

Cost-Benefit Analysis of Improved Water and Sanitation for Women and Girls in Sub-Saharan Africa

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Photo: AP

A woman and child carry water from the city of Mutare, Zimbabwe 12 08 08

Right now, somewhere in New York City, perhaps in Harlem, a businessman is showering, getting ready for work. An artist in the East Village is flushing a toilet. A college student in Morningside Heights finished up a bottle of Dasani, or Fiji, or Voss. A mother in her midtown apartment leaves the water on while she washes the dishes from the family's meal. Everyday activities. No thought given.

A little further south and more to the east, outside of the five boroughs and below the equator, in Sub-Saharan Africa, a little girl finishes the seventh hour of her walk, dragging a forty-pound jerry can behind her. She should be in school, but school won't save her family from thirst. A mother fills her baby's bottle with formula powder and stagnant water, unknowing of the worms and parasites her child will consume. Somewhere, a child dies of a water-borne disease. [Many die from the lack of water needed to wash hands. Many diarrheal, cutaneous, and ophthalmic infections are preventable by hand washing, especially after defecation. However, if the availability of water for washing is constrained by the need to headload it in units of no more than ~20 liters, this precious water can not be spared for washing, and must be confined to cooking and drinking only.] This child will be one of 4,500 today. Everyday occurrences. No thought given.

Around the world access to clean, safe water is a right that many take for granted and is also a right that many don't have. Women and girls, especially those in Sub-Saharan Africa are most adversely affected by the demands and consequences of a lack of access. [Most rural African families obtain their domestic water by headloading it in quantities of ~20 liters from source to homestead. On flat ground, the use of a lightweight handcart enables a woman to transport over 100 liters (using plastic jerry cans or other containers) with less effort than she would expend carrying a 20 liter container on her head.] Improvements in water and sanitation have a psychological and economic impact on the immediate recipients, and a long-term effect for the following generations. This paper shall conduct a cost-benefit analysis of improved water and sanitation projects, utilizing World Health Organization studies as a basis for discussion, and highlight frequently overlooked benefits to women and children in Sub-Saharan Africa.

Water and Sanitation

Right now, an estimated 1.1 billion people lack access to clean, safe access to clean water. 2.6 billion people lacked access to basic sanitation (Hutton, Haller, & Bartram, 2007b). Studies following burden of disease suggests that lack of access to a safe water supply, sanitation and hygiene ranks third in the world as a risk factor for poor health in the developing world. Diarrhea is the main disease associated with unsafe water and sanitation and is responsible for 1.8 million deaths each year (Haller, Hutton, & Bartram, 2007). Ninety percent of these deaths are children under the age of five (Haller et al, 2007). An additional 1.6 million deaths per year can be attributed to lack of clean water and sanitation (Haller et al, 2007). [The lack of surplus water for hand washing at the homestead that is responsible for many cases of diarrhea, arising from fecal-oral transmission. Availability of a handcart and associated plastic water containers can greatly reduce this burden of diarrheal disease.]

Dirty water causes devastating illness and disease in children. This burden translates into lost opportunities for education and associated opportunities for empowerment (UNDP, 2006). Some of the most prolific illness and diseases in the world are water-related. Diarrhea kills 1.8 million children each year (Burrows, Acton & Maunder, 2004). Some 400 million children each year are infected by intestinal parasites, causing anemia and stunted growth. Children are especially vulnerable to guinea worm, which is spread through stagnant water, and trachoma, the largest cause of preventable blindness in the world (Burrows et al, 2004). Illness can impact children for the rest of their lives, decreasing productivity and shortening life spans.

Sub-Saharan Africa, Women and Girls: The Struggling and Forgotten

Labeled frequently as the poorest region in the world, Sub-Saharan Africa has long suffered from the devastating effects of economic mismanagement, government corruption and ethnic and tribal conflicts. This region is also, in terms of basic water and sanitation, one of the most underserved in the world. While nations in this region receive billions of dollars in aid each year, water and sanitation, as well as other basic human needs still go unmet. Water and sanitation projects, especially in Sub-Saharan Africa could provide immense benefits to society and serve as a critical improvement towards combating other pressing social problems. [The scattered very poor population of rural Africa precludes piped water supplies for most villages for the foreseeable future. The provision of boreholes will also never be sufficient to enable the masses of rural Africans ready access to a nearby water source. Water will continue to have to be transported considerable distances from source to homestead. The vast majority of homesteads rely on headloading by women for their water supply.]

While lack of access to basic water and sanitation negatively impacts all of society, young girls and women bear a comparatively disproportionate burden. In many regions of the world, especially Sub-Saharan Africa, women and girls must walk to a water source, as there is not a water point within their village. The time spent in this arduous task. In Mozambique, rural Senegal and eastern Uganda, women spend on average 15-17 hours per week collecting water (UNDP, 2006). These hours translate, one estimate predicts, into 40 billion hours a year in Sub-Saharan Africa- a year's labor of the entire working force of France (UNDP, 2006). Carrying these heavy water containers such as jerry cans or pots is damaging in the long term for women, but for girls there are even greater implications due to their physical immaturity (WaterAid, 2007). Weight of water containers can cause damage to the head, neck, and spine, and in serious cases cause deformity of the spine that will lead to difficulties in pregnancy and childbirth in adulthood (WaterAid, 2007). [The availability of lightweight handcarts and plastic jerry cans can eliminate this problem, while at the same time enabling more than 500% more water to be transported with no lifting and vastly less calories and time expended by women and girls.]

When the water collection process requires hours of tiring labor, female education suffers. The hours spent walking for water cannot be spent in school, accounting for the very large gender gaps in school attendance (UNDP, 2006). [This gender gap can be vastly reduced by the use of handcarts for domestic water (as well as firewood) collection.] Yet another burden falls on young girls after they reach puberty. At this point, girls are less likely to attend school if there are not suitable sanitation facilities. Parents frequently withdraw their daughters from schools, fearing for her safety and privacy. According to the UNDP (2006), about half of the girls in Sub-Saharan Africa that drop out of school do so because of poor water and sanitation facilities. A UNICEF study conducted from 1990-2000 in Bangladesh demonstrated an 11% increase in girls' attendance at school when sanitation programs were implemented to ensure privacy and security (UNDP, 2006).

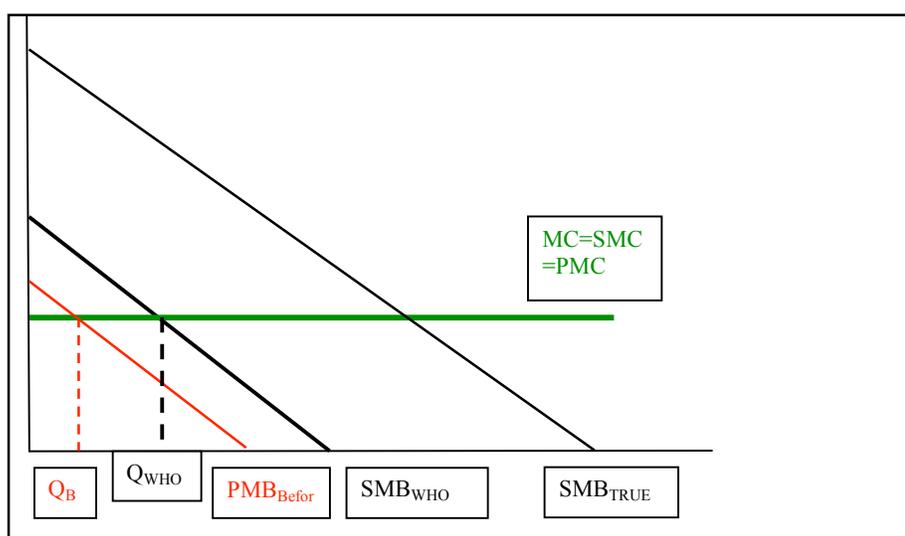
Analysis of Water and Sanitation Projects from an Economic Perspective

The initial implementation cost (capital) for establishing a water source may be considered a sunk cost. Regardless of the outcomes for the community as a result of increased access to water, the costs to establish the water point cannot be recovered. Given that the implementation fee for the necessary infrastructure is a sunk cost, the marginal cost of a one-time improvement in water and sanitation is fixed and relatively high. [The cost of a handcart, or handcarts, and their associated plastic jerry cans is far less than that of most piped water systems, and has the benefit of being suited to manifold transport applications, as opposed to being specific to only transporting water.]

In this analysis, water and sanitation projects are labeled as public goods. As such, the Social Marginal Benefit (SMB) achieved from improved water and sanitation is greater than the Private Marginal Benefit (PMB). As a public good, water and sanitation projects are non-excludable. Thus, water and sanitation "points" may become congested, making access to the good difficult for many. Since women and girls bear the burden of water collection, men and boys are considered free riders as they share in

the benefits of having water without having to pay for them. As with all cases of public goods and free riders, attempts to determine a realistic SMB line are difficult as most will underreport their willingness to pay. Additional complexities in determining an exact SMB line result from an inability to determine the true utility individuals or society have for improved water and sanitation.

Without intervention, a single individual would not possess the means to provide the good, due to the fact that the cost of implementing a water and sanitation project would exceed the individual's willingness to pay. [Here again, individuals, or individual (extended) families, would be willing and able to purchase a handcart and its jerry cans for a cost of well under US\$ 100 per family. This investment would not enable them to have an ample supply of water (assuming that a water source is available, but the handcart would be put to, and hence amortized by, many daily agricultural and marketing applications.) In the current market, the quantity of improved water and sanitation points being provided is below the socially optimal level. The goal of all policies would be to increase quantity closer or equal to the quantity desired by society.



The World Health Organization: Analyzing the Economic Impacts of Water and Sanitation

Since 2000, the World Health Organization has published five studies, in the form of cost-benefit analyses, analyzing the impacts of water and sanitation projects. In their cost benefit analyses, Hutton and Haller (2004) specifically discuss the methods available for increasing access to water [There is little reference to the use of handcarts for this application. In a number of East African cities, handcarts are employed by water vendors to transport up to 300 liters of water at a time, which they sell in urban townships lacking pipes water.] and sanitation. While these options are many, especially in areas with the least access, Hutton and Haller (2004) point out that of all possibilities, the World Health Organization favors intervention options that are “low cost, feasible, and do not require heavy follow-up and maintenance” (Hutton & Haller, 2004).

The WHO centers its analysis on the impact of improved water and sanitation service levels. Working in conjunction with UNICEF, the WHO outlined specific criteria that indicate if a water or sanitation program could be considered “improved”. These criteria can be found in the table below.

Intervention	Improved
Sanitation	<ul style="list-style-type: none"> • Flush or pour-flush to: <ul style="list-style-type: none"> ○ Piped sewer system ○ Septic Tank ○ Pit Latrine • Ventilated Improved Pit Latrine • Composting Toilet
Water Supply	<ul style="list-style-type: none"> • Piped water into dwelling, plot, or yard • Public tap/ standpipe • Tubewell/ standpipe • Protected dug well • Protected spring • Rainwater collection

[Note the omission of the use of handcarts for transporting water from the source (standpipe, well, spring, lake, river, to the homestead. The availability of a “water supply” does not mean that the water will be readily available at the homestead. It still must be carried from source to homestead, usually on a woman’s head.]

Cost Measurement

The WHO uses an incremental cost analysis in all documents. These costs include all resources necessary for implementation and upkeep, as well as any other costs that may arise from a water and sanitation intervention. The main source used for these costs was the WHO and UNICEF’s Joint Monitoring Programme’s Global Water Supply and Sanitation Assessments 2000 Report (Joint Monitoring Programme, 2000).

Benefits

The WHO indicates numerous benefits to water and sanitation programs. These benefits span to include health and economic factors. Health benefits were a critical point in the study, as improved access to water and sanitation can greatly decrease the incidence of water-borne, water-washed, water-based, water-related, and vector-borne diseases and illnesses (Hutton et al, 2007a). [The more water available at the homestead, in excess of that needed for drinking and cooking, the more likely that hand washing will become a regular habit, and the less the likelihood of fecal-oral disease transmission. Availability of a handcart is one of the few practical technologies that can enable this to occur.]

The WHO studies focused on the water-borne and water-washed routes, as they were responsible for the greatest number of water related illness (Pruss-Ustun, Kay, Fewtrell, and Bartram, 2004). Thus, the cost-benefit analyses utilized two indicators to measure the health impact of improved water and sanitation: reduction in diarrhea disease incidence and reduction in mortality rates (Hutton et al, 2007a)

Along with health benefits, the WHO studies also reviewed the economic benefits stemming from water and sanitation programs. Hutton et al (2007a) identify three main types of economic benefits: direct economic benefits of avoiding diarrhea disease, [The prevention diarrheal disease and its attendant health care costs, would amply justify a program to make lightweight handcarts commercially available in poor African countries like Malawi.] indirect economic benefits related to health

improvements, and non-health benefits related to water and sanitation. A table listing these benefits and the affected parties can be found in Appendix B. Additionally, the WHO studies assigned specific monetary values to each benefit.

WHO Results

In 2007, Hutton et al (2007a) estimated a total benefit to Sub-Saharan Africa of \$39.7 billion dollars, when all monetized benefits were considered. On the cost side, Hutton & Haller (2007a) found that the total cost for improved water and sanitation on the basic level in Sub-Saharan Africa would be roughly US \$2.7 billion. Thus, the global cost-benefit ratio for Sub-Saharan Africa to obtain water and sanitation would be 14.85 (Hutton et al, 2007a).

Overlooked Benefits: Stretching Beyond the WHO Analysis

While the WHO findings indicate that benefits outweigh the costs for water and sanitation projects, these studies overlooked numerous benefits to women and young girls. The WHO estimated that improved water and sanitation would equal thirty minutes each day in time-savings. While time saved does vary greatly according to region, Sub-Saharan Africa is one of the most water scarce regions in the world. Thus time spent collecting water is thought to be much higher than WHO estimates. [The use of a handcart with plastic jerry cans can conservatively enable a girl to carry 120 liters of water at a time over smooth and gently rolling terrain. This is in contrast to her ability to carry 20 liters (20 kilograms) of water for any appreciable distance by headloading.] Overlooked benefits include the impact of increased education, which includes an increase in GNI and an increase in life expectancy for future generations.

Calculating the Value

In order to include overlooked benefits, each must be assigned a monetary value. In regards to time saved, half an hour is considered to be an underestimate in Sub-Saharan Africa as some women may spend as much as 7 hours in the dry season collecting water (Nair, 2008). To avoid overestimation, a mean time of 3 hours was used as the new value for hours saved per day from improved water and sanitation. In order to avoid double counting time save values, the WHO's estimated time saved of one half hour was subtracted from the new time saved, resulting in 2.5 hours in time saved per day, equal to 912.5 hours per year. While this time may be spent in a variety of activities, including work, school attendance or leisure, all time is calculated at a minimum wage rate for the region. [If 20 liters is a normal head load, and if 120 liters is the normal handcart load, then the time spent in transporting water greatly diminished.]

In order to calculate a minimum wage, the GNI per capita for Sub-Saharan Africa was divided by total hours in a year, resulting in an hourly wage of USD \$.08. This hourly wage was then multiplied by hours saved per year (912.5 hours), which results in an annual increase in GNI \$77.39. Given that this benefit is directly related to the female population only, annual increase in GNI of \$77.39 was multiplied by the female population of Sub-Saharan Africa only. The final result for Sub-Saharan Africa is USD \$ 29.18 billion in additional income. For a full calculation in additional income generated by times savings, see Appendix A.

Education

In their study, the WHO accounted for increased school attendance as a result time saved from water collection. They do not explore the fact that increasing time spent in school allows for a venue in which hygiene and sanitation education can be provided. This would then increase the success and sustainability of benefits, which will allow for the continued benefits of time available not spent collecting water. [No other affordable means of transporting water is as cost effective as using a handcart and appropriate containers (such as blow-molded plastic jerry cans).] The WHO also does not

account for the impacts of increased education, both on economic productivity and life expectancy of future generations.

We shall assume that an increase in education has a 10% increase in literacy rate for the population. With a 10% increase in literacy rate, there is a 10% increase in life expectancy for the next generation (Burrows et al, 2004). Given that life expectancy in Sub-Saharan Africa is 47.2 years, this would lead to an increase in life expectancy of 4.72 for the next generation. At a population growth rate of 2.3%, the next generation of Sub-Saharan Africa will include roughly 17.3 million people: a group which will benefit from an additional 81.7 million years of life in total. Assuming each of these years is economically productive, at the GNI per capita of USD \$742.90, these added years will bring a monetary benefit of USD \$60.7 billion. This would create a generational impact, which could break the cycle of poverty. For a full calculation in additional benefit generated by increased life expectancy, see Appendix B.

According to Water Aid, an increase in education leads to a 0.3% increase in a nation's GNI. Given Sub-Saharan Africa's GNI of USD\$ 559.2 billion, this would have an impact of USD \$1.68 billion increase in the GNI. For a full calculation of increase in GNI due to increased education, see Appendix C.

Recalculated Values

When all additional benefits are combined, the new benefit from recalculation is \$91,554,306,690. Costs shall be held constant at \$2.7 billion. Therefore the cost-benefit ratio of new calculations is 33.9, as compared to the WHO finding of 14.85 (Hutton et al, 2007b).

If new costs are added to the WHO determined benefit value, total benefit value is an estimated \$131.25 billion, which results in a cost-benefit ratio of 48.61.

Additional indicators, not monetized

The above indicators overlooked by the WHO are not comprehensive. More specifically, further benefits existed that could not be monetized, and as a result, were not included in the monetary analysis. Each of these additional benefits resulting from improved water and sanitation would only further shift the SMB curve upward. These include: a decrease in incidence of rape and sexual assault, the empowerment of women and girls, increased dignity and increase in positive child development. Attempts to monetize these indicators were not made for several reasons. [The use of handcarts for these domestic transport tasks, especially water transport, empowers girls and women. It also, by reducing the number of trips needed per day, reduces their exposure to possible rape and assault.]

One reason is that most existing frameworks for monetization are Western-based. For example, when women and young girls are no longer forced to walk long distances in remote areas to obtain water, they are less likely to be sexually assaulted (WaterAid, n.d). This assumption is based on decreased vulnerability; water points would be located within the village, within range of a far greater number of people. From a Western perspective, it can be assumed that the cost of sexual assault includes actual costs from medical and psychological treatment following the rape or assault. However, it cannot be assumed that parallel medical and psychological services exist in Sub-Saharan Africa, nor can it be assumed that these services would be utilized. [Although as stated earlier, it is unlikely that each village will have its own water point, the availability of handcarts can greatly diminish the exposure time to potential assault.]

An additional difficulty impeding monetization of certain indicators comes from the difficulty in determining causality. Certain benefits may be the result of improved water and sanitation, an increase in GNI, an increase in education, or a combination of all of these factors.

An example of the causality difficulty is the benefit of empowerment. [The handcart has enormous potential for empowering women and girls, not only in reducing their work in transporting water and firewood, but in enhancing their access to markets to sell their farm surplus.] The UNDP indicates that education empowers women to engage in community activities (UNDP, 2006). This empowerment, along with increased dignity of women and girls may also result from increased control of activities. Improved water and sanitation provide women and girls with an increase in available time, as was discussed earlier. Women and girls may use this available time to pursue educational opportunities or engage in income-generating activities, both of which will also attribute to increased autonomy and self-worth. Increased education also causes a decrease in birth rate (Child Research Net, 2007). Decreased population growth decreases poverty as limited resources are shared with fewer people (Blackden, 2000).

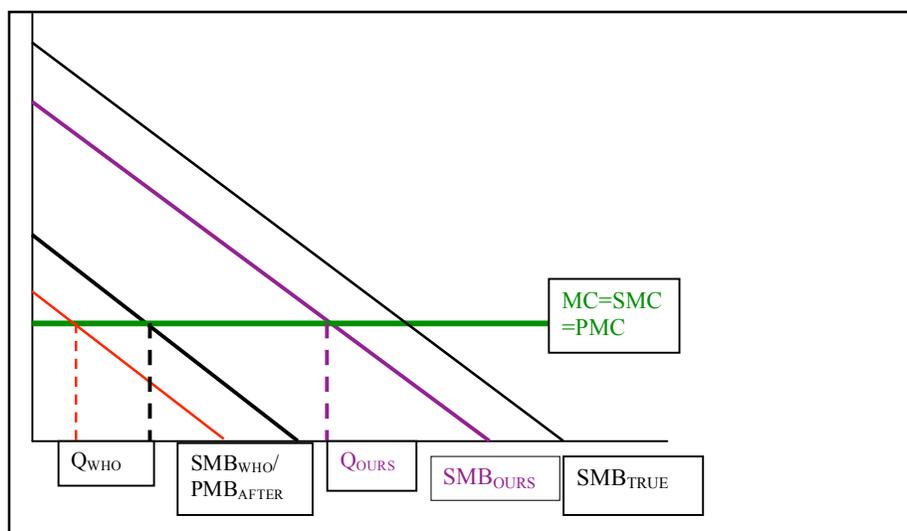
Finally, improved child development is a benefit of water and sanitation projects. With the aforementioned increase in available time, mothers will have a greater amount time to dedicate to their children. [They will also have sufficient water beyond that needed for drinking and cooking, to wash their hands after using the latrine, and to wash their children.] Time spent with children while young helps the child develop positively and with a sense of security. Additionally, it has been shown that women with extremely high workloads are less likely to seek preventative treatments for their children, such as vaccinations or doctor visits (Blackden & Wodon, 2006).

Recommendations

Given that basic water and sanitation are under-produced public goods, our main goal is to increase access to clean water and sanitation facilities. [Although the handcart does not provide clean water, it most definitely can increase the availability of water.] Additionally, within the goal of increasing access to water and sanitation (the public good), ownership of the projects should transfer to the community, especially women and children. Ideally, water and sanitation should be provided to communities at no charge, but congestion may present a barrier in efficient implementation.

Theory would dictate that a subsidy per unit of water may be set equal to the value at the socially optimal point- where social marginal benefit equals social marginal cost. This would be the equivalent of supplementing the work that women and girls are going, so they are compensated for this work. While subsidy implementation is possible, administrative and logistical factors would need to be considered and calculated and it is unlikely that governments would be able or willing to subsidize all who are collecting water.

While water taxes exist, and many communities implement fee-for-use of water after improvements have been made, this is not a solution which raises PMB to SMB, but rather transfers the benefits gained into a tax collected (benefit loss). The collection of a water tax or fee may also be beyond the capacity of communities and villages, and would serve to increase administrative costs. As women often have least control over household income, and many times have no access to money, instating a water tax would only seek to further burden women (Regmi & Fawcett, 1999). Additionally, it is believed that clean water and basic sanitation are basic and inherent human rights. Effective policies regarding natural resources are structured that "institutions be regarded as the means (tools) rather than the end (objectives) of policy" (Cirlacy-Wantrup, 1961). Bearing these challenges in mind, the suggested policy proposals, existing on three levels, were designed to circumvent the need to instate a fee for access in communities.



Gender Sensitive

The voices of women are often hard to hear as women are un or underrepresented in International Aid projects, National Governments and local communities (Blackden, 2000). [Women need to be made aware of lightweight handcart technology. Once they are familiar with it, there is no doubt that they will request access to it.] Within the framework of all recommendations, it is essential that the implementation include gender sensitive approaches as well as direct involvement from women. In order to have successful water and sanitation implementation, the input of women must be sought. [As mentioned earlier, African women (and men) are currently unaware of the existence of affordable lightweight handcart transport technology. Therefore, campaign must be developed and emplanced that will make them aware of this technology, and microfinance arrangements made to enable them to purchase handcarts.] A study by the World Bank indicates that water projects are best sustained when they have been implemented with gender and poverty sensitivity (Gross, van Wijk & Mukherjee, 2000). Failed sustainability of many water and sanitation projects is the direct result of failing to involve women in the planning process (Regmi & Fawcett, 1999).

International Aid

In accordance with Rawlsian theory, increasing the utility (which in this application would be the quality of life) of the least well off in society leads to an increase in utility (quality of life) for all others in society. In this case, it is assumed that improved access to water and sanitation will increase the utility of those granted access. Sub-Saharan Africans are currently the least well off members of the global community, and increasing access to water and sanitation would increase their utility, which would, in return, increase the utility of society as a whole. If Sub-Saharan Africans have access to water and sanitation, less international aid will be needed, and their region will have an ability to contribute more to the global market through time saved from water collection. [Not only will handcart possession result in greater domestic availability of water, but it will enhance agricultural productivity and market access.]

International aid plays a critical role in the implementation of water and sanitation projects in Sub-Saharan Africa. While \$32.6 billion in international aid reaches Sub-Saharan African nations each year, greater funding must be allocated to water and sanitation projects (World Bank Group, 2007). It is also proven that for every USD \$1 invested in water and sanitation projects, a return USD \$3- \$34 results (WHO, 2004). Water and sanitation projects must continue to be a priority of the financial and physical supports of the international community. [Donor money would be well spent in fostering handcart

uptake, which would not only increase water availability, but would enhance agricultural productivity and market access.]

However, while international aid is critical to the progress of water and sanitation projects, contributing nations must maintain cultural competency. International agencies and NGOs, especially those involved in the physical implementation of the project, should involve community members in all aspects of the projects. NGOs and financial partners should encourage the formation of water project committees with the community, so that residents may discuss their own needs. Community members should be trained in project implementation and maintenance, to increase ownership and insure sustainability. As previously discussed, when engaging the community involvement of women must also actively be sought. [However, in order to intelligently discuss their needs, community members must first be made aware of the properties and availability of the lightweight handcart. Currently there is no such awareness, and hence they can not request the technology. In the private sector, this awareness creation is called advertising, and has been widely employed to create demands for scented soap, anti-malarials, cooking oil, and cell phones. Similar techniques need to be used by government and NGOs to make the public aware of handcarts, until the commercial sector begins to advertise them on their own.]

Regional Policy

As Sub-Saharan Africa still faces “growing pains” and is faced with the challenges of its developing status, active participation is needed on the regional level in order to successfully increase access to basic water and sanitation for regional citizens. Essential to the process is for national governments to acknowledge the importance of water and sanitation within development programs. More specifically, these countries may include water and sanitation goals in their Poverty Reduction Strategic Plans, [See my web site <http://mercurypoisoningproject.org/malawi/references.html> for the “*Malawi Poverty Reduction Strategy Paper (Simplified Version) 2004 (Comments by A. P. Wendroff)*” which describes how handcarts can assist in achieving the goals of poverty reduction in Malawi.] and prioritize the creation or improvement of ministries to oversee water and sanitation programming on the national level.

In addition to prioritizing water and sanitation programs, nations throughout Sub-Saharan Africa must also acknowledge the importance of proper hygiene and sanitation practices through the introduction of national education campaigns. These should be modeled after successful campaigns that encourage awareness and behavior modification to promote proper health practices. Education campaigns are essential to the sustainability of the projects. Awareness messages would be presented in all media markets encouraging proper hygiene practices such as hand washing and safe disposal of feces. [Similar awareness messages can be and should be used to familiarize the population with handcarts and their benefits.]

Along with awareness campaigns, hygiene education should be introduced into all primary schools throughout the region. With greater number of girls in school, hygiene education would reach larger numbers of children and serve to further prevent disease. Additionally, schools should receive gender-specific toilets so that girls may feel comfortable and obtain the privacy needed to stay in school after they have reached puberty.

Community Empowerment

The community-focused policy is crucial to ensuring sustainability of water and sanitation projects. Community members must be engaged in all levels of the projects. Many NGOs, such as Gram Vikas and Nepal Water for Health (NEWAH) have focused water and sanitation programs around

community empowerment and mobilization (Asia Development Bank, 2006). More specifically, the community [communities assess and determine] assesses and determines their own needs and appropriate interventions methods, and participates in the implementation and upkeep of community water projects. Water planning groups which are gender and economically diverse, increase a community's feelings on the importance of water and sanitation, and have proven to have more sustainable outcomes (Gross, van Wijk & Mukherjee, 2000).

Just as essential to sustainability as education, training and education must be included with each project. Community members should be trained in proper hygiene practices, including how to prevent contamination of the well, appropriate hand washing techniques, and the best methods for disposing of excreta. These behaviors greatly decrease the risk of the spread of illness and disease. Educating community members about simple methods helps to ensure that their water and homes remain clean and safe.

When these three levels of policy recommendations are implemented, great changes could be made. By prioritizing water and sanitation and recognizing its far-reaching impacts, Sub-Saharan Africa would be able to benefit from improved health and increased productivity. More importantly, the region can benefit from the long-lasting impacts of greater education, empowerment, and dignity of its people. Thus, with clean water comes great change, and the potential for a better future.

Appendix A

Calculation of Time Savings Value

TIME SAVINGS VALUE	
Determining Time Saved Per Day	
	New Estimate of Time Saved – WHO Estimate = (3)-(0.05) =
	2.5 Hours Saved
Determining Time Saved Per Year	
	Hours Saved Per Day (New Value) x Days Per Year = (2.5) x (365) =
	912.5 Hours Saved Per Year (Per Capita)
Determining Hours Per Year	
	Hours Per Day x Days Per Year = (24) x (365) =
	8,760 Hours in a Year
Determining Minimum Wage	
	GNI Per Capita / Days Per Year = (742.90) / (8,760) =
	\$0.0848 Per Hour
Determining Monetary Value to Total Hours Saved	
	Hours Saved Per Year x Minimum Wage Rate = (912.5) x (\$0.0848) =
	\$77.39 Per Year (Per Capita)
Determining Monetary Value for Female Population of Sub-Saharan Africa	
	Value of Time Saved x Female Population of Sub-Saharan Africa = (\$77.39) x (377,052,600) =
	\$29,180,100,710 Value of Time Saved

Appendix B

Calculation of Increased Life Expectancy Value

INCREASED LIFE EXPECTANCY VALUE

A 10% Increase In Literacy Rate Leads to a 10% Increase In Life Expectancy for Future Generation

Determining the Change In Life Expectancy

$$10\% \text{ Increase} \times \text{Current Life Expectancy in Sub-Saharan Africa} = (.1) \times (47.2) =$$

4.72 Years Increase in Life Expectancy for Future Generation (Per Capita)

Determining Number of Children in Next Generation

$$\text{Current Population in Sub-Saharan Africa} \times \text{Population Growth Rate in Sub-Saharan Africa} =$$

$$752.6 \text{ million} \times 0.023 =$$

17,309,800 Children In Next Generation

Determining the Total Number of Years Gained

$$\text{Years Gained Per Capita} \times \text{Children In Next Generation} = (4.72) \times (17,309,800) =$$

81,702,256 Total Years Gained

Determining the Monetary Value of Total Years Gained

$$\text{Total Years Gained} \times \text{GNI Per Capita in Sub-Saharan Africa} = (81,702,256) \times (\$742.90) =$$

\$60,696,605,980 Value Gained From Increased Life Expectancy

Appendix C

Calculation of Value Added to GNI

VALUE ADDED TO GNI

A 10% Increase In Literacy Rate Leads to a 0.03% Increase of the GNI

Determining Value Added To GNI of Sub-Saharan Africa

Increase in GNI Caused By Increased Literacy Rate x GNI of Sub-Saharan Africa =
(0.0003) x (559.2 billion) =

\$1,677,600,000 Added Valued to GNI

Appendix D

Comparison Of Stated and Overlooked Benefits

BENEFICIARY	Direct economic benefits of avoiding diarrhea disease	Indirect economic benefits related to health improvement	Non-health benefits related to water and sanitation improvement	<i>Benefits Overlooked by the WHO**</i>	<i>Future Benefits</i>
Health Sector	Less expenditure on treatment of diarrhea	Value of less health care workers falling sick	More efficiency managed water resources	<i>Achievement of other MDGs</i>	<i>Improvements in Development</i> <i>Improvements in Human Rights and Dignity</i>
Patients	Less expenditure on treatment of diarrhea and less related costs Less expenditure on transport in seeking treatment Less time lost due to seeking treatment	Value of avoided days lost at work or at school Value of avoided time lost of parent/caretaker of sick children Value of loss of death avoided	More efficiently managed water resources		
Consumers			Time savings related to water collection or accessing sanitary facilities Switch away from more costly water sources Leisure activities and non-use value	<i>Increased school retention rate for girls</i> <i>Increased literacy rate</i>	<i>Reduced birthrate</i> <i>Reduced child mortality</i> <i>Increased life expectancy for future generations</i> <i>Increase in education for future generations</i>
Agricultural and Industrial Sectors	Less expenditure on treatment of employees with diarrhea	Less impact on productivity of ill-health workers	Benefits to agriculture and industry of improved water supply, more efficient management of water resources-time-saving of income-generating technology and land use changes		

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