern you <u>the most</u> in this product? (Size, volume, water quality, appearance, maintenance, etc.)						
Is the product enough to treat water you and your family drink per day? (Yes or No)						
The price is listed now. Would you like to buy this product? Please rank Top 1, 2&3 :)	1. Yes! The price is OK. Rank __________ 2. I will <u>NEVER</u> buy. Why __________?	1. Yes! The price is OK. Rank __________ 2. I will <u>NEVER</u> buy. Why __________?	1. Yes! The price is OK. Rank __________ 2. I will <u>NEVER</u> buy. Why __________?	1. Yes! The price is OK. Rank __________ 2. I will <u>NEVER</u> buy. Why __________?	1. Yes! The price is OK. Rank __________ 2. I will <u>NEVER</u> buy. Why __________?	1. Yes! The price is OK. Rank __________ 2. I will <u>NEVER</u> buy. Why __________?
Where would you prefer to buy this product?	1. In fixed location such as this shop 2. Supermarket 3. In shops that I see everywhere (e.g., drink shop) 4. From village volunteers	1. In fixed location such as this shop 2. Supermarket 3. In shops that I see everywhere (e.g., drink shop) 4. From village volunteers	1. In fixed location such as this shop 2. Supermarket 3. In shops that I see everywhere (e.g., drink shop) 4. From village volunteers	1. In fixed location such as this shop 2. Supermarket 3. In shops that I see everywhere (e.g., drink shop) 4. From village volunteers	1. In fixed location such as this shop 2. Supermarket 3. In shops that I see everywhere (e.g., drink shop) 4. From village volunteers	1. In fixed location such as this shop 2. Supermarket 3. In shops that I see everywhere (e.g., drink shop) 4. From village volunteers