Factors Influencing Solid-Waste Management in the Developing World

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FACTORS INFLUENCING SOLID-WASTE MANAGEMENT IN THE
DEVELOPING WORLD

by

Jessica McAllister

A Plan B report submitted in partial fulfillment
of the requirements for the degree
of
MASTER OF SCIENCE
in
Geography

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ABSTRACT

Factors Influencing Solid-Waste Management
in the Developing World

by

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Utah State University, 2015

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As the world becomes more urbanized and developed consumption rates are on the rise. An inevitable consequence of more consumption is the rapid increase in the amount of solid waste that is produced. Today, solid-waste management (SWM) conditions in the developing world are often quite dire and reminiscent of those found in the developed world several generations ago. The impact of inadequate SWM practices on natural and human environments is now being acknowledged.

This report is founded on a comprehensive literature review concerning SWM in developing countries. It also introduces a preliminary research design relevant to a SWM assessment for a hypothetical situation in Peru. The literature review is organized according to three categories of constraints—each paired with intervention concepts—that contribute to the mismanagement of solid waste. These are: 1) culture, knowledge, and microeconomics; 2) infrastructure, social provisions, and technology; and 3) policy, institutions, and macroeconomics. A fourth topic, namely integrated systems for SWM, is
also reviewed because it allows for the simultaneous use of multiple interventions to address multiple constraints.

Solid-waste management is a multidimensional issue that incorporates political, institutional, social, environmental, and economic aspects. Improving SWM in developing countries requires efforts to raise public awareness, increase funding, build expertise, and invest in infrastructure. To make progress communities will need to embrace new systems for SWM that are participatory, contextually integrated, complex, and adaptive.

(94 pages)
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Jessica McAllister
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INTRODUCTION

Throughout history, human advancement has been intrinsically linked to the management of solid waste due to its effect on both public and environmental health. Solid waste management (SWM) has a long and convoluted history (Nathanson, 2015). Systems of SWM can trace their roots all the way back to ancient times. One of the first instances of waste management occurred in the 4th century A.D. with the Ancient Greeks. The Greeks had to deal with the multiple challenges of aligning waste removal systems with a growing population, lack of space, and sanitation problems. Waste management practices were very rudimentary with trash just being collected and transported to pits outside the city. It was not until urban populations boomed that garbage was viewed as a threat to human and environmental health. Cities began to grow rapidly to accommodate the growing population and conditions began to worsen for these cramped communities. The plagues that affected Europe between the 14th and 16th centuries were often perpetrated by vermin that thrived in the unsanitary urban conditions that were common during this time. Early waste-management techniques were developed during this period to combat the spread of disease but the political and social problems of the time did not see great strides in waste management (Nathanson, 2015).

It was not until the 18th century that municipal collection of garbage had begun in some of the world’s major cities, but the methods were still fairly crude (Metzger, 2009). During the Industrial Revolution, Europe and the United States were experiencing rapid development that created greater amounts of waste. Waste started to become a concern
and this “Age of Sanitation” began. Communities began to organize waste collection and disposal to help maintain public health.

In the latter part of the 19th century and into the 20th century, technological advances included the use of garbage cans and creation of incinerators and sanitary landfills; the latter replaced the practice of open dumping and has become a common practice in the developed world (Hoornweg and Giannelli, 2007). Waste systems took on a more organized approach to waste management, and technology, industry, and new policies and regulations imposed on waste helped to dramatically improve the waste management industry. With the passage of the Clean Air Act in the United States in 1970, many early incinerators without air pollution controls were shut down and replaced by modern waste-to-energy plants (Tangri, 2003). In recent years, the solid waste industry has employed other technologies, such as recycling and composting to combat our ever-growing waste issue. Processes of SWM have affected human history in many ways, just as they will continue to do so in the future.

The modern waste-management industry in the developed world has come far, and with recycling and other advances it will continue to grow and change with the needs of the community. However, countries in the developing world have yet to see many of these changes to their own solid-waste management systems (SWMS). Today, solid-waste management conditions in the developing world are quite dire; present SWMS in these countries are more reminiscent of conditions found in past SWMS in the developed world.

Traditionally, the municipalities have been in charge of providing SWM services in developing countries (Al-Khatib et al., 2009). The municipal responsibility is to
organize and manage the public sanitation system, including providing the infrastructure for the collection, transportation, treatment and disposal of wastes. However, with ever-increasing population and economic growth, many municipalities in developing countries are struggling to keep SWMS working in a sustainable manner. Oftentimes these systems either become ill managed or even cease to exist because of various social, institutional, and technical constraints. Global production of waste has practically doubled over the past ten years and is expected to reach 2.5 billion tons per year in 2025 as a result of the combined effect of urban development and changes in consumption patterns (Périou, 2012).

Communities in developing countries often turn to waste disposal methods that have proven to be destructive to human health and the environment, such as open dumping and burning (or unregulated landfills) because they feel they have no other options to manage their solid waste (Mwanthi and Nyabola, 1997; Goett, 1998; Alavi Moghadam et al., 2009; Narayana, 2009; Al-Khatib et al., 2015; Hilburn, 2015). With industrial progress, growing urban areas and rapid growth, solid-waste management has become a major concern in many developing countries. A case study conducted in various rural cities in India found that trash was frequently dumped or burned in unregulated areas (Narayana, 2009). Although burning trash is illegal, hundreds of thousands of people with no garbage pickup have no other choice for disposal of their waste. Households in these communities maintain localized trash pits, where waste is deposited daily and burned biweekly. Once the pits become full, the waste remnants are transported to larger pits on the edge of the town (Narayana, 2009).
In the larger towns or cities like New Delhi, the availability of land for waste disposal is also very limited (Venkateswaran, 1994). In the majority of urban centers, solid waste is disposed of by depositing it in low-lying areas outside the city without following the principles of sanitary landfilling such as leachate collection and monitoring that make this disposal method unsustainable. In both rural and urban areas, open burning of household waste has become commonplace in areas where collection is limited or non-existence (Narayana, 2009).

As the urban population in Nairobi and elsewhere in East Africa grows, so does the solid-waste management burden, a situation worsened by poor funding for urban sanitation departments and a lack of enforcement of sanitation regulations. At least 100 million people in East Africa lack access to improved sanitation (Troschinetz and Mihelcic, 2009). Without proper controls, solid waste is often dumped in abandoned quarries or similar sites. In Nairobi, for example, municipal waste is taken to the Dandora dumping site, a former quarry. Residents living close to the dumpsite are therefore exposed to environmental and disease risks. The disposal sites are, in most cases, located in environmentally sensitive, low-lying areas such as wetlands, forest edge or adjacent to bodies of water. They often do not have liners, fences, soil covers and compactors as is in most developing countries (Troschinetz and Mihelcic, 2009).

More often than not, the urban poor have to make do with living amid waste despite the health risks. Similar situations exist in many other developing nations where population and industrial growth are on the rise and systems are too weak and ineffective to handle to added strain. With this exponential growth of waste, new practices of SWM must be undertaken and these systems need to be sustainable and adapted to the needs
and challenges prevalent throughout the developing world. Understanding the current research on this topic will allow us to fill in knowledge gaps about the topic of SWM in developing countries.

With the world becoming more urbanized and developed, and with populations rapidly increasing each year, consumption levels are reaching historic levels (IPA, 2014). An inevitable consequence of this growing consumption trend is the rapid increase in the amount of solid waste produced. Having effective and sustainable waste management systems in place will help regulate waste disposal and will help alleviate some of the pressure consumption has put on the environment. It is also important to deal with this issue directly because waste can have detrimental effects, if left unmanaged, on both environmental and human health (Narayana, 2009). For example, in a study conducted in India researchers found that when citizens were exposed to open dumping and burning of waste they developed increased health problems due to the release of dangerous toxins such as dioxins, which are known to cause cancer and other health challenges. Important considerations must be made about the ways we manage waste not just to ensure the health of the environment, but to ensure our own health as well (Narayana, 2009).

My personal experiences as a Peace Corps volunteer in Peru gave me a first hand look at the conditions of SWMS in the developing world. Cities are littered with trash and trashcans are few and far between. A variety of factors affect waste management and we need to take a multi-dimensional approach to address this issue. My time in Peru has enlightened me to the real factors that have impeded sustainable waste-management systems (as seen in later sections). I hope this present research will enlighten me of the
most effective options that will allow for the development of sustainable waste-management practices in Peru as well as other developing countries.

It is typical that developing countries lack the financial, human, infrastructural, and related resources to develop effective SWMS (Zhu et al., 2008). Many factors contribute to this dilemma. My report identifies and discusses these types of constraints that have been found to influence solid waste systems, including 1) culture, education, and microeconomics, 2) infrastructure, social provision, and technology, 3) policy, institutions, and macroeconomics, and lastly discusses the ever-popular system of 4) integrated solid-waste management systems (ISWMS) (Oteng-Ababio, 2011). I will synthesize these key factors as well as the related interventions of education and incentives, policy intervention and restructuring, infrastructural updates and changes, as well as look at an all-encompassing approach, an ISWMS, all of which could improve solid-waste management in communities of the developing world.
LITERATURE REVIEW

Culture, Education, and Microeconomics

Major Constraints

Oftentimes when systems are breaking down and problems are escalating, people look to societal factors to fix the issue. This has often been the case when dealing with the mismanagement of solid waste in the developing world. Many researchers have argued that the waste problem is caused by human behavior and therefore the solution lies in changing that behavior (Milea, 2009). Public awareness and attitudes about waste can affect the whole SWMS (Zhu et al., 2008). How is waste defined in the developing world? Why has littering become such a prevalent behavior in these communities? What role do social norms and attitudes play in shaping these behaviors? And what measures must be taken to ensure that these behaviors change? These are questions that must be answered in order to come to realistic solutions to the problem of solid-waste management in developing countries.

The Attitude and Behavior Gap

Waste can mean many things to different people (Moore, 2012). Some people such as the trash pickers of Ghana see “waste” as a resource or a way to make an income in an otherwise limited job market. On the other hand, you have a majority of people living in the developing world that see waste as a burden and a problem that needs to be addressed. To say people in developing countries don’t recognize trash as an issue is an untrue statement. The opposite is often true. However, recognizing trash as a problem does not prevent littering or other negative behaviors concerning waste management.
(Moore, 2012). This attitude-behavior gap often emerges and can be further affected by a variety of reasons including convenience, social norms, lack of public participation, and lack of education and awareness of effective waste management techniques (Milea, 2009; O’Connell, 2011).

Within this attitude/behavior gap exists an inconsistency between one’s values and actions. This specifically refers to the discrepancy between people’s concern over the environmental harm posed by household waste and the limited action by those same people to reduce their waste or engage in other pro-environmental behaviors (O’Connell, 2011). Many researchers observed this gap first hand when conducting observations in communities of the developing world. I personally observed this behavior in my time in Peru, where individuals I had just interviewed, who claimed they were concerned about the trash problem in their community, then proceeded to litter in the street later that day, not connecting their values with this action.

A negative behavior often associated with the mismanagement of solid waste in developing countries is the occurrence of littering. There are a multitude of causes that can contribute to an increase in public littering rates, such as a lack of social pressure to prevent littering, absence of realistic penalties or consistent enforcement, and lack of knowledge of the environmental effects of littering (Al-Khatib et al., 2009). Other causes also include the amount of litter already present at a particular site, presence of signs referring to litter, and the number and/or placement and appearance (if any) of waste collection bins at the site. Convenience of garbage bins has been cited many times in research as a priority when disposing of trash, and when these are not present or lacking in areas this has been reason enough to litter (Henry et al., 2006).
Other times people become accustomed to throwing their waste in streets and other inappropriate places, as there had been no formal system for sorting and disposal in their community, so when changes are implemented people are not changing their disposal behavior out of pure habit and custom (Yousif and Scott, 2007). Similarly, a range of socio-economic factors can affect public attitudes toward littering, frequency of littering, and the effective approaches to impede the littering tendency within an individual (Al-Khatib et al., 2009). These factors are region and culture dependent, and it is very important to study them if an effective littering prevention program is to be designed.

For example, in a study conducted in Cuba looking at the relationship between social norms and pro-environmental behaviors, researchers found that a majority of citizens participated in recycling buybacks and non-littering initiatives, not only because the government supports these efforts for economic reasons, but also because of the social pressure created by the community. Citizens also possess internalized social norms and believe that if they do not adapt their behaviors accordingly, they become outsiders and are looked down on (Mosler et al., 2008).

To get a clearer understanding of the complexity of street litter problems, integration between socio-economic and environmental studies is essential (Al-Khatib et al., 2009). The participation of the community in the production and use of scientific knowledge is considered the best approach to environmental management of waste. Many studies have been conducted in the developed world to evaluate and apply strategies to reduce littering by means of behavioral interventions (Al-Khatib et al., 2009), but in developing countries little has been done.
Lack of Education and Awareness

Another major constraint seen throughout the developing world is the lack of education and awareness of effective waste-management practices. One study in Gaborone, Botswana, found that even though citizens were aware of recycling and other sustainable waste-management techniques, this does not necessarily translate into participation in pro-environmental activities such as recycling initiatives. They appear to have not embraced waste management reforms amid their limited knowledge of such activities (Bolaane, 2006). The lack of interest in the environment creates a culture of non-participation of communities in decision-making processes. That stance enhances lack of responsibility for pollution and waste issues. Ultimately this produces communities that have little knowledge of, or concern for, their impact on the environment (Poswa, 2001). What it may come down to is the difference between information and knowledge. Being presented with the information without prior knowledge may be ineffective in creating change. However, if prior knowledge of waste management was met with new information, these communities may be more willing to accept it and implement these changes.

The need to improve public awareness of, and community participation in, waste management has been widely recognized by researchers as necessary to create sustainable waste systems and to promote environmental citizenship amongst community members (Lumbreras Martín and Fernández García, 2014). Typically, people are more likely to participate in waste management activities, for example recycling, when they observe others in their vicinity recycling. In developing countries recycling programs are
rare, so wealthier members of the country rely on informal recyclers as the behavior norm (O’Connell, 2011).

The results of a study done in Malaysia by Aini and colleagues (2002) indicated that, in order to overcome the solid waste crisis, the “conscience of the individual needs to be raised through environmental awareness and concern, inculcation of sustainable consumption practices and education on waste management.” Environmental awareness and knowledge about environmental conservation were found to affect recycling attitude positively but positive attitude may not have resulted in recycling if knowledge about it was poor (Aini et al., 2002), so waste managers need to take steps to help align the information presented to the public with the knowledge these individuals already have.

**Choice versus Response**

Another problem is that many people feel that they have no impact on the decision-making process, and as a result do not bother to register complaints with the authorities. This attitude differs among socio-economic groups. Wealthier socio-economic groups are more likely to feel like they can make a difference when it comes to these environmental problems or become involved in doing something about them because they feel that they have the ability to make more of a impact in addressing and fixing the problem. Some researchers argue that people of lower socio-economic groups tend to have less regard for environmental issues on the basis that employment and housing are their main priorities (as cited in Périou, 2012).

Turning to more of a response side of this issue, there is often this the lack of a sense of responsibility, which is manifested by the accumulation of huge amounts of litter
in public places such as parks, highways and recreational facilities and in private areas such as business places (Scarlett and Shaw, 1999). This can be explained as a function of ownership. As cited by Scarlett and Shaw (1999), Aristotle (n.d.) said: “What is common to many is taken least care of, for all men have greater regard for what is their own than for what they possess in common with others.” This simply means that people who own property have the incentive to take care of it, unlike the one owned by a large number of people or where there is non-ownership like public places. This appears to be a “tragedy of the commons” issue (Hardin, 1968). In this theory individuals act independently and rationally according to their own self-interest and behave contrary to the best interests of the entire group by depleting some common resource such as a river, or in the case of waste management, public places like parks.

In one study it was pointed out that in the past, waste management in South Africa was largely treated as a technical issue and the participation and cooperation of households were overlooked (WRC, 1995). The outcome of non-participation of communities in waste management was manifested in careless and irresponsible disposal of waste in public streets, along the roads and highways, and around communal bins for residential waste. A problem of this kind highlights the need for the implementation of vigorous programs of public education (UNESCO, 1996) as well as increased participation among community members.

**Interventions**

Looking at the current research, one can identify key interventions to help improve some of the social factors mentioned in the previous section. For developing
countries, improved education and awareness programs about solid waste are an important step in more effective SWMS. Increased community participation and introducing incentives have also been cited by various researchers as some of the most effective social interventions in establishing sustainable SWMS (PAHO, n.d.; Bolanne, 2006; Al-Khatib et al., 2009; Narayana, 2009; O’Connell, 2011).

Improvements in Education and Awareness

When reviewing current research on the topic of social interventions, recycling is often emphasized when talking about education and awareness programs as they relate to SWM. The low level of awareness regarding the health and environmental impacts of improper management of solid waste makes it difficult to implement recycling and disposal programs in many developing countries (Mrayyan and Hamdi, 2006). Recycling requires community involvement and social awareness to be successful. In recognition of the importance of public participation in the success of recycling programs, recycling policy and legislation need to be geared toward promoting people centered approaches to recycling with public education as the main driver towards increasing public participation (Bolaane, 2006). A study done in Palestine focused on this educational gap came to the conclusion that there was a positive relationship between the level of education and the participatory behavior of the people in recycling activities (Al-Khatib et al., 2015).

Unfavorable results present local authorities with the challenge to educate citizens and disseminate sustainable measures and practices aiming to: 1) reinforce environmental sustainability, public health, family and child safety; and 2) practice the principles of waste management: reduction and segregation at the source, reuse and commitment to
participate in recycling schemes. A similar study conducted in Jordan found similar results that by implementing proper environmental awareness programs public understanding will be enhanced and achieving greater efficiency of waste management practices will result (Mrayyan and Hamdi, 2006). These are just two findings of many that identify public awareness and education of SWM as vital in achieving waste segregation that would, in turn, reduce solid waste pollution. Also incorporating health messages, such as communicating the negative health effects of open-burning of waste on air quality and human health, in the education and awareness campaigns may prove to be the push many community members need to change their waste management behaviors.

Another study conducted in Malaysia, found that educational programs affect the relationship between people's attitudes towards SWM and their recycling motives. Consequently, attitudes toward recycling were found to have a significant effect on waste recycling. In terms of extrinsic (i.e social reinforcement and monetary reward) and intrinsic motivation (i.e. personal satisfaction) both were found to affect recycling behavior. However, having a sufficiently high level of motivation itself and positive attitudes toward recycling do not guarantee that an individual will act accordingly (Aini et al., 2002). Systematic and holistic approaches and efforts should be undertaken by various government and non-governmental agencies to educate the public by focusing on the underlying reasons for recycling and the adverse effects of mounting garbage on the environment. The intrinsic motives, which were found to be higher motivational factors among the respondents, should be nurtured and developed so as to encourage recycling participation specifically and be more environmentally responsible behavior in general.
When people understand the connection between their behaviors and environmental harm they are more likely to engage in pro-environmental behaviors. Recycling behavior is strongly influenced “by the knowledge of where, when, and how to recycle” as stated by O’Connell (2011). The findings of a study conducted in over twenty-two developing countries (Guerrero et al., 2013) suggests that when citizens receive information about the benefits of recycling and how to sort the waste, and they participate in the designing of the programs, they are more likely to participate in recycling campaigns. Social norms can also play an important role in changing waste behavior and participation in recycling activities. People are more likely to recycle when they observe others in their community recycling, so it would be beneficial to reach out to key members of the communities to take the lead on changing these negative environmental behaviors (O’Connell, 2011).

While recycling is a very important aspect of waste management, authorities in developing countries tend to overlook the significance of waste minimization strategies, leading to situations where more waste than necessary is sent to disposal sites or recycling facilities. According to the EPA (1988), waste minimization is a process of elimination that involves reducing the amount of waste produced in society and helps eliminate the generation of harmful and persistent wastes, supporting the efforts to promote a more sustainable society. Waste minimization involves redesigning products and/or changing societal patterns, concerning consumption and production, of waste generation, to prevent the creation of waste.

There has not been a lot of research on this topic especially in developing countries, but the few studies that have been conducted have found waste minimization
both an effective and economically viable option in managing solid waste (O’Connell, 2011). One such study conducted in Ghana yielded interesting results (Yire, 2012). As a result of rapid urbanization, Ghana is currently suffering from an abundance of waste, specifically plastic bag pollution. These bags are creating drainage issues and have proved to be hazards to local livestock that feed upon them. Ghana is taking active steps to ban the use of plastic bags to help alleviate this issue. Somalia, Botswana, Uganda, Kenya, Tanzania, Eritrea, and Ethiopia, among others, have already placed an outright ban on plastic bag use. This is a great example of attacking waste at the source. Waste minimization is an excellent opportunity for all countries, both developing and developed, to stop waste at its source (Yire, 2012). Educating the public about the benefits of waste minimization is key to reducing waste on the long-term scale.

Waste minimization is a new concept in the developing world where residents’ consumption levels are only starting to rise. However, addressing this problem directly may be the most cost-effective way to address waste management in the developing world. There are several methods to increase participation in solid waste minimization efforts and these include: using the power of social norms, emphasizing environmental benefits, providing convenient access to facilities and adequate information, appealing to positive emotions surrounding waste minimization, and waste minimization through responsible consumption. Including social and cultural norms, involvement at the household level, and analysis of individual needs are crucial to the success of recycling and waste-reduction interventions in which change of individual behavior is the key factor and main focus. These may all prove to be effective in different situations and in different countries. Many of these methods are similar to or modified versions of methods
to encourage recycling, and many options can be implemented in conjunction with one another to provide a more effective program of waste management that focuses on waste minimization as a major priority.

Public Participation

Another major social intervention for more effective SWM is increasing community involvement in waste management activities such as recycling, and increasing participation in decision making when it comes to waste management programs. The issues of public acceptance, changing value systems, public participation in planning and implementation stages, and changes in waste behavior are equally as important as the technical and economic aspects of waste management (Marshall and Farahbakhsh, 2013). Effective waste management must be fully embraced by local authorities and the public sphere, and must include all stakeholders in the entire waste management decision-making process. Key elements to the success of these integrated programs are public participation and empowerment, decision transparency, networking, cooperation and collective action, communication, and accessibility of information (Marshall and Farahbakhsh, 2013).

In a study conducted in India (Milea, 2009) researchers found that although the majority of respondents perceive garbage as a big problem in Delhi, there is little knowledge on the ways one could contribute to solving it. The sense of responsibility for one’s waste was found to be the major factor determining littering and waste separation, but waste minimization is mainly associated with income and not perceived as part of the waste problem. Researchers suggested that public campaigns should emphasize residents’
responsibility for their waste and the importance of each and every citizen’s cooperation, thus creating a sense of a shared community goal around solving the waste problem. The information and motivation campaign should be supplemented with measures that would facilitate citizen participation.

According to another study (WRC, 1995), communities should be required to take responsibility for their own waste collection and disposal. Through community self-help, waste management costs are reduced and community self-interest is increased. The advantage of this strategy is its emphasis on community involvement in the reuse of waste materials. The study suggested the following steps to encourage community involvement: 1) Promotion of environmental education, information and capacity building in communities; 2) Promotion and provision of support for community-based initiatives to seek solutions to waste management, sanitation, and access to resources; and 3) Creation of community forums responsible for developing integrated environmental, developmental and spatial plans.

**Incentives**

The last major social intervention cited by researchers to increase the effectiveness of waste management systems is through incentives. One of the major motivators for behavior change is the use of incentives. Incentives, both economic and socio-psychological, can be incredible tools to help change behavior and are considered an effective social intervention in developing countries by many researchers (Bolaane, 2006; Mrayyan and Hamdi, 2006; Milea, 2009; O’Connell, 2011). Socio-psychological incentives are referred to as incentives that change attitudes and behavior through
disseminating information, persuasion by relating waste minimization to the achievement of valued goals and making use of social pressure, among others (Milea, 2009).

Media can play an important role in increasing public participation and awareness and can serve as an instrument for many socio-psychological incentives. A study conducted in Cuba (Mosler et al., 2008) found that mass media involvement, through the use of advertisement and campaigns geared towards recycling and reusing products, was seen as a useful incentive to public participation in waste management informational sessions and activities. Television campaigns involving local celebrities or other influential people participating in these SWM activities could also prove useful in developing countries where television usage has become popular and widespread, such as Peru. However, information is not enough. People have to believe that the particular action is a contribution and feel it is their own responsibility to do it. Therefore, when the media is used to create these awareness campaigns they should endeavor to create a common goal around solving the waste problems and be very clear on how people can contribute to this and why it is urgent and important to do so (Mosler et al., 2008).

Many researchers have also cited economic incentives as an important tool in changing behavior and in some cases market and financial incentives can be even more effective in modifying public behavior and increasing waste diversion (see Figure 1). Economic incentives are those that give financial rewards for cooperation (Milea, 2009). Waste-picking or scavenging activities are commonplace in developing countries. These waste-pickers have little education and limited opportunities to make a stable income. The existence of waste pickers/scavengers often creates an obstacle to the operation of solid waste collection and disposal services (Schübeler et al., 1996). This has to do with
the fact that these scavengers are taking out all the recyclable materials from waste piles to make money—which many local governments depend on for funding SWMS. However, if organized properly, their activities can be effectively incorporated into a waste recycling system. This type of an opportunistic approach is required for sustainable development of SWM programs in developing countries (Schübel et al., 1996).

A successful example of an economic incentive program can be seen in Gaborone, Botswana (Bolaane, 2006). Most stores in the city accept empty beverage bottles from customers in exchange for the return of their deposit. A majority of respondents (51 percent) set aside glass bottles because of the economic incentive for returning the bottles. Similar exchanges exist throughout the developing world, and this is a great example of how economic incentives can be a sustainable activity.

The results of the effectiveness of both of these incentive approaches have varied. An evaluation of Mexican projects showed that economic benefits had more influence on behavior changes such as source separation than environmental education (Bolaane,
However, a review of literature conducted by Cecere et al. (2013), revealed that if motivations are extrinsic from the beginning, the increase of external incentives will be likely to increase effort as predicted by many researchers. According to Cercere’s findings, the importance of non-monetary incentives in waste recycling has been emphasized in the literature (as cited in Cercere et al., 2013), and this suggests that recycling is increased more by social incentives than by economic ones, to the point that households may even be willing to pay for the opportunity to recycle. Non-monetary incentives must also be considered when waste reduction is the aim.

**Conclusions**

After looking over the cultural, educational, and microeconomics of waste management many things become clear. Public awareness and attitudes towards waste can impact the entire SWM system, from household storage to separation, interest in waste reduction, recycling, the amount of waste in the streets, and ultimately the success or failure of a SWM system. Being aware of problems does not necessarily mean that people find it their responsibility to solve them. It is up to all stakeholders involved to work together towards the common goal of sustainable waste management.

Governments should take steps to educate the citizenry on waste reduction and separation as a matter of national policy and they should enact waste-minimization legislation as a first step. Emphasis on the need for information about environmentally responsible behaviors, such as recycling and waste minimization, needs to be presented in a culturally and emotionally appropriate context. Behavior change and waste prevention policy needs to be designed with convenience in mind, based on the needs of today’s
households for time and space. This has been proven to encourage householders to engage in waste management practices, provided that such a scheme is well publicized.

Socio-economic characteristics (especially wealth) may determine attitudes such as the perceived ability or willingness to recycle municipal solid waste, but these attitudes may be positively influenced by awareness-building campaigns and educational measures. This can be achieved using a variety of factors such as the integration of environmental education centered on SWM and the environment into the school curriculum beginning with the elementary schools. Public awareness can also be improved through some low cost methods such as seminars, workshops, newsletters, speeches, and church bulletins. Solid waste planners can also make the best use of all available community resources which include elected officials, the news media, interested groups and community organizations, all of which have the ability to generate community support. Although municipalities generally deliver urban SWM services, efficient and effective service delivery is difficult to achieve without the active participation of and support from local communities.

Even though socio-psychological incentives, or moral and social motivations, may prove effective in the long term scale, these public campaigns aimed at changing attitudes and norms are also the most difficult to achieve. However, a combination of socio-psychological and economic incentives, along with educational awareness campaigns and increased community involvement, may just be the winning combination for success in many developing countries.
Infrastructure and Technology

Rapid growth of population has created a number of extreme land use planning and infrastructural challenges that have crippled the capability of national and municipal governments in developing countries in increasing SWM service levels at the rate that they are demanded (Périou, 2012). In the municipal solid-waste management system (SWMS) of developing countries typical problem areas can be identified. These can be described as: 1) budgetary constraints, 2) inadequate service coverage and operational inefficiencies of services including unskilled manpower, 3) ineffective technologies and equipment, 4) inadequate landfill disposal, and 5) limited utilization of waste reduction activities such as recycling.

Major Constraints

These situational constraints may prevent the possibility of responsible environmental behaviors even when individuals are willing and determined to do so. In other words, if the infrastructure isn’t in place citizens have very limited options to deal with their waste. Some studies have already supported this notion and point to infrastructural problems as the main impediment to sustainable SWMS in developing countries like India, Botswana, and Honduras (Hoornweg and Giannelli, 2007); and should be the first priority for municipalities to improve waste collection and disposal. Breaking down each of these infrastructural and technical constraints further will allow us to gain a better understanding of these challenges and will help inform our technical interventions for more sustainable SWMS in developing countries.
Budgetary Constraints

Budgetary constraints are often felt in developing countries where resources are limited and distribution of these limited funds are mismanaged. Many municipalities are struggling to achieve acceptable quality and coverage of service due to these financial constraints. A study conducted in Palestine stated that on average, up to 50 percent of residents lack collection services in urban areas of low and middle-income countries. There are limited opportunities for the development of sustainable SWMS, as government budgets are limited and proper waste collection is overlooked (Al-Khatib et al., 2010). Another study conducted in Kenya found that much of the municipal budget for waste management is directed to pay for an over-staffed and under-qualified workforce (Henry et al., 2006), and not allocated to make improvements within their own infrastructure. The data from another study suggests that the inadequacies of vehicles, supervisors, and solid waste collection crews were the major obstacles to the management of solid waste in the country (Mwanthi and Nyabola, 1997). These problems were attributable to financial constraints and possibly to misappropriation of finances within the offices that manage waste.

Inadequate Service and Operational Inefficiencies

Inadequate service coverage and operational inefficiencies of services including an unskilled workforce is another major set of challenges faced by municipalities in providing sufficient waste services to citizens. Municipal solid waste collection schemes of cities in the developing world generally serve only a limited part of the urban population. The people remaining without waste collection services are usually the low-
income population living in urban and rural areas (Zhu et al., 2008). One of the main reasons is the lack of financial resources to cope with the increasing amount of generated waste produced by the growing cities.

A study conducted in Kenya found that resources were often centralized in the more affluent areas because there was not enough man-power to cover entire cities and these areas were more likely to pay for the services (Henry et al., 2006). Dwellings with courtyards may have space for storing waste for several days, but compact housing with no space for storage may necessitate that some waste is taken outside the property as soon as it is generated. Narrow streets may not have space for locating storage containers and may be so narrow, treacherous or irregular that motorized collection vehicles cannot be used. Houses that are considerable distances from the nearest accessible road also pose particular problems in receiving adequate waste services. In another study conducted by Mwanthi and Nyabola (1997), it was also concluded that the lack of skilled and technical human resources along with poor management of finances and resources, and laxity among employees (leading to inconsistent service) were major contributing factors to mismanagement of solid waste in Nairobi City.

When talking about recycling habits of citizens, a case study in India found that the location of recycle bins seemed to be ill situated and not readily available. The author concluded that location and convenience are important determinants in acceptance or rejection of the activity (Venkateswaran, 1994). Irregularity of services such as street sweeping and collection were also observed. He found that the lower the socio-economic level of the residents of an area, the lower the frequency of collection. This was also found to be true in a study in the poorer parts of Nairobi City where the majority (91
percent) of the residents interviewed had no storage receptacles. Of this group, 84 percent resorted to either burning the waste in their backyards or to indiscriminate dumping; 90 percent of the time they discarded waste indiscriminately (Mwanthi and Nyabola, 1997).

*Ineffective Technologies and Equipment*

Ineffective technologies and equipment has been another source that may contribute to the inadequate service coverage and operational inefficiencies discussed above. In a study looking at SWM in the developing world, many sources of waste might only be reached by roads or alleys, which may be inaccessible to certain methods of transport because of their width, congestion, and elevation. This is especially critical in unplanned settlements such as slums or low-income areas and thus largely affects the selection of equipment (Zhu et al., 2008). Another study done in India found that poor conditions of containers and inadequate maintenance and replacement of worn-out collection vehicles contributed to behaviors such as littering and illegal dumping by citizens who felt they could not properly dispose of trash because trash bins and waste services were not properly maintained (Hazra and Goel, 2009).

Another major constraint is the misuse of technology, which has been documented in numerous cases where sophisticated and expensive technological recycling and composting plants as well as other waste management systems in developing countries have failed (as cited in Yousif and Scott, 2007). Reasons for a breakdown include a failure to adequately and extensively consult the public and relevant stakeholders, adoption of inappropriate technology characterized by imported mechanical and electrical parts which are too expensive to replace or too difficult to maintain, a
failure to conduct economic and financial assessments, limited development of a market for recyclables, financial constraints, and absence of skilled technical personnel to manage these systems have been observed in many developing countries (as cited in Yousif and Scott, 2007). Techniques that have often proven effective in developed countries prove to be ineffective in many situations in developing countries that do not have the needed infrastructure, need, or know-how to properly implement these technologies. The lack of overall plans for SWM at the local and national levels results in solid waste technologies that are often selected without due consideration to their appropriateness in the overall SWMS.

**Inadequate Landfill Disposal**

Inadequate landfill disposal is the next factor that contributes to infrastructural challenges. In Ghana, Asase and colleagues (2009) noted that there was a lack of proper disposal sites in the country. Unprotected and uncontrolled dumps, which pose a danger to the public health, environmental health, waste renewable resources, and jeopardize residential development in these areas, are a commonality found in many developing countries. Unlike developed nations, third world countries lack sanitary landfills and oftentimes disposal sites are located at a considerable distance from communities. This ultimately creates even more financial constraints because costs to collect, transfer, and dispose of waste are more than many municipalities can afford. Rapid population growth and urbanization have put limits on the location of future landfills, and this reality is something that many of these developing countries confront. Finding ways to minimize waste such as recycling are excellent tools to combat this waste issue.
Limited Utilization of Waste Reduction Activities

This brings us to the last contributor to the infrastructural constraints on waste management systems in the developing world. Researchers often cite limited utilization of recycling programs as a main infrastructural issue in sustainable waste management. Information collected in a study in Botswana found that the absence of ‘visible’ recycling centers and receptacles was found to limit participation in recycling initiatives (Bolaane, 2006). The lack of access to recycling facilities was cited as a major reason for households in developing countries not to participate in recycling (O’Connell, 2011). Oftentimes when recycling programs are introduced to a community either by NGOs or municipalities, these programs are found to be unsupportable either because of financial constraints or poor participation by community members.

Interventions

Many different interventions have been undertaken by developing countries to help improve the infrastructure of SWMS. These include improvements to local infrastructure such as upgrading roads, tucks, routes schedules, conversion and updating of storage containers, investing in community collaborations, and formalizing recycling facilities.

Improvements to Service Operations, Technology, and Accessibility

A report of a study conducted in Palestine suggested that local authorities should increase the number and optimize the distribution of litterbins on the streets and other public places as a measure to discourage people from littering (Al-Khatib et al., 2009).
Convenient access to these units will cut down on littering and alleviate some of the pressure on municipalities and redistribute resources to help properly dispose of waste. Another improvement could be undertaken when it comes to storage containers. Open storage enclosures should be eliminated and converted into closed containers. Also, the volume of the storage enclosures should be designed by overestimating the generation of waste, not underestimating it, as is currently being done (Hazra and Goel, 2009). This also goes along with upgrading transportation and other equipment, which in the long run will increase operations. However, since distance and access to paved roads is often still an impediment to service, transfer stations should be established through the collaboration of communities and municipalities (Parrot et al., 2009). This is a great way to reduce transport costs while at the same time increase services.

Another study conducted in India suggested that labor could replace technology, for instance in collection of waste from areas with poor accessibility. This could be accomplished with the involvement of residents of low-income areas, which in turn can create jobs and income for these poorer residents. A successful example of this occurred on the North Coast of Honduras, with community members participating in recycling and composting activities as well as establishing localized waste collection and disposal systems (Goett, 1998). If this is not a possibility, municipalities need to invest more resources into a smaller but more skilled group of personnel instead of wasting money on a large but inefficient and ineffectual workforce.
**Utilization of Recycling Initiatives and Improvements in Disposal**

According to one researcher, “the most important determinant of recycling behavior is access to a structured, institutionalized program that makes recycling easy and convenient” (O’Connell, 2011). The importance of ‘visible’ and accessible recycling centers as well as financial incentives to encourage participation in recycling is supported by many studies as an effective measure in improving SWMS (Bolaane, 2006). A study looking at waste management in Ghana advocates for communities to network, collaborate, coordinate, and develop common waste treatment and disposal infrastructure in order to improve waste disposal methods (Oteng-Ababio, 2011). Formalization of recycling and encouragement to do so would significantly reduce the volume of waste and could save municipalities a substantial amount of money and resources. This approach could also create informal employment opportunities.

**Landfill Creation**

Lastly, creating new landfill sites with social, economic, and environmental needs in mind is important to sustainable waste management systems. While sanitary landfills are expensive to maintain, that does not mean that communities in developing countries do not have sustainable waste removal options at their disposal. Composting and recycling initiatives as well as waste reduction are all available options for the developing world to take advantage of. Examples of these waste minimization activities have already begun to be looked at as viable options in reducing the amount of waste for disposal in places such as Cameroon (Parrot et al., 2009). What it comes down to are the choices that
Communities have to make. They need to choose the best infrastructure and technologies that best meets their current needs and capabilities.

**Conclusions**

The collection of municipal solid waste is a public service that has important impacts on public health and the appearance of towns and cities. However, increasing population has caused severe pressure on basic infrastructure and amenities, creating large areas underserved by public services. Unfortunately many urban administrations seem to be losing the battle of coping with the ever-increasing quantities of waste. The predominantly technology-oriented nature of waste management systems, without due social, ecological, and economic considerations, has been responsible in large part for many of the constraints and inefficiencies experienced in waste management.

Financial constraints, inadequate service coverage and operational inefficiencies, ineffective technologies and equipment, inadequate landfill disposal, and limited utilization of recycling initiatives are all found to be challenges to the infrastructure of waste management systems in developing countries. These gaps in service relate not merely to availability of infrastructure and investments, but also to inappropriate management of the service. Major interventions need to take into account the circumstances and needs of the communities for which they are implemented. Improvements to infrastructure and technology within the waste management system need to be accompanied with community involvement and participation as well as educational and awareness campaigns in order to be successful in creating sustainable waste management systems.
Policy, Institutions, and Macroeconomics

It is asserted in the 2005 UNEP Annual Report (cited in Pérou, 2012) that in many developing countries, the greatest impediments to efficient and environmentally effective handling of solid waste are managerial rather than technical. Improving the operational and management capabilities of individuals and institutions involved in SWM at the local level is therefore extremely important. According to an article looking at SWM in the developing world, operational inefficiencies of solid waste services operated by municipalities can be due to inefficient institutional structures, inefficient organizational procedures, or deficient management capacity of the institutions involved, as well as the use of inappropriate technologies (Zhu et al., 2008). That same study also points to the lack of enforcement of waste management legislation as a major impediment to effective and sustainable waste management in the developing world.

Major Constraints

Extremely slow and inefficient institutional structures have had a disastrous effect on the quality and reach of SWM services in many regions in the developing world (Marshall and Farahbakhsh, 2013). Multiple studies on waste management in developing countries have cited financial and institutional constraints as the main reasons for inadequate disposal of waste especially where local governments are weak or underfinanced and rapid population growth continues (Zhu et al., 2008). An example of this can be seen in India where inadequate and disinterested staff as well as absence of efficient management and planning has led to gaps in waste services that can be observed throughout the country (Oteng-Ababio, 2011). According to a similar study on waste
management in Palestine, activities such as collection, storage, transportation, processing, treatment and disposal, which are the responsibility of municipalities, are not performed due to lack of organization, financial resources, complexity and system multi-dimensionality (Al-Khatib et al., 2015). In another study done in Guatemala, researchers found that the range of waste management services was limited because waste management did not constitute a major priority for policy makers and planners (Yousif and Scott, 2007). However, on a larger scale, many nations in the developing world possess policies that directly address waste management issues.

*Lack of Policy Enforcement and Responsibility*

Often it is not the environmental legislation itself that is at the heart of the problem; some developing countries have more refined legislation than developed countries. Rather, it is the lack of enforcement that is the real challenge to sustainable waste management (Al-Khatib et al., 2010). This lack of enforcement of policies and laws is a major institutional issue that greatly contributes to the mismanagement of solid waste in the developing world. An example of this can be seen in Kenya; although there is sufficient legislation covering waste management, local authorities lack the capacity to implement them (Henry et al., 2006).

Another example of how lack of enforcement can lead to the mismanagement of waste can be seen in Nigeria. In 1985 the federal government of Nigeria introduced a major initiative called “the environmental sanitation cleanup campaign.” All residents were mandated to carry out required environmental cleanups once a month. It was an impressive initiative, but due to institutional problems—namely lack of enforcement and
poor management—the initiative created even more waste problems. Waste was dumped along roads and in the outskirts of towns where many of the most impoverished lived, or citizens did not comply with the program and there was no agency to enforce the regulations. The actions continued until the program was abandoned (Ogbonna et al., 2002). A lack of clear lines of responsibility among the various stakeholders was evident in this situation. Municipalities demanded this program but then did not provide the necessary resources and services to accomplish it. Programs such as this need strong leadership and management organization in order to become sustainable and effective in these settings (Ogbonna et al., 2002). Oftentimes there is a lack of communication and dialogue among private and public stakeholders and the resource users. Local citizens are not always aware of the various operations and therefore cannot be involved in them or follow and comply with the directives.

*Lack of Monitoring and Regulation*

Most of the stakeholders, municipalities, the official waste collection companies, and households acknowledge the need for better monitoring and regulation of SWM but cite challenges at the institutional level as major barrier in overcoming these problems. One such major problem is the fact that in some locations during any change of government, all municipal office workers, even those not involved in elections, are replaced (Yousif and Scott, 2007). This presents a serious problem of continuity when trying to implement new projects that require time and planning—which is often the case for projects concerning waste management.
Interventions

When thinking about prospective interventions concerning the political and institutional aspects of waste management, one can look at four specific areas for improvement: the role of institutions, better enforcement and/or enactment of policies and regulations, privatization and decentralization of waste systems, and finally, more public involvement and cooperation in the waste management systems. These interventions have been cited by researchers as important improvement aspects of SWMS in the developing world.

Role of Institutions and Funding Management

Society’s goals and priorities regarding environmental protection and equitable service access must be clearly articulated in order to mobilize popular support and resources required for their realization (Yousif and Scott, 2007). A clear definition of jurisdiction and roles is essential. Appropriate distribution of responsibilities, authority and revenues between national, regional and local governments must be determined so that waste management programs may succeed and be effective. There needs to be a shift in the role of government institutions from service provision to regulation. Also, contribution of informal waste collection workers may be significantly improved through appropriate organizational measures. Utilizing a governance approach to solid waste planning in developing countries would entail the development and implementation of an action master plan and policies/by-laws with the participation of the community and key actors from different sectors and political parties (Yousif and Scott, 2007).
Concerning the financial aspects of waste management, there needs to be greater concern for budgeting and cost accounting, as well as capital investment, cost recovery and cost reduction. Some suggestions by the World Bank collaborative program on municipal SWM in low-income countries for financing capital investment for SWMS include local budget resources, loans from financial intermediaries and special central government loans or grants. SWMS fee collection performance is often poor (Schübel et al., 1996). Improvement can often be achieved by attaching solid waste fees to the billing for another service, such as water supply. Clear political decisions and autonomous accounting procedures are required to ensure that SWMS revenues are employed for the intended purpose. Lastly, cost reduction, “doing more with less,” is almost always the best way to improve financial sustainability.

The best way to promote efficient use and conservation of materials is to internalize the costs of waste management as far as possible in the production, distribution and consumption phases. Possible solutions to the funding problem include effective enforcement; integrating payments into the tax system based on household income; and facilitating community-based organizations’ own management of solid waste in parts of the city (Marshall and Farahbakhsh, 2013).

Enactment and Enforcement of Policy/Programs

A straightforward, transparent, unambiguous legal and regulatory framework, including functioning inspection and enforcement procedures at the national, provincial, and local levels, is essential to the proper functioning of municipal SWM strategies (Marshall and Farahbakhsh, 2013). Enacting strong and adequate legislation both from
the national and local levels to guide waste management decisions and strategies is essential (Asase et al., 2009). These policies should focus on promoting knowledge, education, skills, and empowerment of the urban poor as means of promoting their living conditions (Murad et al., 2012).

Authorities in developing countries tend to overlook the significance of waste minimization strategies, leading to situations where all “wastes” are sent to dumpsites for final disposal, which greatly increases the cost of waste management. There should be state intervention to enhance opportunities for recycling and reuse of waste materials as well as consumer awareness campaigns in cities that do not already have them (Oteng-Ababio, 2011). Municipalities can support extended producer responsibility (EPR) programs by banning the disposal or incineration of recyclable goods and products that are covered by government EPR programs.

Providing incentives to manufacturers by increasing the costs of extracting raw materials and involving them in the expense of disposing of their products is another way governments can make producers more accountable for disposal and reduce waste. Eventually, as consumers become more educated about the benefits of and need to reduce and eliminate solid waste, they will begin to demand more products made from materials that can easily be returned to manufacturers and not require disposal (O’Connell, 2011). However, these types of programs can only be successful when there is active citizen participation and proper implementation of regulations by municipalities.
Another potential solution to the mismanagement of waste programs that goes hand-in-hand with identifying the role of institutions is through the privatization or semi-privatization of waste management with government transitioning into a more regulatory role. Decentralization of responsibility for SWMS requires a corresponding distribution of powers and capacities. It normally calls for revised organizational structure (Kruljac, 2012). In many developing countries there is currently great interest in involving private companies in SWM in order to cut down on costs, and this is slowly becoming the norm in SWM (Zhu et al., 2008). The involvement of the private sector to provide waste recovery services could help generate revenue to fund some aspects of the waste management system such as an increase in resources to help better enforce waste policies.

In a study conducted in Kumasi, Ghana, privatization was looked at as a promising solution to the mounting institutional constraints concerning waste management seen in the city. As the private sector gets involved in the collection of waste, waste diversion programs could be explored in collaborations with the informal sector involved in waste recycling in the city. However, the researchers in the Kumasi study state that private sector involvement in the development of waste diversion in Kumasi could be more effective if the environment created is competitive and there is a way to monitor performance and provide accountability (Asase et al., 2009). Therefore, three key components of successful arrangements with the private sector are competition, transparency, and accountability.

To achieve an optimal handling system, solid waste should be classified and separated. This can be done by enhancing the cooperation between the public and private
sectors, supporting cost recovery systems, establishing city organization plans, and making handling and collecting systems flexible (Mrayyan and Hamdi, 2006). With more effective institutional governance the private sector could probably provide further developments in the solid waste system.

Private-public partnerships need a few conditions to be successful. These include:

1) A positive culture that encourages leadership and citizen participation and is related to the long-term development concerns of a community,
2) a realistic commonly accepted vision among the public, private and community members that is based on the area’s strengths and weaknesses, as well as a good understanding of the potential for the community,
3) a participatory ethic in concerned organizations (such as NGOs) that can blend the self-interests of the private sector, with the broader interests of the community, and
4) continuity of policy, with the ability to adapt to changing circumstances while at the same time reducing uncertainty for businesses and individuals who can take economic risks (Kruljac, 2012).

Public Involvement

Adequate public participation involves the stakeholders from the beginning and provides a creative forum for the public to discuss issues, identify key actors, generate possible solutions and alternatives, implement part of the selected solutions and participate in the monitoring and evaluation of solutions (Yousif and Scott, 2007).

The literature mentions repeatedly the issue of stakeholder involvement and collaboration as a way to improve the various aspects of SWMS. Thus, this research recognizes stakeholder involvement as an overarching theme essential to sustainable and
effective SWM in the developing world. Communities should be involved in making decisions concerning waste management strategies. There should be a method of communicating waste management system performance and proposed strategies with the community in order to get feedback and support from the community (Asase et al., 2009).

**Conclusions**

Diaz (as cited in Troschinetz and Mihelcic, 2009), focusing on Latin America, encourages attention to the following non-technological issues with respect to SWMS: national policy, institutional capacity, regulatory activity, personnel education, and financial stability. Any substantial change in SWM is not possible without close cooperation between government, the private sector, and citizens. The financial support of the central government, the interest of the municipal leaders in waste management issues, the participation of service users and the proper administration of funds are essential for a modernized sustainable waste system. Also, economic evaluation constitutes an important input to strategic planning and investment programming for SWMS.

An excellent example of successful implementation of some of these institutional improvements can be seen in Curitiba, Brazil (Kruljac, 2012). Waste managers in Curitiba take into account operation strategies, monitoring, and institutional controls when implementing waste management systems. Their program heavily focuses on integrated public-private partnerships and deliberative democracy approaches in order to achieve sustainability within the SWM sector. The presence of political commitment, organizational capabilities and policy consistency at the local level facilitates Curitiba’s
success (Kruljac, 2012). Formulated in a comprehensive SWM plan, Curitiba has devised innovative solutions—such as a prioritized recycling campaign and refuse collection programs—for dealing with the municipal solid waste problem.

Integrated Solid Waste Management Systems

There is a growing understanding among local authorities of developing countries of the negative impacts that wastes can have on the local environment and human health. Local authorities also realize that the ever-increasing complexity, costs, and coordination for waste management requires the involvement of all stakeholders at every stage of the waste management process as well as the consideration of multiple dimensions in the decision-making concerning SWM. The World Bank estimates that in developing countries, it is common for municipalities to spend 20 to 50 percent of their available budget on SWM. However, services cover only about 40 to 70 percent of all urban solid waste, with the remainder being uncollected and less than 50 percent of the population being served (UNEP, n.d.). There is a clear need for strategies to redesign conventional waste generation systems in such a way that municipalities can effectively and efficiently handle the growing and changing amounts of waste.

Complexity and Multi-Dimensionality

The management of solid waste in the setting of developing countries is a complex problem with multiple dimensions and challenges. So an equally complex and multi-dimensional approach is needed to combat this ever-growing waste problem. Effective governance of solid waste requires integration of four components: environmental, economic, social and governmental/administrative dimensions. One of the
most widely cited and supported solutions that cover all of these dimensions can be found in the concept of integrated solid waste management system (ISWMS). This could prove to be the most effective and sustainable option for developing nations to deal with the mismanagement of waste systems within their borders.

SWM is a multi-dimensional issue: effective systems are not only based in technological solutions but also environmental, socio-cultural, legal, institutional and economic linkages that should be present to enable the overall system to function (Oteng-Ababio, 2011). The ISWMS model is a model that allows studies of complex and multi-dimensional systems in an integrated way. The model acknowledges the importance of multiple dimensions when analyzing, developing or changing a waste management system (see Figure 2).

ISWMS entails the selection and application of suitable techniques, technologies and management programs to achieve specific goals and objectives including environmental and health regulations, economic reliability, and social acceptability (Oteng-Ababio, 2011). It takes into account local conditions and the selection of a proper mix of alternatives and technologies to meet changing local challenges without compromising on legislative demands. The decision making process is informed by environmental, economic, and social considerations. In order to protect the environment and society, SWM requires multifaceted methods of handling and disposal, tailored to each community’s needs.

The ISWMS can be adopted as a sustainable approach to SWM in any region in the world. It can be applied in both developed and developing countries. It is perceived by many researchers that adopting a strategic framework based on the principles of
Figure 2. Integrated Solid Waste Management Model. Adapted from Marshall and Farahbakhsh (2013).

ISWMS with a strong political and social will, can transform the current waste management in any city in the developing world. Lessons can be drawn from experiences in developed countries to guide developing countries as they seek to improve on existing SWMS systems, since waste management systems have evolved through many steps over the years in developed countries (Asase et al., 2009).

The concept of ISWMS according to McDougall et al. (as cited in Asase et al., 2009) takes an overall approach and manages waste in an environmentally effective, economically affordable and socially acceptable way. It involves the use of a range of different treatment options at a local level and considers the entire solid waste stream. To address the mounting global waste management challenges many communities and
governments in the developing world have focused on countries have focused on implementing a variety of ISWMS strategies to tackle the long-term management of waste.

According to a study conducted in Zarqu City, Jordan, sustainable SWM will require an integrated and holistic approach to managing the waste in the city (Mrayyan and Hamdi, 2006). Jordan is in need of appropriate management techniques to successfully address issues such as regulatory work and advocacy for stable long-term financial incentives, enforcement of pollution control recommendations and environmental awareness among Jordanian decision-makers, as well as to promote the utility scale investment in the public and private sectors. Finally, researchers recommend a holistic program integrating all the technical, economic, cultural, social, and psychological factors that are often ignored in solid waste programs in Jordan.

In another study conducted in Nigeria, researchers found that an integrated approach to litter prevention that combines empowerment, cognitive, social, and technical solutions is the most effective tool for tackling the litter problem among residents in the country (Ojedokun, 2011). In Palestine, there is an urgent need to develop a framework or strategy that encompasses the full range of inter-relationships between municipalities and village councils and their litter management responsibilities (Al-Khatib et al., 2009). An ISWMS program seems to be a good fit in each of these situations.
**Continuity and Integration**

When thinking about ISWMS one must also think about a continuous improvement strategy. This is important because countries and their waste needs are constantly changing and developing, and new integrated approaches will undoubtedly become necessary to keep up with the changes in these nations. This concept of continuous improvement strategies involves annual establishment of community needs and priorities, monitoring of the existing and other waste management systems, implementation and assessment of approved initiatives, and utilization of various methods of communicating results. Two major elements of continuous improvement are the establishment of annual and short-term goals and systematic frameworks for evaluating system performance (environmental and economic). Annual and short-term system goals include: minimizing the production of garbage, minimizing the environmental burden of the overall system, minimizing costs to taxpayers and maximizing opportunities for new business (Asase et al., 2009).

ISWMS also focuses on the integration of the many interconnected processes and entities that make up a waste management system. To reduce environmental impacts and drive costs down, a system should be integrated throughout the entire waste management process, market oriented (looking at energy recovery) and flexible, allowing for continual improvement (as cited in Asase et al., 2009). ISWMS are tailored to specific community goals by incorporating stakeholders’ perspectives and needs in the local context.

The issues of public acceptance, changing value systems, public participation in planning and implementation stages, and changes in waste behavior are equally as important as the technical and economic aspects of waste management (Marshall and
Effective waste management must be fully embraced by local authorities and the public sphere, and must include all stakeholders in the entire waste management decision-making process. Key elements to the success of these integrated programs are public participation and empowerment, decision transparency, networking, cooperation and collective action, communication, and accessibility of information (Marshall and Farahbakhsh, 2013).

Essentially ISWMS implies that decisions on waste handling should take into account economic, environmental, social and institutional dimensions. Economic aspects may include the costs and benefits of implementation, the available municipal budgets for waste management, and the spin-off effects for other sectors in the economy in terms of investments. The environmental dimension may consist of local problems (e.g., increased risk of disease or drinking water pollution), regional problems (e.g., resource depletion), and global problems (e.g., global warming). Social aspects include employment effects for both the formal and the informal sector, impact on human health and ethical issues. The institutional dimension of ISWMS aims to develop a system, which effectively involves the main stakeholders in waste management (Van Beukering et al., 1999).

In ISWMS, waste prevention is given the highest priority. The hierarchy continues with reuse, recycling and composting, and waste to energy or recovering energy before disposal. Then there is treatment such as compaction or chemical treatment and last on the list is dumping waste into sanitary landfills (Milea, 2009; see Figure 3). As one can see, the methods of open dumping and incineration are not seen as viable methods for waste management under the ISWMS. While a generally agreed upon ISWMS hierarchy exists, the selection of management methods should be based on the
needs and means of the local government, as well as environmental regulations and national, regional and local policies, and the availability of markets for compost, recyclables and electricity. Each community must decide which waste management method is best based on its unique environmental needs, economic situation and public policies.

Additionally, no single process or technology can handle all of a community’s waste; therefore, a number of integrated methods for effective waste management should be considered. Initiatives from one city cannot always be exported to another and be expected to work as the local volume and composition of waste, infrastructure, economic
resources, climate and cultural traditions and social norms can vary significantly. In addition, economic considerations must be evaluated to identify the most appropriate solutions. Overall, an ISWMS approach appears to be the most effective and sustainable option in handling the mounting solid waste issues of the developing world. However, this approach takes great planning and restructuring in order to achieve its goals, and developing countries need to understand all the dimensions associated with waste management and how these can be effectively incorporated into their own countries’ needs.
APPLICATION AND DISCUSSION

When it comes to applying the knowledge and information presented in the literature review to a country such as Peru, the following considerations must be addressed: 1) cultural; 2) infrastructural; and 3) policy or institutional. In the following sections I will look at the overall study area of Peru and Peru’s current waste management situation. Next I will present my initial experiences concerning SWM in Peru. Lastly, I will present recommendations for sustainable solid waste systems and propose a potential study design that could be implemented in Peru as a first step.

Study Area

Description of Peru

The Republic of Peru is located in western South America (see Figure 4). It is bordered in the north by Ecuador and Colombia, in the east by Brazil, in the southeast by Bolivia, in the south by Chile, and in the west by the Pacific Ocean. Peru is known for its extreme biodiversity with habitats ranging from the arid plains of the Pacific coastal region in the west, to the peaks of the Andes Mountains that extend from the North to the Southeast of the country, and to the tropical Amazon rainforest in the east including the Amazon River (SERNANP, n.d.).

Peru has been home to many ancient cultures including the famed Incan Empire, which was one of the largest civilizations in Pre-Columbian America. During the 16th century the Spanish conquered the region and remained in control of the area until 1821 when Peru gained its independence. Since independence, the country has undergone several changes in government from oligarchic to democratic systems. Peru has also gone
through periods of political unrest and internal conflict, as well as periods of stability and economic upswing.

Today Peru is a representative democracy. It is divided into 25 regions or departments (see Figure 5). It is still considered a developing country with a poverty rate of about 26 percent. Despite the high poverty rate, Peru has a growing economy (INEI, 2013). Its main economic activities include mining, manufacturing, agriculture and fishing. The population consists of about 30.4 million people and the population is growing. Peruvians are admired for their strong cultural traditions in hospitality, dance,
art, and music as well as their family-centric approach to life. Peru is a multiethnic country with a mixture of Indigenous, European, African, and Asian populations. Spanish is the official language but there are many native languages including Quechua, which is spoken by a majority of the inhabitants in the Andes Mountains. This mixture of diverse traditions has created a rich culture that millions of tourists experience (INEI, 2013).

**Current SWMS in Peru**

Over 20,000 tons of solid waste are produced every day in Peru, most of which is dumped in waterways or informal trash heaps, making SWM an area of increasing concern for the country (IPA, 2014). Two changes in the flow of solid waste have
occurred over the last few decades: 1) the volume of waste generated by residential households has significantly increased; and 2) the composition of waste has changed from primarily organic material to a mix of synthetic and organic matter (Yousif and Scott, 2007). The increase in volume and change in composition are attributed to the following factors (Yousif and Scott, 2007): 1) Rapid population growth and economic expansion (meaning more people to create waste and more money to buy products that will become waste); 2) lack of infrastructure to deal with the growth; 3) limited funding for planning and proper operation; 4) lack of a legal framework and political will for implementation and enforcement; 5) lack of community participation; and 6) simply the lack of knowledge and skills to deal with or prevent such problems. From research and my firsthand observations, cultural, infrastructural, and policy or institutional aspects seem to play significant roles in the mismanagement of solid waste in Peru. These factors were also highlighted by many scholars in the previous literature review.

After conducting interviews and attending community meetings as part of my Peace Corps assignment in rural Peru (described below), I became aware that there was a general lack of awareness and education among the local people in my communities when it came to SWM (see Appendix, pp. 78-80). Many people cited trash accumulation as one of the major problems in the community, but they did not appear to understand their role in the problem. Waste management involves a large number of different stakeholders who all play a role in problem solving. Despite this, it seemed as though the local people I encountered viewed trash accumulation as a problem that local government needed to deal with. Community members need to share in the responsibility of waste management practices and their actions should align with their attitudes.
In terms of SWM infrastructure, one of the weakest points of Peru’s situation is the lack of landfills. As of early 2014 (when I collected my observations), only eight landfills existed, with three in and around the capital city of Lima. The rate of waste disposal in these landfills is estimated at only 30 percent of the flow. The remaining 70 percent is disposed in the environment (Beveridge and Diamond Law, 2011). From my observations in my host community of La Zaranda there were rarely trashcans or recycling programs. Also, waste management services were inconsistent. Often families resorted to dumping waste in the streets or burning it in pits in the yards of their homes.

With regard to the political and institutional aspects of SWM in Peru, the General Office of Environmental Health (or DIGESA as the Spanish acronym) is the national organization in charge of regulating, supervising, evaluating, and coordinating waste flow with regional governments. This organization is also charged with promotion of environmental protection, sanitation, food safety, and environmental health.

Traditionally, municipalities have been in charge of providing SWM in Latin America at the local level. The municipal responsibility is to organize and manage the local public sanitation system, including providing infrastructure for the collection, transportation, treatment, and disposal of waste (Hoornweg and Giannelli, 2007).

Only a few countries in Latin America have explicit environmental policies, with the topic of solid waste usually included in some fashion. The environmental policy for Peru—stated as General Law on Solid Waste N° 27314—was enacted in 2000. It puts the emphasis on waste production minimization, waste reuse, and minimization of environmental impacts and risks. Over the past decade Peru has had a Comprehensive Solid Waste Management National Plan (PAHO, n.d.). The most important challenge of
the current legislation is to ensure coverage and quality of service, with municipalities incorporating and integrating sustainable methods of waste management, including waste minimization, recycling, and composting initiatives.

Currently, Peru’s Congress is considering a bill to amend its waste law to better define the role of regional governments in the provision of waste management services. This bill would require regional governments to provide technical support to the municipalities, with a goal of improving waste-management services. Regional governments would be required to: 1) develop a regional plan for environmental management of solid waste (in coordination with the municipalities under their jurisdiction); 2) exercise oversight over the provision of waste management services within their jurisdiction; and 3) promote local private investment in the provision of waste-management services. The legislation is an attempt to address the lack of adequate sanitation services, particularly in the smaller municipalities (Beveridge and Diamond Law, 2011).

**Initial Experiences Concerning Solid-Waste Management in Peru**

The U.S. Peace Corps in Peru appointed me as a volunteer dealing with environmental issues. I had three main areas of service: 1) SWM; 2) reforestation; and 3) environmental education. I was sent to start my service in the Department of Lambayeque, located on the northwest coast of Peru. My host site was a very small community that is home to less than 1,300 people called La Zaranda (see Figure 6). La Zaranda is situated in Pitipo District, with a population of 20,000. The district is in the Province of Ferreñafe. La Zaranda is a town like many others in rural Peru where the
houses are made of adobe (a mud and straw mixture), indoor plumbing is rare, and domesticated animals outnumber the people. Each family owns their own “chacra” or farm. Livestock are raised for subsistence purposes or to sell for income. La Zaranda has one road through the community. The only automobiles passing through were various forms of public transportation. It is a remarkable, close-knit community where everyone knows each other and where a “gringa” (e.g., female Caucasian) such as me stood out, but was always welcome.

The first few months I spent on-site was a very enlightening time. I spent much of this period simply getting to know my community and experiencing local culture and traditions while compiling information for my community diagnostic report (see Appendix pp. 81-91). Through these observations I gained a solid foundation from which to start my volunteer work and establish my relationship with the community. I began to teach English and environmental education at the local schools and built viveros (tree nurseries) in several locations. I also had the opportunity to work with the National Park...
Service of Peru (e.g., El Servicio Nacional de Áreas Naturales Protegidas por el Estado or SERNANP). In this effort I worked in the local protected dry forest (e.g., bosque) called the Bosque de Pomac (see Figure 7). This area is known as a Historical Sanctuary (as is the famed Machu Picchu site) due to its historical significance to the Sican culture (SERNANP, n.d.). After adjusting to the community and starting my work, I began to take note of things that seemed to need my help the most. One topic that emerged early on was the fact that La Zaranda lacked any apparent system to deal with solid waste.

Trash seems to be an issue in this area for two main reasons. First, littering is common and apparently socially acceptable. This results in trash being thrown into the local river or the streets. The second problem is where to put the trash. Many times there was very little established infrastructure to deal with trash, even if trash was viewed as a public problem. Both problems are interconnected and I felt needed my attention. As an environmental volunteer the Peace Corps gave me several targets to strive for concerning SWM in my area. By December 2019 the targets were: 1) that 5,400 households in my locality would be implementing solid waste-management practices; 2) 108 new or improved solid-waste management programs would be implemented; and 3) 135 schools would be implementing one or more new or improved solid-waste management programs (Shoobridge et al., 2010). Each of these targets would be achieved with the help of multiple cycles of volunteers.

Many residents in my community with whom I spoke were proud of their environment. Despite this pride, it seemed as though they did not really understand all aspects of their environment or want to help keep it clean. It was clear to me that there
was no solid-waste management plan, no standard approach for waste collection, and that public education and awareness was limited. This made dealing with this complex issue that much harder.

As Peru becomes more modernized and developed, the nation is taking more and more strides toward a sustainable SWMS in general. One such example can be seen with the Ciudad Saludable program that was created in 2002 by a Peruvian NGO in Cerro el Pino, Lima (WHA, 2010). One of the major problems in this locale was that there were no waste collection services, despite about 13 tons of solid waste being generated daily. The waste was simply thrown into open dumps, resulting in negative environmental and health consequences. Also the terrain of the locale made accessibility to waste sites difficult for the local municipality (WHA, 2010).

The Ciudad Saludable project trigged the creation of micro-enterprises and income generation opportunities for waste collectors and recyclers (WHA, 2010) (see Figure 8). It innovatively used motorbikes as a means to access remote dumping sites. A
major objective of the program is to get the population, including local school children, to take part in changing the mentality of the residents by transferring the knowledge of rights and duties in the maintenance of a clean environment from the municipality to the community.

Residents have also been involved in the implementation and development of all project activities, including focus group discussions to address issues of environmental awareness, participation in cleaning campaigns and service payments, and separation of organic from inorganic waste at their homes (WHA, 2010). Other key components of this program have included (Lumbreras Martín and Fernández García, 2014): 1) strengthening social networks and establishing a committee for local environmental management; 2) establishing a micro-enterprise within the community with a non-conventional system of solid waste collection via people on the motorbikes; 3) creating
jobs for locals; 4) implementing recycling programs; 5) organizing a door-to-door collection of payments according to preference and financial possibilities for each family; and 6) raising public awareness of environmental and health issues.

Overall, it has significantly improved the quality of life of residents. It has also proved to be a tool of empowerment for local residents, which has resulted in behavior changes and habits concerning reducing, reusing, and recycling (Lumbreras Martín and Fernández García, 2014). Programs such as the Ciudad Saludable help to address the complexity of waste management in the developing world and empower the community to make sustainable strides to addressing their waste issues. Many of the components of this program can be adapted to any situation in the developing world, creating more sustainable and effective waste management programs. The following section discusses my recommendations for SWM in Peru and proposes a study design that could be implemented.

**Recommendations and a Proposed Study Design**

After reviewing the current research on the factors that contribute to the mismanagement of solid waste in the developing world and prospective interventions that waste managers may undertake, I believe a modified ISWMS would be the best waste management option to implement in a situation as I encountered in Peru. This type of system takes into account social, political, economic, institutional, financial, and environmental aspects when making SWM decisions, and these are all deemed important by Oteng-Ababio (2011).
More effective environmental governance is required to reverse the effects of poor waste-management planning. Such a strategy includes government collaboration with key stakeholders and sharing of responsibilities and information. However, better SWM services in Peru and the rest of Latin America will depend on municipalities strengthening their role. While municipalities are generally responsible for all matters relating to urban solid waste, those in Latin America tend to focus almost exclusively on collecting waste, cleaning streets and public spaces, and ensuring proper waste disposal (Hoornweg and Giannelli, 2007). Their roles need to go beyond this, namely in the form of integrating waste management in a more comprehensive fashion.

My proposed study design would incorporate this knowledge, as well as the information collected in my literature review in the creation of a qualitative and quantitative analysis of SWM within target communities. Ideally, when conducting this study I am assuming I would have ample funding from a donor agency. In this study I would set up two to three pairs of small towns, each having a population of about 5,000 people. In each pair one town would serve as a control where no changes would be implemented. In the other town I would implement a modified ISWMS as a treatment, with details noted below. In total there would be three control towns and three intervention towns. These pairs would be located in several regions—from the coast to the mountains and the jungle lowlands to capture a wide degree of cultural and ecological diversity.

The treatment ISWMS package would include a comprehensive waste prevention, recycling, composting, and disposal system taking into account social, economic, political, institutional, and environmental aspects. The modified ISWMS would take into
account local needs and conditions and then the most appropriate management techniques would be included in the treatment package. The study design could also be informed by citizen stakeholders using focus group methods. Public participation is vital.

Two major components the treatments would include are improvements in the trash-disposal infrastructure and public education. These would directly address the over-reaching theme of public engagement and participation that is needed in order to make any of these changes successful. The infrastructure would include trashcans and recycling bins. Each of the treatment communities would also receive a means of transporting waste; this might be a wagon pulled by animal power or a small truck—whichever is more sustainable. The treatment infrastructure would also include a certified landfill within a reasonable distance of these communities to allow for proper disposal of solid waste; the project would pay for the excavation.

An education and awareness-raising program would be implemented among children and adults. Environmental education would be offered at the local school by trained volunteers and teachers in conjunction with the curriculum. In addition, monthly fieldtrips to local locations of environmental significance will be arranged for all interested parties for further opportunities for informal education. These trips would be funded by recycling buy-back money and donations (see below). Weekly seminars could be provided to build environmental knowledge and skills. For example, one week we could teach composting and then give demonstrations as to how to create and manage a compost pile. Another example would be how to establish a community tree nursery using compost as a soil amendment. All seminars would add to the environmental
knowledge base of the community and promote more pro-environmental behaviors that transcend simple waste management.

The ISWMS activities could provide economic opportunities for the community. For example, this research design could integrate pilot employment projects for some locals. Some may have access to their own transportation, with employment opportunities in the collection and transportation of waste to the landfill. Each landfill would need trained workers to manage them. Funds to support a minimum sized staff might come from a national source related to improved environmental management.

Another economic opportunity could include implementation of recycling buy-back programs. Each month buy-back events could be held and community members could come and sell their recyclables for money. In turn, these materials would either be reused by the town or transported to the nearest major city to be sold to larger recycling plants. The money received from this endeavor could be donated back to the community to fund related activities. This modified ISWMS could include not only economic incentives—such as buy-backs—but also penalties including fines for littering that could be enforced by the municipality with the cooperation of various community groups.

As mentioned in previous sections, creating an environment where public participation and engagement is intertwined with the entire waste management process allows for a more effective and sustainable system. This study design would strive for: decision transparency; networking; cooperation; communication; collective action; and accessibility of information throughout the waste management decision-making process. Giving all stakeholders involved the opportunity to contribute to this process creates a
citizenry that is empowered and takes responsibility not only for their decisions but also their actions.

To start the study, I would first need to collect some initial baseline data and information from each of the paired communities. It would be good to establish that each community is indeed similar with respect to waste production and management at the start. One of the first steps could be having my graduate students walk perhaps a half dozen transects in each town and the associated locale. They could systematically take photos and randomly sample areas of a specified size by counting and categorizing the trash they observed. After the ISWMS plan is initiated for at least a year, the data collection would be repeated in an endline fashion with the goal to see if each pair of communities differed with respect to waste generation and occurrence. Baseline and endline data would be compared.

Another type of baseline data that could be collected would include interviews with a sample of households in each community. With a town of about 5,000, there may be about 1,000 households (assuming an average household size of five). At least 30 households would be a good sample size for each community. To get a random sample I would get an alphabetized list of all families in each town from the local municipality, and then I would use a random-number generator pick the households to interview. I would develop a survey questionnaire for data collection. The initial interviews of community members would inform me of the prevailing attitudes, behaviors, knowledge, and changes people wanted or hoped to see in their communities as related to solid-waste management. It would also be an opportunity to estimate the daily production of solid waste and what was done with it. The same households would be interviewed again at the
completion of the study period to determine if any of the social variables had changed. Changes may not be observed immediately, but if this is to be an effective study, I believe five years (at minimum) would be necessary in order to observe if the treatment has had any affect on the community’s waste management. Further observations should be made after this time to see if these changes have been effective and sustainable.
CONCLUSIONS

In recent years, the impact of poor waste-management practices on the natural environment is finally being acknowledged and understood by many countries. Approaches for developing sustainable waste management, particularly those that integrate social, economic, and environmental systems, have received increasing attention in these countries. This paper’s contribution to the field is that it provides a condensed and accessible overview of the current research on the topic of SWM in developing countries and summarizes prospective interventions waste managers could implement to develop more sustainable SWMS.

My report identifies and discusses major types of constraints that have been found to influence solid waste systems including: 1) culture, knowledge, and microeconomics; 2) infrastructure, social provisions, and technology; 3) policy, institutions, and macroeconomics; and lastly I discussed a popular management method known as 4) ISWMS. I synthesized these key factors and the related interventions of education and incentives, policy intervention and restructuring, infrastructural updates and changes and looked how the all-encompassing approach, ISWMS, could improve solid-waste management in communities of the developing world. Understanding these factors and how they relate to one another can ultimately help clarify the current constraints present in the SWMS in developing countries.

Adequate municipal SWM is much more than a technological or infrastructural issue. It is a multi-dimensional issue that includes political/institutional, social, environmental, and financial aspects and involves coordinating and managing a large
workforce and collaborating with all stakeholders. Waste production is increasing and is compounded by a cycle of poverty, rapid population growth, decreasing standards of living, poor governance, and the low level of environmental awareness in developing countries around the world. To enhance the sustainability of SWM in developing countries, public awareness, funding, expertise, equipment and facilities, as well as other necessities that are currently lacking or inappropriate, must be provided. Furthermore, since the envisioned SWM practices call for some behavioral changes, there is a need for community participation and education and awareness programs on related issues.

The waste management regime in developing countries is seldom integrated, and there is often no clear assignment of responsibilities for tasks and schedules among the organizations involved. There is often no umbrella organization to coordinate overlapping responsibilities for waste management that involve more than one agency. This situation not only hinders the effective implementation of waste management operations, but also produces confusion in relation to technical cooperation and the development of projects among stakeholders.

Along with these organizational and operational problems, the lack of an effective policy enforcement system and technical standards represents a major constraint. The overall lack of environmental awareness and education of the public and policy-makers about the topic of waste management only perpetuates these unsustainable waste management systems. Communities will need to embrace a strong participatory, contextually integrated, complex, but adaptive SWMS if real progress is to be made in the SWM practices of the developing world.
REFERENCES


Solid Waste Management Interview for Community Members

Basic Information

1. Community? 

2. Age? 

3. State? 

4. Sex? 

5. How many people live in your home? 

6. What level of education you have completed?
   a. No education
   b. Incomplete primary
   c. Complete primary
   d. Incomplete secondary
   e. Secondary complete
   f. Technical
   g. Top

7. What is your main occupation? 

8. You involved in any community organization? Yes__ No__
   What?
Solid Waste

1. What kind of trash is more at home? ________________________________

2. What you do with the trash?
   a. Use the dump collector  b. Burning  c. Bury

   Why?
   _______________________________________________________________________

3. Ever separate their trash for recycling? Yes_____ No_____

4. You think there's a problem with trash in the community? Yes_____ No_____

   What kind?
   _______________________________________________________________________

   Because it's a problem?
   _______________________________________________________________________

Reforestation

1. You have planted trees on their property in the past? Yes_____ No_____

   What type of trees?
   _______________________________________________________________________
2. Interested in planting trees on your property? Yes____ No____

Why? ________________________________________________________________

3. You have planted trees in the SHBP or collected seeds for reforestation project in the
   SHBP? Yes____ No____

4. Interested in planting trees in the SHBP or collect seeds for reforestation project?
   Yes____ No____

5. What are some of the benefits that trees give us? __________________________
   __________________________
   __________________________

Other Topics

1. Has knowledge of organic fertilizer or compost? Yes____ No____

2. Would be interested in learning to compost or compost? _________

3. Interested in making a bio-garden on your property? Yes____ No____

4. Would you have interest in attending educational lectures? Yes____ No____

About what topics? ___________________________________________________
                     ___________________________________________________
Executive Summary

This document is a summary of the activities that the Peace Corps volunteer Jessica McAllister conducted while in the Town Center of La Zaranda, in the district of Pitipo, Lambayeque. Jessica McAllister is a voluntary environmental program and works at the Community Environmental Management Peace Corps Peru. Jessica arrived in La Zaranda November 23, 2014 with Twenty-Two group of volunteers to work in Peru and end their service December 9, 2015. Since her arrival at La Zaranda Jessica has been working with staff Pomac Forest Historical Sanctuary (SHBP), schools and other community organizations on projects related to the environment. Most projects focused on issues of natural resource management and reforestation, solid waste management, environmental education and renewable energy. In addition to this volunteer also worked on a number of projects not related to the environment that the community could benefit from such as English and health classes. In addition to a summary of the activities of volunteer this document also contains recommendations for future projects in the community and the SHBP, more personal reflections on time Volunteer The Shale.

Introduction

This is a community environmental assessment for La Zaranda and can be used as a source of information to the authorities and community members who are working on environmental projects. The paper includes descriptions of reforestation, solid waste management, environmental education and child projects. The information was collected by community meetings, surveys (Annex 1), interviews with officials, visits to these places, people reviews, meetings with organizations active in the area and my own observations. The intent of this approach is not to criticize La Zaranda, rather to inform and new opinions and ideas regarding the current situation.

The Peace Corps was established in 1961 by President Kennedy to promote world peace and friendship by U.S. service volunteers abroad. The Peace Corps is guided by three goals: support the people of foreign countries in making their needs for trained men and women, to promote better understanding of the U.S. in the people of foreign countries and promote a better understanding of foreign countries for the part of the people of the U.S. More than 178,000 American volunteers have served in 138 countries since 1961. Volunteer living in La Zaranda (by Jessica McAllister) is part of Community Environmental Management Program-Peru Peace Corps. This program also has 3 goals: to raise awareness of environmental issues and conduct environmental activities and educational programs with Peruvian communities, support the Peruvian communities with practical implementation of sustainable management of natural resources including
planting trees and supporting communities with the practical implementation of sustainable management solid waste.

Background

La Zaranda is an annex of Pitipo located in the buffer zone of the Forest Historic Sanctuary Pomac (SHBP). La Zaranda is divided into four parts: La Zaranda, Los Aguilares, Huaca Partida and The Curve. Because La Zaranda is so close to SHBP villagers have a good understanding on the environment and why it is important to take care more than other communities in Peru.

The Sanctuary Pomac Forest Historical Sanctuary is set the first of June 2001 to preserve the cultural landscape unit that forms the Equatorial Pacific Dry Forest and Sican archaeological complex with extraordinary historic and tourist potential for the development of the region and the country. The sanctuary covers an area of approximately 5887 hectares. This area accounts for 0.41% of the area of the department. Its average altitude is 80 meters above sea level and the highest point of 300 m corresponds to the peak of Cerro Gigante in the hills of Las Salinas in southwestern sanctuary. The management of this protected natural area is the responsibility of the National Service of Protected Natural Areas (SERNANP), part of the Ministry of Environment, which was the National Institute of Natural Resources (INRENA) before.

The Sanctuary is within the ecoregion called dry forest in northwestern Peru. This is part of the Tumbesian region is also called the Equatorial Pacific Dry Forest. These forests are isolated from other areas of dry forest and bordering the Pacific, the Andes mountains, the humid coastal deserts and Choco. Strong El Nino phenomena cause heavy rainy seasons that mark regenerative cycles of the forest. Most of the forests in the region Tumbesina were destroyed over the past century. As a result of the development of road infrastructure, allowing uncontrolled extraction of wood, overgrazing, and the use of wood for agriculture, 92-95% of the original forest was destroyed. The SHBP is part of the 5-8% of the intact of its kind in the world dry forest.

Reforestation

There is a great opportunity to capitalize on the interest the community has in the issue of the environment with respect to reforestation. Most of the people I interviewed told me that they are interested in planting trees in the SHBP. Also, most people told me they are interested in planting trees on their properties. A large percentage of people in la Zaranda has worked in reforestation projects in the past and are participating right now. The Environmentalist Association La Zaranda rangers and volunteers are doing projects in the area sowing seeds of recovery in the SHBP.

The largest reforestation project being undertaken in the area is in the SHBP. Ten years ago there was an invasion of SHBP where a group of people entered the sanctuary to farms and communities. In January 2009, the occupants of the villages within the SHBP
had been removed, but they deforested hectares more or less 1700, nearly a quarter of the forest within the sanctuary. The communities in the buffer zone recognize the importance of the sanctuary and the forest and have over 350 volunteer rangers seven communities including La Zaranda Pomac III, Huaca Rivera Eye Torro and Las Salinas. SERNANP is in the process of making programs in other communities in the buffer zone as Sapame. Volunteers receive benefits rangers protect the forest and to support projects in the SHBP. These projects include planting trees, cleaning and rounds to protect the forest. Benefits include permission to graze their animals in the SHBP, food, the ability to collect firewood in the forest fall and they also get preference for jobs when no money to pay workers. Also volunteer rangers are responsible for maintaining tree nurseries for the reforestation project within the sanctuary. There are nurseries Huaca Rivera Eye Toro, Huaca Partida and Las Salinas.

In addition to the project in the SHBP, there are places in the buffer zone where they can carry out reforestation projects. One example is the elementary school that has 5 hectares of deforested forest. Another place where you can plant more trees is in the chakras. Most people told me that they are interested in planting fruit trees on their property. And in many places there is space inside La Zaranda to plant decorative trees to benefit the community.

Recommendations

When asked about what benefits give us the trees, the most common responses were "clean air, provide fruit for animals and carob to sell." These things are right and good but the trees do much more than this and we can also use trees in many more ways. For example, in addition to cleaning the air, the trees provide habitats for other wildlife, they cool the planet and stop desertification. These are things that trees do for the environment in general, but also trees give more practical benefits in their lives. They can plant trees in and around their fields to add nutrients to the soil in order to have better crops. Also, they can use the trees to make a living to protect their plants and animals to control their surrounding. There are many benefits that trees can provide us. So it is important that we protect forests and forest planting in deforested. This included not only the SHBP, but reforestation projects with decorative trees to beautify the villages, planting fruit trees and trees beneficial (as Tara adding nitrogen in the soil) in the chakras.

It is important that there is a nursery in the Interpretation Centre. Most tourists come to the sanctuary for the Curve, but no information about the reforestation project and the ecosystem in the sanctuary. There is an opportunity to communicate why this ecosystem is important and also to win support for the movement by nature. A nursery in the interpretive center with an exhibition that gives information on the importance of forests and ecosystem, and why it is important to take care of. This nursery also can provide information about the benefits that trees provide. In addition to reforestation projects in the SHBP may use this nursery to support reforestation projects in the buffer zone that is very important for forest health.
To maintain a healthy forest is important to have a buffer zone also healthy. So we need to have reforestation projects in private areas and public places in the buffer zone in addition to the project within the sanctuary. A good opportunity would be to nurseries in schools in the buffer zone. Nurseries in schools will give students first-hand experience with nature and the importance of protecting the forest.

Almost all villagers expressed interest in planting trees on their property. Most people want some want fruit trees and decorative trees and native trees also. That's all good, but there are native trees that can give benefit to their pastors and their plots. A living fence is a good example of how a tree can improve their pastors and tara tree like that can give nitrogen to the soil can improve the plants in their gardens. There are many different benefits of trees, the most important part is that we plant trees to have a healthy environment.

**Solid Waste Management**

The solid waste management is one aspect of La Zaranda that needs more attention. This is an aspect of the environment is very important. The effects of solid waste can have on the environment are huge and serious. As part of the solid waste environment have an effect on humans too. There are toxic solid waste that pollute the soil, water, air and human, especially when they burn trash. According to surveys, most families burn garbage because they believe it is better to have a burning pile of trash in the street or because the garbage is dirty and can contaminate soil and cause disease. This means that families know that litter is a problem and are aware of some of the problems associated with solid waste. The problem is how we are handling solid waste.

When the trash is burned, especially plastics, the process of burning chemical changes in the plastics to a toxin called dioxin. These dioxins are very dangerous at low levels, cause cancer and reproductive disorders in adults and development in childhood. Dioxins escape during burning plastic in the smoke. But it is not necessary for breathing smoke these dioxins into your body, you can also ingest dioxins through food. When the smoke dioxins passes a bush, tree or other plant (such as their farms), dioxins in the smoke are concentrated in the leaves of plants. Hence a goat or other animal will eat the leaves with dioxins. The dioxins are stored in the fat of this animal and when a person eats meat animal, also eats dioxins.

In addition to dioxins, other toxins leaving the smoke, such as sulfur dioxide, lead, mercury and chlorobenzene. These toxins cause a lot of problems with human health. These problems include: asthma, emphysema, and problems Downs, brain damage, kidney and liver, and disorders of development and reproduction. Furthermore, ash after burning Heavy metals such as lead, arsenic, mercury and chromium. These are the same toxic produced by mines. These toxins are absorbed into crops and foods we eat and toxins pollute the children if they are playing where someone burned their trash.
The best alternative to burning is that the municipality collect all trash and deposit it in a landfill. A landfill is a place where you can bury solid waste, limiting pollution solid waste produced. Landfills can completely eliminate contamination that occurs with the trash. There is a national law called SGLA (Local Environmental Management System) and is part of the Municipal Environmental Commission (CAM). This law states that each municipality must have a complete system for management of solid waste. This system of management of solid waste collection and disposal need solids for each zone of the city. It is also necessary that the collection and disposal of solid waste is about health and healthy environment.

The municipality has a collector Pitipo dump for solid waste that passes through La Zaranda every Tuesday at nine o'clock. This collector gets dump solid waste into a ditch beside the road Pitipo city. The problem is that the collector dump only sometimes and only comes by the house in the center of La Zaranda.

I think the lack of the problems associated with poor management of solid waste is evident when we see that there is a program for solid waste management within the SHBP and the sanctuary also burning trash. Litter has a negative effective not only at a local level but also on a global level. The amount of waste produced and the way to eliminate waste is something that needs attention. The SHBP is a place that has the ability to teach the importance of proper management of solid waste to people visiting to learn something. In addition to learning something about ancient cultures, it is important that we take the presence of tourists to distribute information about the importance of keeping the environment and how they can do it.

Recommendations

Until we can solve the problems with the dump collector, we need to do something different with our trash. We do recommend micro-fillers. Is the concept of a landfill, but it is smaller and the level of the family. A micro-filling is simply a hole in the garbage is buried. It is important that each drive home their trash in a proper way so that the filling does not fill up very fast. When there is no more space in the hole and cover it we will plant shrubs above the micro-filler to consolidate the waste into the soil and prevent future pollution.

To limit the amount of our trash is important that people practice the concept of "reduce, reuse, and recycle." This concept can support decrease the amount of waste produced. First is "reduce," this means producing a high amount of waste possible. For example, the purchase of a large soda bottle instead of buying four personal bottles. The second is "reuse", which means we can reuse certain products and, in the event that the product is not used for its function, try giving other uses. For example, you can reuse a bottle of soda and a bottle of water after drinking all soda. The last, "recycle" means you can sell the material so that it can be converted into another product and get some profit on reuse. This will reduce the amount of waste that is produced, is good for the environment in general and is a way to make money.
Regarding the SHBP is obvious that some form of solid waste management needs exist. Inside the SHBP recommend that four containers of solid waste in the most popular places in the forest (the Millennium Tree, Mirador and Ventanas Huaca), interpretation centers and each entrance to the forest. One plastic, one glass, one for paper and board and the last organic wastes. If people do not want their garbage boots in the sanctuary needs to places where they can put their trash. Also before each entry to the forest guides should explain the importance of not throwing their trash in the woods. And this rule must be in the brochure given to visitors. Rangers can check and dump the solid waste receptacles as needed as part of a round. You must deposit the garbage collector does in SHBP tipper or do micro fillers to bury the trash.

The buffer zone is the responsibility of the municipalities. To have a healthy buffer zone SERNANP and NGOs should work with area municipalities to make obyecto Local Environmental Management System and the Municipal Environmental Commission. It is easier to work in a system that exists to make your own system. Also if the municipalities develop a system of solid waste management that can serve only a larger buffer zone population and makes a healthier environment.

Environmental Education

Because there are many government organizations and NGOs in this area, there are many environmental education workshops in the buffer zone for adults and teenagers. The most active NGOs in the area are Pronaturaleza, Aecid, Eco Center Moche Route, Oikos and Sican National Museum and the most active NGOs in the area are SERNANP and regional government. NGOs support projects within the forest, but they also support environmental education in the buffer zone. Government institutions and NGOs provide educational sessions on the environment during meetings of associations and environmental organizations in the area.

With the exception of some people, all told me they want to attend educational lectures on topics related to the environment. These include the development of organic manure, hedges, trees that can improve the soil of their plots, and other good things about solid waste management and forestry. In addition there are meetings of associations and organizations such as voluntary ranger and ecological association, NGOs and government institutions are using to distribute information about conservation. These organizations exist to provide knowledge on sustainable development with regard to the environment. In organic association they attend workshops on the dry forest can be used harmlessly. This includes issues of how to improve the production of honey and honey wine and carob. They also share information and tools that can enhance your products in a way that is good for the environment. Volunteer rangers are also an organization that cares for the environment. They work more in the sanctuary doing things like rounds and works, but the goal of the organization is to protect the environment.

Also there are courses in colleges of science, technology and environment. This course is reinforced by some NGOs working with students. Environmental NGOs teach things
such as making compost. There are also some NGOs working with the primary in La Zaranda. Sican Museum has a program to promote tourism with elementary students and some classes are on environmental issues. Peace Corps also has an environmental project team with primary SHBP performs an environmental project each month as a nursery or forest management program to make a green school.

The SHBP is working with teachers from the regional government and NGOs like Oikos and Aecid to make a master plan for environmental education in the buffer zone. This plan will include a system of informal and formal environmental education for children and adults. This plan is a must because it saves the NGOs and government agencies doing the same work many times and there is no communication between the different groups.

The SHBP has an interpretation center in La Curva giving visitors to the sanctuary one introduction to SHBP and NGO Eco Center is in the process of making a new interpretation center near the Huaca Merced by SHBP. The exhibits at the Interpretive Centre in Curve are not very good. Most of the exhibits are old and do not give a good concept that can be found on the SHBP or the importance of the sanctuary. There is little information with presentation writing malaise. The exhibition on wildlife is dark and real animals on display are not very well preserved and do not represent how animals look alive. The exhibition on birds and their nests in some respects is good. Nests are in good condition and nest information is good too. But no pictures of the birds made nests and no information on the role of birds in the ecosystem. No discussion of the ecosystem and how the forest changes between showers and dry times. The exhibition on the trees only give examples of spices and no information about the benefits of trees. The thing I think is most interesting is that this is a historic sanctuary and there is only one exhibition on the Sican culture that only has some old photos and some ceramics. Aecid The NGO plans to make an addition to the Interpretation Center in La Curva for this year to convert the room Interpretacion now exists an auditorium with a new room Interpretacion they built.

Recommendations

The first step is to connect the youth of the area and teach them the importance and how to save the forests and the environment. It is therefore very important that the schools in the area have programs on these issues. An environmental project in colleges is very easy to do and does not cost much. Ideally an environmental program in this area should include things like educational sessions on environmental issues, training on solid waste management, and nursery. This is the first step of creating an environmental and sustainable community. With the education of children and youth we can change habits and better protect the environment in the future and Protected Areas.

With regard to adult residents of the community, it is important that NGOs and government institutions give more educational sessions focusing on the importance of environmental stewardship. The best way to do this is at meetings of volunteer rangers.
and ecological associations. These people have an interest in the environment and therefore be easier to implement the changes necessary to save the environment.

To improve the environmental education of visitors to the SHBP recommend that the interpretation center Curve I get the best new shows or exhibitions there. A visitor can not learn everything about the sanctuary in a day in the forest. They can not see all the animals, huacas and beautiful places in one day. In addition, visitors may not know which is the forest during the other parts of the year. If visitors arrive in February they will see a green forest, but they do not taste as dry forest can be. Also, visitors arriving in September during dry weather will not know that the forest can be like a forest. It is the same for the culture. If a visitor does not have time to visit the museum and can not cross the river by water visitors are unfamiliar with much information. This is because it is important to have good centers interpretations. You can submit information about the sanctuary where visitors can not only receive exploring the forest. Presentations on changes between dry and rainy weather and because these times exist, the ecosystem and birds and animals and affect the forest, the more important the area and because they are important and some artifacts as interactive real skin of a ceramic or Youth can play snake or some thing that kids can craft builder.

One other suggestion I have is an exhibition about the four most important or common dry forest by Habitat Cortarrama endemic birds. This statement must have a photo of each of the four birds and information on diet, nest, some physical characteristic and because these birds are important. An exhibition of this type provide knowledge on the fauna of the dry forest and generates interest in birds and naturilla. In addition it is easier for people to identify a bird if there is a photo and information about the birds they are seeking. This exhibition will enhance the experience of people visiting the sanctuary to see the birds (bird watching) and introduce the activity to people who have no knowledge.

Guides and Crafts in the SHBP

The SHBP has the potential to be a great attraction and a major tourist spot and that the guides need to be able to relate the importance of this area to visitors of the sanctuary. Protected areas need to be leaders in the environmental movement. Part of this is the dissemination of ideas about the importance of protecting natural places and SHBP in particular. In addition, to attract tourism and making a Protected Natural Area SHBP gauge worldwide, as Manu, or Chaparrí Huascaran, the guides need the ability to speak intelligently about everything in the sanctuary. This includes wildlife, ecosystem and climate, forest management, archeology, ancient cultures of the area, knowledge of the function of other protected areas, etc.. It is also important that they can interpret information to different groups of visitors, for example children, college groups, groups that want to see birds, aliens and people who want to explore the archaeological complex.

A local guide association called APOTUR. In the past they worked with Pronaturaleza a training guide. The guides Mochic attended lectures on language, the bird sanctuary, the
Sican culture and other things. He was also a brief training of English 3-month Peace Corps. During this month the guides learned some phrases and greetings in English but they did not learn at a level that they can use the English language to interpret and guide visitors.

There are also groups of crafts in the forest. There is a group in Pomac III is learning how to make organic cotton products. This group is working with crafts Ruta Moche NGOs on how to make handicrafts. But they are still in the first steps of the process and are not selling their products in the interpretive center. There is a place where they can sell their stuff but the only group using this space are the people selling honey and mead algorrobina. There is also a project to Banzi with carob trees. A Banzi is such a small tree that can put it on a table, but it’s a mature tree that has many years and can produce fruit. There are these types of trees in other parts of the country that sold almost 60 new soles. The process for doing this type of tree is very slow and therefore is ignored if it is possible to make a carob tree Banzi.

Recommendations

Local guides are interested in learning English and they need more practice guiding too. Therefore it is important to continue the training guides in training facto guides must be continuous to produce the best possible guide who knows the most information possible. The classes must consist of skills in the English language, environmental issues and the ancient cultures of the area and guiding and steering. The guides who attend most of the classes, pass an exam and can demonstrate the ability to lead in a basic level of English, will receive a certificate of course completion. The idea is to have intelligent and charismatic guides.

There is a great opportunity to leverage the tourism handicrafts. Time people visiting the sanctuary can not buy a souvenir of your visit to the sanctuary. In addiction forest products such as honey, which is sold in the Interpretation Centre, must sell things like polos, hats, replicas of ceramics, masks and cochilos sacrifices, books, photos, calendars and craft products that communities in the Damping also made. Shop for a gift or keepsake is a major source of income for the SHBP and SERNANP and villagers in the buffer zone as well.

Management of Protected Natural Areas

The way visitors interact with the SHBP is very important. The SHBP need to have a good presentation of places in the forest to ensure that visitors have a good chance to promote tourism and to protect the forest of people visiting experience. This presentation needs to be present in every place that people visit the shrine. Presentation of places in the SHBP regards things like cleanliness and presence of garbage, ease of walking on a trail, the possibility of finding a place in the SHBP without a guide, toilets, etc.. This presentation will ensure that people visiting the SHBP have a good experience and recommend to friends and family as the SHBP is a place they should look. This is also
important to preserve the forest for the future. In addition to improving the experience of visitors with a good clean forest trails ensure that the forest is healthy in the future and the people who come to enjoy the sanctuary do not destroy the forest when they are there. This is because it is important to have good trails. No trails in good condition and people can lose most important new trails that will destroy more forest. Trails are not only a way to improve an experience, are a form of control to protect the ecosystem.

A good example of this is the Habitat of Cortarrama the other side of the road Millennium Tree. This natural exposure has the potential to be very attractive and informative with a little more attention. When I go inside this habitat the first thing I see is not a Cortarrama is toilet paper on the floor and sometimes there is a bad smell too. When a tourist visits the sanctuary to enjoy nature, they do not want to see the deposits of the previous group. Also not having an idea is a Cortarrama or because it is so important that has a habitat that can explore. In addition there is no official trail but there are many paths that people made. If you have much people in one place and they can go in any direction that they will destroy the vegetation and habitat.

On the other side of the street is the Tree Millionaire. It is one of the most impressive trees in the country. It is also one of the most popular tourist destinations in Lambayeque. Due to its high popularity is very easy to damage the tree. When enough people in one place is easier for people to have a large and negative impact on nature. There are rules that protects the tree but visitors to the SHBP not know all of these rules. For example, many times when I'm walking down this part of the forest I see people climbing the Millennium Tree. This is forbidden but if they do not have a local guide they do not know that raising the Millennium Tree is prohibited.

The last observation I have on this is the improvement of some of the other trails in the sanctuary. If a person wants to explore the sanctuary without a guide is hard to find places. Many foreign and Peruvian want to explore places by foot and they want to know where they are, know the distance between places and have a path or trail is well marked and easy to navigate. There are signs that indicate these things and there are good trails are well marked, but not all the trails are. A good example of this is the equestrian trail. This trail is very nice but if visitors have a good knowledge of the forest will not know that this path exists because there is nothing that indicates that it is an official route. And when this walking down this route there are many small trails where you can double and sometimes difficult to know which route to go to your destination. There is the same type of problem on the other parts of the forest. The path to the Mirador by road through the forest does not have signs indicating that the road is there. The Huaca de Merced has the same problem and really can not find this Huaca alone. The House of Carl Weiss has no signage but a path. If the SHBP will get more people to tourism these are the things you need to consider to protect the forest and to ensure that visitors have a good experience.
Recommendations

The problems with the Habitat Cortarrama can be solved easily. First is the problem with the toilet paper. Obviously the Millennium Tree is one of the most popular places in the SHBP and when there are enough people in one place is inevitable that some people will have to use the bathroom. You can add a latrine at the entrance to the Cortarrama Habitat to eliminate the problem. A latrine is much more health and do the most beautiful habitat. Second is the state of the path. I recommend that circulates passing through places where different bird nests trail. I recommend that this path be circular because at this time the visitors going down this path and from there back to the same parties. If people can circulate back to the entrance of habitat but see a different part of the forest. They must also be signs saying "NO PATH" by unofficial trails with branches or stones in front of unofficial trails marking the official trail.

Signaling also be used to inform people climbing the tree Millionaire is prohibited. If you signaling that says climbing the tree Millionaire banned, reduce the amount of people who do. Decrease resulted as a human damage to the Millennium Tree. In the same line of thought is not a bad idea to put a similar signaling in the Huaca of Windows that explains that it is prohibited in the area, for the same reasons and in every other place where visitors to the sanctuary can hurt things the sanctuary is caring.

Many foreign desfrutan nature by foot and if this is a group of people who would want to attract good to clean the trails a bit and mark well. It will be good to put signage at the entrance to the equestrian way to identify and be signage that says "NO PATH" by the unofficial trails with branches or stones front marking the unofficial trails equestrian trail. As in this type Cortarrama Habitat protect the forest trail of human damage. I recommend that no other signage on the street by Illimo where they can fold the Miradora, saying "Miradora (X.XX km)". More signage should be by Merced Huaca so that people can find it. You also need to clear the path to the house of Carl Weiss. It is very easy to get lost on the way to this place if you have no knowledge of the forest. There are other paths to the Temples that can be mejoraros too. There is a path to a near Huaca Pomac III that have trees growing in the middle. I think small projects like these can make a big difference in improving the experience of visitors to the SHBP also protecting the forest.

Conclusion

The Community of La Zaranda has many opportunities and challenges with respect to the environment. With more awareness and education of the people, we can overcome challenges and have a healthy, clean, and sustainable environment for the future. The environment is the source of life for all in La Zaranda and environmental awareness and some environmental efforts can ensure a better situation for the people and future generations.