Water Pollution at Thetsane Industrial Area[1]: A portrait of Attitudes, Values and Willingness to Participate in Pollution Abatement Activities♦

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ABSTRACT

This study investigates the relationship between the socio-demographic characteristics of a sample of resident households and their behaviour towards environmental problems at Thetsane Industrial (TI) area, Lesotho. Using Logistic Regression Model and Descriptive Statistics on the set of data collected from a sample of 88 households in the TI area, the paper estimates factors that influence people's decisions to participate in pollution abatement activities as well as assessing their attitudes towards environmental problems and environmental improvement programmes. The results from the paper show that in general, home-ownership and length of stay in a particular location are very important in explaining the household decision to participate in pollution abatement activity and that higher income earners and more educated individuals possess more positive attitudes toward environmental problems than those with less income and low level of education. Households that participate in environmental programmes are female headed households. The paper further shows that the absence of markets for permits, lack of property rights, and lack of law enforcement despite the presence of environmental laws as well as government institutions charged with enforcement of such laws implies continued pollution in this area. On the policy front, it is argued that it is profitable to allocate property rights to the citizens that are willing to participate in environmental projects and perhaps they would be in a better position to sue the firms for the damage they cause on people's welfare.

Keywords: Thetsane, Pollution, socio-demographic characteristics, environmental improvement,

JEL: Q00, Q53, Q58

[1]Thetsane industrial area is in urban Maseru, Lesotho where textile industrial activities are prevalent. It is also blessed with a river that traverses the area that is constantly being polluted by textile industrial waste

♦ This paper was presented at the 12th Annual African Econometrics Society Conference, 4th to 6th July 2007 at School of Economics, University of Cape Town, South Africa.

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1. INTRODUCTION

Early stages of industrial development in developing countries are usually accompanied by rising incomes and worsening environmental conditions (Todaro, 1996). In many cases, environmental harm is attributed to the activities of the industries, which tend to be predominant in most developing countries. These countries have become seriously engaged in the implementation and enforcement of environmental protection measures, Daniere and Takahashi (1999). However, empirical evidence has shown that the success of such measures is inclined to community participation more especially at local level. In Sub-Sahara Africa one of the industries that usually attract a larger proportion of foreign investors is the textile and apparel industry. This is due to trade privileges and agreements offered to African countries by various western governments. The textile sector accounts for approximately 11 % of organic industries in all Sub Sahara Africa (World Bank, 2002). The textile industry was formally introduced to Lesotho in the early 1980's, between the 1980's and the late 1990s the clothing industry in Lesotho grew. This was because of the advantage that Lesotho based clothing companies had in terms of trade agreements in the western world as signed under the Lome Convention which allow duty-free access of clothing exports into the European Union (EU) Market. It was not until the year 2000 when the African Growth Opportunity Act (AGOA) was introduced by the United States of America (USA), that Lesotho realized increasing foreign investment from Asian textile companies (DFID, 2002). All factories in the industrial garment sector in Lesotho are classified as Cut Make and Trim (CMT) factories. This means that the fabric is imported and then knitted into clothes, which are then washed/cleaned within the country, then exported. However, no proper/correct methods of waste disposal are used. After washing the finished products, the waste water is disposed untreated into nearby streams and rivers that cause a lot of pollution. [2]

In June 2003, a document called the Blue River Report was written by a group of representatives from the Water and Sewerage Authority (WASA), the National Environment Secretariat (NES) and different NGO's (AENRC, 2003). The blue river report stated that a blue effluent was being discharged into streams located next to the stonewash denim factories at the Thetsane industrial area. The stream showed no signs of support for aquatic life and the banks

[2] Pollution is defined as waste that has been disposed off in the air, water or on land and that reduces the value of those resources for alternative use (Hynman, 1992).

were steep and bare, with no vegetation at all as a result of the pollution caused by the polluting factories. Further, there were speculations that people who had illegally settled near the factories use the polluted water for domestic purposes. Gibbs and Gibbs (2002) noted that "due to the lack of grazing space residents were forced to graze their animals in land that is periodically flooded by water from this stream with the fibres from the factories building up in them."

Lesotho's National Environmental Act of 2001 calls on the Government of Lesotho to set up a national body responsible for overall coordination of environmental matters nationwide, and to put in place an enabling legal framework to facilitate this coordination to address environmental challenges. The overall goal of the national policy on environment is the attainment of sustainable livelihood and development http://www.ecs.co.sz/env_leg_lesothoenvpolicy.htm (as retrieved on 2 April 2007). At the moment the government is still in the process of formulating a department that will deal with pollution control (Ramatekoa, 2005). The environment officer of the Ministry of Tourism Environment and Culture gave this view when he explained that presently the Environment Act of 2001 was supposed to be functional in Lesotho, but due to financial difficulties there is presently no administrative body appointed to deal with pollution charges. According to this environment act production of textiles and clothing should be done in a pollution free manner. The ministry is also in the process of formulating a translated version of the Environment Act of 2001 where polluters are expected to pay for their pollution. Thus, on paper, Lesotho has a sound environmental policy as contained in the Environmental Act 2001, but lack of putting the operating structures on ground is the problem. This is expected to be functional in the next few years which will be executed by the Department of Environment, which is currently known as the Ministry of Environment Tourism and Culture (Ramatekoa, 2005).

Some corrective measures that were taken included requesting manufacturers to recycle their waste water and a penalty was suggested in case of delinquency. The penalty was vaguely that if a firm failed to recycle waste water, it would be cut from the water supply line. However, such resulted in illegal connections and more waste water pollution. The Lesotho National Environmental Act 2001 provides impetus of dealing with all environmental problems in the country. One of the basic principles and strategies for the implementation of national environmental policies is getting people involved by raising public awareness and promoting understanding of the essential linkages between environment and development. It also encourages individual and community participation to improving their lives and environment through development and other activities (Lesotho National Environmental Policies, 2001). In pursuance of this goal, this means that the community's behaviour has to be such that the community is

willing to support such projects. There are factors that may determine or influence the way in which the community or individual behaves towards the environment. These are the duration of stay in the polluted area, the level of education and the distance of their homes from the source of pollution as well as gender of household head. The behaviour will determine whether they are willing or not to improve the environmental conditions

Against this backdrop, it is important that there is need to investigate the attitudes of a cross-section of the Thesane residents on how they feel about these environmental problems and methods through which the problems could be ameliorated. Could these among other things require the participation of the community? Although greater participation of the community in environmental issues is explicitly identified as necessary for success, behaviour of local residents regarding environmental issues across the developing world is poorly understood (Danire and Takahashi, 1999). This study therefore investigated the socio-demographic characteristics of the respondents and their attitudes toward the environment in the Thetsane area. This was achieved by investigating how their socio-demographic characteristics relate to their willingness to take part and actual participation in environmental projects and also by looking at their methods of waste management other characteristics that may influence environmental behaviours.

The next section of the paper examines some relevant literatures in the area. This was followed by a methodological framework for the study, data analysis and results and discussions and implications thereof.

2. REVIEW OF LITERATURE

Externalities are defined as conditions arising from when actions of some individuals have direct effects on the welfare or utility of other individuals, none of whom have direct control over that activity (Hussen, 2000). These externalities can either be positive or negative, and in this case pollution is a negative externality; having a negative effect on the welfare of people living in the polluted area.

Economists are divided as to the causes of environmental degradation (Pearce and Turner, 1990). Some see it as mainly one of the side effects of the behaviour of a capitalist society. The creation of environmental problems is not only a struggle for survival but it is also increasingly a product of social organisation. “The ever increasing waste is part of the capitalist system” (Johnston, 1989). The nature of Capitalism requires the continued growth in the value of production and the volume of commodities consumed, this is why the problem of waste increases and failure to manage the increasing wastes lead to environmental problems. Kurian (2002) views modern science and technology as sources of both hope and despair, modern science has shaped

humanity's attempts at mastering nature, but it has also failed to address environmental problems that are mostly a result of the modern science in production. Rural-urban migration has also contributed to deterioration of environmental conditions in the urban areas across most less developed countries. This is more obvious in highly urbanised cities; the population of people residing in urban areas over the past years has grown at an increasing rate. About half of the world's population live in urban areas while in 1972 it was only one third (Global Environment Outlook, 2002).

As a way of attempting to ameliorate the problem, the literature shows various approaches that can be used. The classical and neoclassical efficient market resource allocation is often cited as a model for addressing environmental problems. This model can serve very well for problems that meet its basic assumptions. Allocative efficiency is defined as condition achieved when resources are allocated in a way that allows the maximum possible net benefit from their use. When an efficient allocation of the resources has been attained, it is impossible to increase the well-being of anyone person without harming another person Boutiaga (2000). Socially optimal levels of production can be achieved in different ways; these levels can also be referred to as allocatively efficient levels as well. It implies that resources are devoted to their socially efficient use. At an allocatively efficient point, the marginal cost are equal to the marginal benefits. If pollution increases the marginal cost of production through taxes and other penalties, less output will be produced. Hence a point of allocative efficiency will be at lower point of output as compared to when there were no pollution costs at all.

The Pigouvian tax was originally suggested by Pigou as a way of achieving a socially optimal level of production. A Pigouvian tax is a tax levied upon each unit of a polluter's output in an amount just equal to the damage it inflicts at the efficient level of output, such a tax gives the producer a private incentive to produce to efficient output (Rosen, 1985). Another way through which such a level can be achieved is through a Pigouvian subsidy, in this case the polluter is paid a certain amount of money to stop him from polluting, here polluter is subsidized for each unit he does not produce with the given level of available resources in this manner the level of pollution is lowered to a controllable level.

Another way of pollution control is through the Coasian solution of property rights assignments among the concerned parties. With proper distribution of rights, private bargaining could lead to outcomes that correct for externalities through compensation scheme. Tradable pollution rights can also be used as a way of achieving allocative efficiency. Usually the basic source of negative externalities is undefined property rights. Pollution rights can be purchased to give the right to pollute to the buyer; they allow the buyer to pollute to a certain degree. Pollution

rights are issued by the government at a fixed quantity. The rights can be traded within firms. The government can buy back the rights if there is a need to reduce pollution. Other methods include emission charges, regulation of emission standards and subsidies which are also methods of attaining allocative efficiency.

Empirical investigations have come up with a number of points of views. "Assessments of the efficiency of water pollution control allocations are usually based on abatement cost comparisons. The general rule is that efficiency is improved by reallocating abatement from sources with high marginal costs to low-cost sources" (Shortle, 1990). Parker (2004) suggests that allocative efficiency can be achieved through optimal taxation," a tax that is equal to the marginal damage cost at the optimal level of abatement could bring about the socially optimal level of abatement." Here firms have an incentive to clean up pollution as long as the costs of cleaning up are lower than the tax rate. Above this level, firms would rather pay tax and let pollution occur. This tax is found by multiplying the level of optimal emissions by the marginal damage function. As long as the tax rates are lower than the costs of cleaning up pollution, the firm will save money. A firm will clean up to the point where the cost of cleaning to a point where the marginal damage cost is equal to the tax. In this way tax has succeeded in achieving an allocatively efficient level of emissions.

Allocative efficiency plays an important role in the growth and development of investment, both local and foreign, if resources are not allocated in a way that allows the possible maximum net benefit, investment may be discouraged. Gibbs and Gibbs (2002) after conducting a study on shortages in water supply and pollution at Ha- Thetsane in the textile industries discovered that the rate at which infrastructural support was adjusting was not enough for the rate at which investment was taking place. And since there was no sustained collective action in the area of water supply and pollution, it is likely that the AGOA initiative will just perpetuate a footloose pattern of investment by an international textile industry rather than provide an opportunity for sustained investment and growth that lies at the heart of the AGOA vision.

Pollution may also have an indirect effect on a firm's performance. Shale (2005) shows that in 2004 from 39 textile manufacturing factories in Lesotho from which a sample of 10 was taken, 14% experienced decline in profits due to air pollution related illnesses. Witzch and Ambrose (1992) also conducted a study investigating whether the manufacturing processes in Lesotho were safe for people living in the surroundings of the firms. Their results suggested that the processes were not safe. Much emphasis was made on the environmental laws of Lesotho, they stated that the laws were not clearly expressed hence it becomes difficult to monitor pollution.

Danire and Takahashi (1999) conducted a study attitudes, values and behaviour on the environment in Bangkok, Thailand. The primary objective of the study was to test the explicit linkages between behaviour that improves environmental conditions and attitudes, values and socioeconomic characteristics. Data was collected through a questionnaire with close and open ended questions. The questionnaire contained questions based on socio-demographic characteristics, water and waste services, health and sanitation, cultural values and attitudes. The method of analysis used was in two steps. The first was on how individuals who practiced certain environmental behaviour differed from those who do not (in terms of socio-demographic characteristics). This was a way of determining how socio-demographic characteristics, values and attitudes interact. The second method used multinomial logistic regression to analyse the quantitative contribution of socio-demographic variables to specific behaviours. In this study individuals with high levels of education are assumed to show an environmentally positive behaviour which also involves taking measures to protecting their health through treatment of water, proper waste disposal methods and regular visiting of the doctor.

Some studies show that gender also plays a significant role in the way that one relates to the environment in the third world. According to Agrawal (1992) women's and men's relationship with nature is shaped by the specific ways in which they interact with the environment. This is explained by the fact the production process vary by class and gender, and due to the differences in division of labour, property, and power. Men and women have different experiences and hence understand the environment differently. Sen and Grown (1987) further show that in the third world, women play a crucial role as food producers, providers and managers, they are also responsible for fetching water and fuel. They are likely to be affected adversely in specific ways by environmental degradation.

According to Johnston (1989), an individual's behaviour is dependent on spatial distribution; most externalities are limited in their spatial extent, the farther one is located from the pollutant or source of the pollutant the less likely they are to be affected. This study benefited from the diversity of the literature cited here in achieving our objectives.

3. DATA AND METHODOLOGY

3.1 Sample and Sampling Procedure

Thetsane industrial area is located outside the capital city of Maseru next to the Caledon River with about 1000 households. The village is has four main sections. These are Upper Thetsane, Lower Thetsane, Matamong and Sepetlele, which have been identified as locations 1, 2, 3 and 4 respectively. In order to obtain the representative sample for the study, the stratified

sampling procedure was used. The different locations in the industrial area were classified as strata from which simple random sampling procedure was employed to obtain the needed sample[3]. Since the strata did not have an equal number of households, the sub-sample obtained from each stratum was different. From stratum 1 and 2, the sub-samples of 30 households each were selected, and another two sub-samples of 20 households each were selected from locations 3 and 4 to give a total of 100 respondent households. However, due to incomplete information on some questionnaires, only 88 questionnaires were valid and information on the valid questionnaires was used in the study.

The survey instrument used in the study contained questions on the individuals' socio-demographic characteristics. The household head responded to the questionnaire. Due to sensitivity in revelation of information, there were difficulties in obtaining exact figures from respondents, some of the variables about which data were collected have been grouped and expressed as ranges. These variables are age, average monthly expenditure, and the distance from the polluted river. This means that a certain individuals characteristics fall within a certain range and the actual values or figures of the characteristic in question are recorded as part of the respective interval.

3.2 Conceptual Framework and Model Specification[4]

The paper uses two complimentary methods of analysis. The first is the analysis of survey outcomes using descriptive statistics and the second relates to econometric framework based on dichotomous choice models. Specifically, the logistic regression model is used to determine various factors that explain the probability of individuals' willingness to participate in environmental projects as well as factors that determine the probability that they actually took part in pollution abatement activities. The use of descriptive statistics aids in giving patterns that socio-demographic variables follow in relation to individuals who behave in different ways towards the environment. This collectively helps in giving a better understanding of ways in which certain groups or classes of individuals behave towards the environment problems. The logistic regression equation used in this paper and which is based on the cumulative logistic probability function is specified as follows:

[3] Note that Stratification was based on the four sections of the village as these sections are located at different distances from the river. Distance is important here because it has implications on peoples' behaviour as shown in the literature Johnston (1989).

[4] Conceptual Framework outlining the complete model on household decision to participate in pollution abatement activity is provided in Appendix A.

$$P_i = \frac{1}{1+e^{-Z_i}} = F(Z_i) = F(\alpha + \beta X_i) \quad \text{..... (1)}$$

where Xi is a Vector of variables containing households characteristics such as household size, age of household head, sex of the head of household, gender of the household head, education attainment of the household head, tenure of stay in the given location e.t.c and household income, (Appendix A gives detailed definition of variables included in the regression model). The second logistic regression model estimated took the same format as that specifies in equation (1) however the depended variable was then defined as the probability that an individual actually participated in pollution abatement activity. This model was similarly regressed on various household socio-economic characteristics, level of income as well as household tenure in a given location and distance from the waste effluent river (the set of definition of the various variables and their values is defined in Appendix A).

The *A priori* expectations of variables included in the two regression model and shown in Appendix A are grounded on empirical evidence under review of literature. Households headed by individuals with higher levels of education and income are expected to be more willing to take part in environmental conservation as compared to those with lower levels of education and income. Persons located further from the pollutants and their sources may be expected to be less willing to participate in environmental projects if they treat it as personal, otherwise, they may still participate if they treat the environment belonging to all. The length of one's tenure in the area is also expected to have positive relationship with his or her willingness to invest in improving the environment. Finally gender of the household head is expected to have influence on the willingness to participate in projects aimed at improving the environment as well as past behaviour toward the environment with female headed households being more environmentally friendlier than males.

4. EMPERICAL RESULTS AND DISCUSSION

4.1 Descriptive /Statistical Analysis

The results of the descriptive analyses revealed the relationship between income level of household head and location of household, that is, whether a household is situated near or far from the so called "Blue River". Low income households are located closer to the "Blue River" while high income households are located farther away. This points to the fact that households farther away from the river are more likely to be sensitive to environmental problems compared to households within close proximity to the river. This situation is well highlighted by the

frequency distribution of respondents based on their income (represented by monthly expenditure) and willingness to participate in solving environmental problems. Over 80% of households with monthly expenditure of M500 or less are not willing to participate in solving environmental problems compared to over 80% of households with household expenditure of M2000 or more who are willing to participate (See Table 1, Appendix B).

Similar behaviour was also observed between the level of education of the household head and willingness to participate in pollution abatement activities. Over 80% of household heads with junior secondary education or lower were not willing to participate in solving environmental problems compared to 70% of those with high school education or better who were willing to participate in ameliorating environmental problems (see Table 2, Appendix B). However, there was no clear cut pattern of behaviour on the basis of duration of stay in the area as can be seen in Table 3, Appendix B.

Individuals who treated water and owned waste bins were found to have higher level of education as compared to others that did not show much of these environmentally positive attitudes. No discernable pattern was found in the relationship between an individual being affected by pollution and education or income. However, the closer one is located to the firms, the more he or she feels affected by the pollution. The responsibility to clean up was highly placed on the firms and the government without any recourse to income group, level of education, gender or age. Even though the responsibility was put on the government and firms, most people were still willing to participate in environmental clean up most of which possess characteristics necessary for environmental improvement.

An important observation that was made was that residents of the Thetsane Industrial Area use piped water as their primary source of water supply. Not all of them own water taps, those that do not have taps use those of their neighbours. None of the residents uses bottled water or water from the river as a form of primary water supply. Even though these residents use tap water, certain proportions treat this water under the precaution that it was unsafe to drink raw water. This also demonstrates environmentally positive attitudes among some respondents.

4.2 Econometric Analysis

The outcome of the logistic regression model used to determine factors that affect individuals' willingness to participate in pollution abatement activities/projects, show that in general, home-ownership and length of stay in a particular location are very important in explaining the household decision to participate in pollution abatement activity. These two variables that were statistically significant at 5% level of significance positively affect the

household decision to participate. The marginal effect of these two variables reveal an increase of 32 percent impacted on the willingness to participate on pollution abatement activity exerted by a unit change in each variable ceteries paribus. The implication from this relationship is that individuals who have spent one year or more years in the area are 32% likely to participate in environmental projects, thus the marginal effect of one unit increase in the number of years one spends in this area, increases his likelihood of participating in pollution abatement activities by 32% holding all other variables constant.

The impact of the length of tenure on willingness to participate agrees with expectations that were based on empirical evidence. Danire and Takahashi (1999) found that the likelihood of an individual to participate in environmental projects increased with the length of tenure. This could be due to the nature and effects of pollution in both studies. Perhaps, the Thetsane industrial area is much active and polluted as the Bangkok metropolitan, however, some great differences in the population, size of land covered is observed. The Bangkok metropolitan had an estimated population of 10.8 million residents in 1990 while on the other hand the Thetsane Industrial area is a small village with only a few thousands of residents. Nevertheless, these differences have implications on the seriousness of the environmental conditions. An observation by Gibbs and Gibbs (2002) was that due to lack of grazing space at Thetsane area, residents are even forced to graze their cattle in land that is periodically flooded by these streams. This raises a question on the effects of water pollution in the area. Based on the results from this study, one could conclude that the longer the tenure of individuals in an area, the more they are informed of the effects of pollution in the area and the more likely they will be willing to participate in environmental clean-up in order to avoid the adverse health effects or even if there is no strong incentive, then they will still remain likely participate in eradicating pollution.

Similarly, the size of the household, distance from the "Blue River", and usage of the waste bin for garbage disposal, all exerts a positive influence on household willingness to participate in pollution abatement activities. With particular reference to ownership of waste bins, this implies that people possessing such have a positive attitude towards environmental cleanness. This is illustrated by the observed positive relationship between the willingness to participate in environmental projects and ownership of waste bins.

The level of education that is less than complete secondary schooling and income less that M500 are in line with the Apriori expectations. The results show that people with lower levels of income and people in the lower level of education are less likely to participate in environmental projects/pollution abatement activities than those with higher levels of either of the

two variables or both. The implication from the results is that education matters for environmental awareness and pollution abatement. It is therefore very imperative for governments to introduce in the school curriculum at lower levels of schooling (primary and post-primary level), the environmental awareness education so to minimize lack of knowledge on adverse effects of pollution among citizens.

It is also observed from the results that Gender is very important determinant of an individual's likelihood to participate in environmental projects and of course this is inline with a priori expectations. Compared to females, males are about 17% times as likely to avoid participating in environmental projects as women. This is justified by the negative relationship between the likelihood of participating in environmental projects and the gender variable. Of course empirical evidence shows that women are likely to participate in pollution abatement activities than their counterparts. It is therefore very important to involve women in planning and executing environmental projects/ enforcement of environmental protection measures if any meaning success of such measurers is to be realized.

Location from the factories showed a positive relationship with willingness to participate; this is in contrast with what was expected. The implication of the result is that people located further from the firms show a more positive environmental behaviour that those located next to them. The relationship between these variables brings the question of the level of income into mind, according to Danire and Takahashi (1999); the more income one receives the more they worry about environmental pollution hence they are more likely to worry about environmental degradation. This view indirectly affirms that low income earners worry less about environmental conditions. Descriptive statistics (Table 1, Appendix B) showed that a greater proportion of individuals located next to the river were low income earners, the composition changes as one moves further from the river; most high income earners are located furthest from the river. This could be the reason why such behaviour exists between the variables

5. CONCLUSION AND RECOMMENDATIONS

Following the persistence of water pollution at Thetsane Industrial area, this paper set out to assess people attitudes and awareness of such pollution. Moreover, to estimate factors that could perhaps influence their willingness to take part in environmental projects. The purpose of determining such factors was to evaluate those that would really be very important and need attention, in case, an alternative policy that minimizes such pollution, but which requires people's participation is implemented. Therefore to accomplish this task, the paper uses survey data collected from Thetsane residents and two methods of analysis are employed in the analysis of

such data; the descriptive statistics and the econometric analysis. This paper argues that residents who fall in the category of high income level, more educated and are younger tend to show more positive behaviour towards environmental awareness and are more willing to take part in environmental protection measures if given chance than those that earn lower incomes and are less educated and older. The paper identifies that length of tenure at the Thetsane residence has direct positive impact on influencing individuals' participation in environmental projects and conservation. It is therefore deduced that tenure of land is very vital for environmental protection and pollution abatement activities. It is also argued in this paper that despite well documented laws meant to govern environmental degradation and provide preservation, the institutions charged with such mandate are ineffective hence adverse effects on the environment are observed day after day.

On the policy front, although, Teitenberg (2000) indicates that pollution is not an evitable consequence of economic activity, but rather results from societal choices about how resources are used, the case of Thetsane industrial pollution represents a different scenario. In this scenario, it represents a consequence of economic activity by firms who absolutely fail to take into account social cost in their production processes and profit maximization. The absence of markets for permits, lack of property rights, and lack of law enforcement despite the presence of environmental laws as well as government institutions charged with enforcement of such laws implies environmental degradation and pollution are bound to persist over a foreseeable future period. This by no doubt will continue harming the society that lives in this vicinity of firms. It is true from the discussions of this paper that people are aware of the harm caused by pollution hence are willing to participate in environmental projects that perhaps will restore their welfare but this undermines the effectiveness of the "polluter pays principle" which basically charges firms with the clean-up of the pollution they cause. This principle fails because of no proper allocation of property rights and non-effective government institutions administering environmental protection laws. It is therefore suggested that government should in this case allocate property rights to the citizens that are willing to participate in environmental projects and perhaps they would be in a better position to sue the firms for the damage they cause on people's welfare.

On the other hand, addressing pollution not caused by firms at other places within the country, this paper shows precisely that involvement of young people taking into consideration gender balance in policy formulation and implementation is very important hence aught not be undermined. Similarly, other groups that aught to be targeted are those with higher education and higher income levels since they seem to possess a better understanding and positive

environmental attitudes towards environmental cleanness/protection hence could promote environmental conservation. However, this does not mean that other groups should be ignored in these environmental projects, there has to be a way through which uneducated can be taught about the environment and basic ways in which it can be taken care of perhaps through the media or any other possible means. This will be an investment that will lead to a change in welfare and efficient ways of waste management.

This paper concludes by showing that if the respective government (Lesotho Government) is interested in maximizing the welfare of citizens especially those staying within Thetsane industrial area, a need arises of enforcement of the environmental protection laws otherwise if it is a rather heavy and difficult measurer to undertake, it is recommended that proper allocation of property rights be made. It is worth mentioning that several extensions of the present work seem worth pursuing in the course of further research and struggle for better welfare of Lesotho Citizens. In particular, the most appropriate extension of this work would be to evaluate the extend of the harm that such pollution has caused among the residents of Thetsane industrial area, and to explore critically other alternative ways of addressing the pollution problem within this area that perhaps are easy to be implemented. It would also be particularly profitable to assess the other likely adverse effects of water pollution in this area on the future generation. It goes without saying that such extension would provide a solid work for informed government policies.

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Appendix A:

Conceptual Framework:

In order to appreciate the modeling framework for water pollution and participation in environmental projects, it is worth discussing the representative model of the consumer where the consumer maximizes utility in the presence of negative externalities and imperfect markets which results into failure of the ideal conditions of the Walrasian Model (Theorem of Welfare Economics II).

In this case we assume the representative consumer with the following utility function:

$$U^i(.) = U^i(y_{i1}, y_{i2}, y_{j1}, y_{j2}) \ \ \forall i, j = A, B; i \neq j \ldots\ldots(a)$$

where y_{ik} is the consumption of commodity k by individual i

Assumption: individuals, A and ***B,*** *have preferences over theirs and their neighbour. Therefore, the quantity of a given commodity consumed by an individual may be distinguished according to whose utility function it appears in. hence i's utility function may be written as:*

$$U^i(.) = U^i(y^i_{i1}, y^i_{i2}, y^i_{j1}, y^i_{j2}) \ \ \forall i, j = A, B; i \neq j \ldots\ldots(b)$$

where y_{ik} is still the consumption of commodity k by individual i

If we assume a competitive equilibrium with a full set of markets, an individual i's utility may be described by an indirect utility function:

$V^i = V^i(P, \Omega^i)$ *Where P is a set of prices associated with each commodity the consumer purchases for consumption and Ω is an exogenous endowment of commodities. However, because of the presence of incomplete markets and negative externalities, an individual's utility function takes an extra parameter space, A^i which represents externalities from the firm:*

$V^i = V^i(P, \Omega^i, A^i)$. *The elements in the parameter space A though endogenous to the economic system are not controlled by the recipient in whose objective function they appear. This may be a result of lack of enforcement of property rights over the good.*

Deriving Pareto Optimality Conditions for such a representative consumer:

Model augments & Assumptions:

$Xij \in \Omega^i, x_{ij} = the\ ammount\ of\ good\ i\ consumed by\ individual\ j \forall i = 1,2...n : j = 1,2...m$

$y_{ik} \in \Omega^i, y_{ij} = the ammount of\ the\ good\ i\ produced by\ firm\ k\ \forall i = 1,2...n : k = 1,2...h$

$r_i = the total\ quantity of\ the\ resource available to the community;$

$s_k = the emission of\ externality\ (particulate\ \ cuasing water\ pollution)$

$Z = \sum s_k = total\ \ emisions\ in the community$

$U^j = U^j(X_{1j}, X_{2j},,, X_{nj}, Z) : individuak's\ j\ utility\ function$

$f^k = f^k(y_{1k}, y_{2k},,, y_{nk}, Z) : firm\ k's\ production\ set$

The consumer's problem is to:

$$Max\ U^1(X_{11}, X_{21}, ...X_{n1}, Z).....(c)$$

subject to

$$U^j(X_{1j}, X_{2j},...X_{nj}, Z) \geq U^{*j}, \forall j = 2,3....m$$

$$f^k(y_{1k}, y_{2k},...y_{nk},...Z) \leq 0, \forall k = 1,2...,h$$

$$\sum_{j=1}^{m} X_{ij} - \sum_{k=1}^{h} y_{ik} \leq R_i, \forall i = 1,2...n : X_{ij} \geq 0, S_k \geq 0, Z \geq 0$$

Lagrange function:

$$L = \sum \lambda_j \left[U^j(.) - U^{*j}\right] - \sum \mu_k f^k(.) + \sum \omega_i \left[r_i - \sum_{j=1}^{m} X_{ij} + \sum_{k=1}^{w} y_{ik}.....(d)\right]$$

From The Kuhn-Tucker conditions for an optimality with pollution externality for the consumer:

$$\lambda_j U_i^j - \omega_i \leq 0;\ X_{ij}\left(\lambda_j U_i^j - \omega_i\right) \leq 0,\ \forall all\ i\ \&\ j$$

$$-\mu_k f_i^k + \omega_i = 0,\ \forall all\ i\ \&\ k$$

$$-\mu_k f_i^k + \sum_{j=1} \lambda_j U_z^j - \sum_{j=1}^{m} \mu_k f_z^k \leq 0$$

$$S_k\left(-\mu_k f_i^k + \sum_{j=1} \lambda_j U_z^j - \sum_{j=1}^{m} \mu_k f_z^k\right) = 0,\ \forall all\ k$$

If the above Kuhn Turner conditions hold, then the consumer is bound to participate in environmental projects that would help minimize the adverse effects of pollution and help him attain the highest level of utility in the presence of externalities and imperfect markets.

We can therefore safely say that the consumer's participation would be a function of all characteristics and other variables that make the consumer better off, such as his income, security of tenure of stay in the residence...Etc. Thus Willingness to participate can formally be expressed as a function: WTP = F($(\alpha + \beta X_i)$, where X is a vector that contains all variables which influences the consumers decision).

Definition of variables included in the models:

Model One: Probability that individuals are willing to take part in environmental projects

Names of variables contained in the vector X_i:	**Description of variables**
P_i the probability that the individual participated in environmental project(s) in the past	P_i = 1, if the individual participated in environmental project(s) in the past; 0 otherwise;
$Expen_2$ household expenditure (used as proxy for income)	$Expen_2$ = 1 if household expenditure is M500-999; 0 otherwise;
$Owntapn_3$: households' ownership of water tap	Owntapns= 1 if household owns a water tap; 0 otherwise;
$HHSsize_4$: household size	$HHSsize_4$ = number of members in a household
$Educ_1$: level of education of household head;	$Educ_1$ = level of education of household head;
$Gend_2$: gender of the household head	$Gend_2$ = 1 if household head is male; 0 otherwise;
$Dist_3$: distance from river to residence of respondent in m;	$Dist_3$ = distance from river to residence of respondent in m;
$Turn_4$: tenure of stay in area	$Turn_4$ = 1 if tenure of stay in area >1 year; 0 otherwise;
Ownhome: ownership of house of residence	Ownhome = 1 if house of residence is owned; 0 otherwise;
Ownwbins: household usage of pollution abatement vessel	Ownwbins = 1 if household uses dustbin/waste bin; 0 otherwise;
WTreat: household treatment of domestic water before usage	WTreat = 1 if household treats water; 0 otherwise.
α is a constant and the β's are parameters to be estimated from the relationship between the dependent and the independent variables in the model.	

Model Two: Probability that individuals actually took part in environmental projects/pollution abatement activities

Names of variables contained in the vector X_i:	**Description of variables**
Pi :the probability that an individual is willing to take part in environmental projects	P_i = 1, if the individual is willing to take part in environmental projects; 0 otherwise;
$Gend_1$: gender of the household head	$Gend_1$ = 1 if gender of household head is male; 0 otherwise;
$Educ_3$: level of education member	$Educ_3$ =1 if ever completed primary level of schooling, 0 otherwise
$Dist_1$:	$Dist_1$: = 1 if household is located less than 500m; 0 otherwise
$Dist_2$:	$Dist_2$: = 1 if household is located 500m -1000m; 0 otherwise
$Dist_3$:	$Dist_3$: = 1 if household is located between 1000m – 5000m; 0 otherwise
$Dist_4$:	$Dist_4$: = 1 if household is located >5000m; 0 otherwise
Age_5 : Age	$Turn_5$ = Age of household head;

$Turn_7$ = tenure of stay in area 1-5 years	$Turn_7$ = 1 if tenure of stay in area 1-5 years; 0 otherwise;
$Turn_8$ = tenure of stay in area 6-10 years	$Turn_8$ = 1 if tenure of stay in area 6-10 years; 0 otherwise;
$Turn_9$ = tenure of stay in area >10 years	$Turn_9$ = 1 if tenure of stay in area >10 years; 0 otherwise.
α is a constant	
β's are parameters to be estimated from the relationship between the dependent and the independent variables in the model.	

Appendix B: Tables of Empirical Results

Table 1 Willingness to Participate and the Level of Average Monthly Expenditure

	Willingness to participate		
Expenditure	Yes	No	Total
Less than M500	2	12	14
M500-999	13	14	27
M1000-1499	6	7	13
M1500-1999	19	2	21
M2000 or more	11	2	13
Total	51	37	88

Table 2 Willingness to Participate and the Level of Education

Level of Education	Willingness to participate		
	Yes	No	Total
No formal education	0	7	7
Primary education	1	8	9
Junior Secondary	3	2	5
Senior Secondary	12	6	18
Diploma	14	12	26
First Degree	20	2	22
Postgraduate	1	0	1
Total	51	37	88

Table 3 Willingness to Participate and the Length of Tenure

Length of Tenure	Willingness to participate		Total
	Yes	No	
Less than one year	9	5	14
1-5 years	19	22	41
6-10 years	12	6	18
> 10 years	11	4	15
Total	51	37	88

TABLE 4: Results of the Logistic Regression Model on willingness to take part in environmental projects

Dependent Variable: Willingness to participate (Pi) = 1: yes, 0: otherwise)

Method of estimation: Log likelihood Method

Observations: 88

Names of variable (in the vector X_{ij}:	Co-efficient (β)	Marginal Effect (dy/dx)	Z-statistics	P>$\|Z\|$
$Gend_1$	-1.2200	-0.1684	-1.34	0.18
$Educ_3$	-0.1904	-0.0241	-0.54	0.62
$Expen_1$	-0.0791	-0.0101	-0.17	0.86
Ownhome	2.5089***	0.3368	1.81	0.07***
$HHSsize_3$	0.17977	0.0223	0.18	0.86
$Ownwbins_4$	0.9451	0.1028	0.93	0.35
$Dist_6$	0.4783	0.0605	0.99	0.34
$Turn_7$	2.5323**	0.3206	3.06	0.002**
$Owntapn_8$	-1.4676	-0.2256	-0.04	0.301
$WTreat_9$	--0.7723	-0.1206	-0.40	0.69
Constant	-5.2304**	-	-2.19	0.03**

Log Likelihood = -27.260738 LR Chi^2 (10)=42.19 Probability > chi^2 = 0.0000 Pseudo R^2 = 0.4363

N.B Asterisk *, **, *** denotes rejection of null hypothesis at 1%, 5% and 10% level of significance respectively

The null hypothesis for each parameter is $\beta_i = 0$ for i =1,2,3,4…

Table 6 Classification Table (cut off point =0.500)

	Predicted		
	Willingness to participate		Percentage Correct
Observed	**No (0)**	**Yes (1)**	
No	**28**	**9**	**75.7**
Yes	**4**	**47**	**92.2**
Overall percentage			**85.2**

TABLE 5: Results of the Logistic Regression Model on individual's actual participation in environmental projects/abatement activities

Dependent Variable: participated in abatement activities (Pi) = 1: yes, 0: otherwise)

Method of estimation: Log likelihood Method

Observations: 88

Names of variable (in the vector X_{ij}):	**Co-efficient (β)**	**Marginal Effect** (dy/dx)	**Z-statistics**	**P>$\|Z\|$**
$Gend_1$	-3.4406*	-0.5622	-4.28	0.000*
$Marital_2$	-0.6141	-0.3066	-1.58	0.117
$Educ_3$	1.3565**	0.5866	2.19	0029**
Age	-0.8777	0.1757	-1.54	0.12
$Dist_2$	0.2708	0.05282	0.18	0.85
$Dist_3$	-1.3831	-0.3186	-0.81	0.42
$Dist_4$	2.9598**	0.3982	2.36	0.018**
$Dist_5$	1.6352	0.2409	1.06	0.29
$Turn_1$	-4.1737*	-0.7286	-4.04	0.00*
$Turn_2$	-4.1913*	-0.7751	-3.99	0.00*
$Turn_3$	-7.8517*	-0.9049	--12.97	0.00*
Constant	1.5440	-	0.63	0.53

Log Likelihood = -26.349111 LR Chi^2 (12)=67.06 Probability > chi^2 = 0.0000 Pseudo R^2 = 0.5600

N.B Asterisk *, **, *** denotes rejection of null hypothesis at 1%, 5% and 10% level of significance respectively

The null hypothesis for each parameter is $\beta_i = 0$ for i =1,2,3,4…