Prioritization of Environmental Issues Based on Surveys Applied to a Settlement in Nepal

Bimal Aryal

Saint Mary's University, Halifax, Canada

aryal2004@hotmail.com

***Abstract*-In developing countries, such as Nepal, the expansion of cities produces parallel growth of large informal settlements, in which aspects the qualities of life are threatened. This study focuses on prioritizing 6 different environmental issues (Health and sanitation, Water availability, Solid waste disposal, Food, Flood and Transportation) observed in one informal settlement. Two focus group discussions were conducted, one with 12 and the other with 14 participants. One hundred and twenty respondents (out of 700 households) were selected through proportional stratified sampling based on gender and age strata. Water shortage was found to be the major environmental issue in the settlement. The study describes the livelihood challenges in the settlement, such as water shortages, solid waste disposal, health and sanitation. It also proposes alternative solutions for managing the enclave's infrastructure, while addressing changing climate.**

Keywords- Water; Health and Sanitation; Informal Settlement; Flood

I. INTRODUCTION

Land is increasingly being lost to non-agricultural purposes. Forests are being cut down; fertile land is being built over more and more [1, 2]. Land degradation, deforestation, industrialization and urbanization [3], have contributed to global warming [4] which is considered to be one of the major global threats of this millennium [5]. Many countries, particularly those less developed, such as Nepal, face serious challenges to their economies (e.g., agriculture) as a result of climate change [6]. This is seen as a serious problem to sustainable development, having an adverse impact on the environment, human health, food security, economic activity, natural resources and physical infrastructure of both individual countries and the global community [6, 7].

Nepal has a diverse topography with plains in the south, mid-hills in the central region and mountains in the north. The melting of ice and glaciers in mountains makes the country as a whole more sensitive to climate change [8-10]. The country's economy which mainly depends on agriculture cannot produce enough food because of erratic rainfall [11]. Therefore, the change in precipitation creates a significant negative impact on the livelihoods of people [10]. The change may be incurred in the hydrological cycle, with drought, landslide or flooding [12], and may also produce health problems for humans and animals alike [13, 14]. In addition, their lands and houses may have been either flooded, or made unsuitable for agriculture because of drought. They are forced to migrate to other areas within their reach. Kathmandu is a major choice for the majority of homeless and landless people [15]. They move to urban areas, finally settling on easily approachable banks of rivers. The displaced people build poor quality houses to eke out a living on the corridors of rivers, where they are at considerable risk [15, 16]. None of these people have land title in their new area. The explosive physical growth of urban areas has occurred, with concomitant rapid and uncontrolled urbanization [17]. Out of 30 million people of Nepal, 9.3% population live in urban slums [18], causing poverty and many environmental problems such as health and water shortage [15, 19]. Consequently, the goal for better lives is rarely achieved [20, 21].

About 15,000 people, representing 9% of the total population of Kathmandu valley, are informal settlers [22]. Such migrants commonly live along the corridors of Manohara, Bagmati and Bishnumati rivers, which pass through the city. These so-called "informal settlements" are illegal, unauthorized collections of dwellings accommodating low-income and impoverished people [23] with no land titles. In the present context, there are many visible urban informal settlements in Nepal, where the residents have no housing rights [24]. People living in such places lack even the most basic infrastructure, with decaying and infirm housing structures, poor ventilation, acute over-crowding, faulty alignment of streets, inadequate lighting, and lack of safe drinking water. In most of the settlements, water supply is through stone taps which may not function during drought and winter season. The frequent food insufficiency [25, 26], flooding during rains, absence of toilet facilities and non-availability of basic physical and social services are other basic factors that people lack [23, 26]. Living conditions have a direct influence on public health, making the lives of poor and vulnerable people all the more difficult. People living in these communities contribute to and are victims of urban pollution [27].

In Kathmandu in 1990, the late Dr. Ramesh Manandhar, an architect and pioneer of raising awareness of urban poverty, organized the first workshop on informal settlements in Nepal [24]. Participants in the workshop felt the need for an institution to support these settlements. Three years after this first workshop, a non-governmental organization (NGO), the Lumanti Support Group for Shelter, was established. The settlers' movement in Nepal, led by Lumanti, has developed both national and regional networks [22] and has established good relationships with government officials at local and national levels, especially

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in connection with upgrading housing [28]. In spite of such efforts, there exist many environmental problems in informal settlements of Nepal.

The purpose of this study was to uncover the basic environmental problems. Addressing many environmental problems at once was not possible and therefore, the prioritization method was necessary. The prioritization method was modified and developed from the urban environmental management plan for Bistrita municipality [29]. Furthermore, the study would assist policy makers in formulating new policies concerning informal settlements as a whole. As a preliminary step, this study prioritized different environmental issues and considered ways to rectify at least a few of the problems.

II. METHODOLGY

A survey-based study was carried out in the eastern part of Kathmandu, Nepal, on the bank of Manohara River. This densely populated informal settlement of about 700 households covers an area of about 10,000 square metres. Physical observations, focus group discussions and key informant interviews were carried out as a preliminary study. After completion of the preliminary study, a field study was carried out which included primary and secondary data collection. Primary data were collected through observation (site visit, field survey and investigation), questionnaires and interviews with community leaders, men, women and children. Similarly, secondary data were collected from government reports, newspapers, journals, and internet websites.

From frequent visits to the study area and from a group discussion with 12 participants, six major environmental problems were selected, namely, Health and Sanitation, Water Availability, Solid Waste Disposal, Flooding, Food and Transportation. These issues were ranked, based on five criteria and a scoring system which included scores on both qualitative and quantitative scales [29]. These criteria, shown in Table 1, are Impact on human health, Impact on children's education, Impact on environmental quality, Support from government and private sectors and Willingness of people to pay for managing environmental issues. The criterion, willingness to pay, was identified through focus group discussions, because 100% participants were ready to provide their labour in solving these environmental issues.

TABLE 1 WEIGHTING OF DIFFERENT CRITERIA DEVELOPED FROM FOCUS GROUP DISCUSSIONS

Criterion	Distribution for different criteria (%)
Impact on human health (C1)	30
Impact on children's education (C2)	25
Impact on environmental quality (C3)	20
Support from government and private sectors (C4)	15
Willingness of people to pay (C5)	10

For each issue, the five most applicable criteria were selected and weighted from 1 (least important) to 5 (most important). Two focus group discussions, one with 12 and the other with 14 participants were conducted. In the first discussion, the participants were asked to write three problems faced within the settlement and two solutions for solving those problems. 95% reported that human health, children's education and environmental quality were the emerging impacted issues. 90% of them said that the support from the government and private sectors, along with their own labour, were necessary to solve the environmental challenges. In the next discussion with 14 participants, these five criteria were given for ranking. The result obtained is shown in Table 1. The impact on human health received 30%, the impact on children's education received 25%, the impact on environmental quality received 20%, the support from government and private sectors received 15% and willingness of people to pay received 10%. After obtaining the percentage distribution for these five criteria, weighting was applied. Human health, the top ranking with 30%, received a weighting of 5, the highest, and willingness to pay which is at the bottom received a weight of 1.

Eighty households were selected through proportional, stratified sampling based on gender and age. These 80 households included 120 respondents. Five volunteers (three male and two female) were selected through participation to help distribute questionnaires to all the respondents. These five volunteers were instructed in how to handle questionnaires. In addition, they were also told to explain questionnaires to other respondents. After completing the survey, five volunteers were given light refreshments thanking them for their support.

For each criterion, the qualitative scales were rated as high (most severe), medium, and low (least severe); quantitative scales were given scores and weights. These criteria received scores from 1 (lowest/less severe) to 3 (highest/most severe) and weights from 1 (least important criterion) to 5 (most important criterion), as shown in Table 2. Calculations were made for each criterion by multiplying scores and weights allotted to each criterion for each problem, using the following formula.

$$Partialscore = ScoresXWeightofthatcriterion$$

The total value for each environmental issue was then obtained by summing partial scores of 5 criteria using the equation below:

$$TotalScore = \sum (PScC1 + PScC2 + PScC3 + PScC4 + \text{PSc C5})$$

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Where

PSc = Partial score, C1 = Criterion 1, C2 = Criterion 2

C3 = Criterion 3, C4 = Criterion 4, C5 = Criterion 5

TABLE 2 SCORES AND WEIGHTS FOR CRITERIA 1, 2, 3, 4 AND 5

Criterion	Qualitative Scale Rating	Quantitative Scale	
		Scores	Weights
Impact on Human health	High	3	5
	Medium	2	
	Low	1	
Impact on children's education	High	3	4
	Medium	2	
	Low	1	
Impact on environmental quality	High	3	3
	Medium	2	
	Low	1	
Support from government and private sectors	High	3	2
	Medium	2	
	Low	1	
Willingness of people to pay for managing environmental issues	High	3	1
	Medium	2	
	Low	1	

Source: Adapted from Urban Environmental Management Plan of Bistrita Municipality, Cape Town

The total value was then used to prioritize the environmental problems, the first priority being the parameter with the highest value obtained by the above calculations and the lowest priority being that with the smallest value. The collected data were triangulated through direct observation and feedback from key informants. Comparative analysis was carried out to determine the most severe environmental issue.

III. RESULTS AND DISCUSSIONS

Six environmental issues were chosen, and five criteria are applied to each environmental issue. From the focus group discussion, human health emerged as the most important criterion and a weighting of 5 was assigned to it. Children's education was the second important criterion with a weighting of 4. Thirdly, the impact on environmental quality received a weighting of 3. Next, a support from the government and private sectors received weight 2. Finally, a weighting of 1 was assigned to willingness of people to pay. When asked about willingness of people to pay, it transpired that, although they were interested in paying, their poverty prevented them from doing so.

The total value for each issue was calculated by summing partial scores of all criteria. Each criterion was calculated by multiplying scores and weights to obtain a partial score and then summing them to obtain a total value. The resulting total value from Table 3 clearly showed that the most severe problem observed in the settlement was the water crisis with a total score of 45, followed closely by solid waste disposal with a total score 42. Similarly, food availability also seemed severe and ranked third place with a total score 41. The bottom three were flood (33), health and sanitation (30), and transportation (27), where transportation was the least, flood problem the most severe, health and sanitation being in between the two.

TABLE 3 SORES, WEIGHTS AND CALCULATIONS

Environmental issues	Partial scores for problem importance and severity (Score x Weight)					Total scores (Σ C1+C2+C3+C4+C5)
	C1	C2	C3	C4	C5	
Health and Sanitation	2x5=10	2x4=8	2x3=6	2x2=4	2x1=2	30
Water Availability	3x5=15	3x4=12	3x3=9	3x2=6	3x1=3	45
Solid Waste Disposal	3×5=15	3×4=12	3×3=9	2x2=4	2x1=2	42
Flooding	3×5=15	3×4=12	1×3=3	1x2=2	1x1=1	33
Food	3x5=15	3x4=12	3x3=9	2x2=4	1x1=1	41
Transportation	2×5=10	2×4=8	2×3=6	1x2=2	1x1=1	27

People living in the settlement felt that they suffered from major problems ranging from lack of water, through living in a flood zone, to having no title of the land they occupied. They felt the acute lack of security, schools and a health centre. The residents were mainly concerned with water supply, in particular drinking water, which came from a stone tap and was untreated. According to them, the elderly and especially the young, often fall victim to illnesses caused by drinking contaminated water. The author feels that an immediate solution is needed to minimize illnesses resulting from contaminated

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and insufficient drinking water. Moreover, cases were also found from students being unable to attend school, because their time was spent collecting water. Thirteen year old Sumitra Tamang, who studied in grade 6 at a local school, reported that there were only 2 taps in the area, of which only one operated during the winter season. She further added that the people often had to wait several hours before their turn came, giving low rainfall as the cause of the deficiency. Fetching water was the job of children in this settlement, preventing many from attending school. The community leader, Mr. Laxman Paudel, reported that they had a water source near the settlement, but substantial investment was required for making a reservoir to supply the whole community. He sought help from the government and several potential private sector sources, but without success.

The waste produced from 700 households is generally thrown into the river, the road, or an open area. Biodegradable waste can be effectively utilized and managed for generating biogas. Based on the data obtained from 80 households (Table 4), it is revealed that the 700 houses generate about 1374 kg of biodegradable solid waste per day. This is enough raw material to fuel 15 plants of 10 cubic meters, each of which can theoretically generate 15 x 10 x 2,400 = 360,000 litters of biogas daily [11, 30]. However, there are other factors which prevent generation of biogas, such as money and installation of a biogas digester. The gas thus generated can be used in school canteens, or given to those who cannot afford to buy commercial gas, or to those who are currently using firewood [31]. This can allow a considerable saving of time and labour for housewives. It will also help to keep the settlement clean and free from disease. Furthermore, such usage would result in a reduction in the emission of carbon dioxide into the atmosphere, thereby helping to minimize Kathmandu's pervasive smog.

TABLE 4 TOTAL BIO-DEGRADABLE SOLID WASTE GENERATION IN THE SETTLEMENT

Waste Generation	No. of Households(80)	Generation of total waste/day from 80 households (kg)	Generation of total waste/day from 700 households (kg)
1 kg	15	15 x1 = 15	$(157\ x\ 700)/80$
2 kg	53	53 x 2 = 106	
3 kg	12	3 x 12 = 36	
Total	**80**	**157**	**1, 374**

Source: Field survey, 2013

Sanitation in the settlement is unhealthy because some people deposit waste in a nearby pit, field or open area. This creates the very great risk of transmission of diseases in the settlement population [26, 32]. In addition, the settlers feel that there is an increase in mosquitoes, with a concomitant increase in illnesses such as malaria [33]. Although there were no cases of such diseases at the time of the study, people were nevertheless fearful of this danger. The community needs clean drinking water, a well-managed solid waste disposal system and proper sanitation.

The majority of the houses in the settlement are simply constructed, mainly of cement block, bamboo and brick, with almost all roofs made of galvanized iron. They are situated on the bank of the Manohara river and are always under the threat of flood. When the people were interviewed regarding flooding, the majority of them said that water from the river came into the house whenever it rained heavily. Anti-flooding measures are necessary [34], but none are being undertaken at the present time. Furthermore, most of the houses have only one room, in which daily household activities are carried out, including cooking [35]. Some people still use firewood and some LPG (liquefied petroleum gas), both of which may be dangerous, especially to small children [35]. Similarly, transportation in this settlers' colony is deficient, with roads being slippery and muddy during the rainy season. Transport within the Kathmandu Valley by automobiles has a direct impact on air quality, especially in terms of greenhouse gas emissions and noise pollution.

To rectify these and other problems, people living in the settlement say that they are willing to cooperate and participate in setting up reforms, but can pay nothing. Eighty-five percent of people are ready to provide labour support for projects in solid waste management, construction of flood control walls, road repair and maintenance, planting trees and making open public spaces. What they lack is proper guidance, government financial support and other infrastructure in the settlement. Ninety percent of the people living in the settlement are working to stop water from the rain-swollen river coming into their houses, by constructing a small threshold dam in front of the house using stones and bricks. Community managerial functions are undertaken by a community leader and 5 women volunteers. A non-governmental organization, Dial, is currently working in the community helping the children by providing a meal once a week. Nevertheless, the settlement needs money and government support, which will be instrumental in helping to solve some of these problems.

IV. RECOMMENDATIONS AND STRATEGIES

The informal settlements movement in Nepal, led by Lumanti, has developed networks through exchange visits, upgrading housing, and monitoring evictions [24]. Although settlement groups have been able to establish good relationships with government officials at local and national levels, the settlers are not able to eliminate the environmental problems. In this section, a series of recommendations and strategies is proposed that can lead to solutions to some of the environmental problems that exist in this community.

First, the pressing issue of securing an adequate supply of potable water will be considered. The people of this colony are attempting to identify and secure a source of water near the settlement. If they succeed, and if that water can be used, a significant problem will be solved. Next, carbon dioxide emissions can be reduced through carbon sequestration of biomass,

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which is the most natural medium for storing carbon. Hence, an increase in forested areas by actions such as planting trees along the bank of the river would help to store carbon produced in the city. Furthermore, planting trees [36] can be one of the most important long-term solutions, both for preventing flood by limiting erosion, and for sequestering carbon. Planting bamboo near riverbanks will eventually provide additional income to families through selective harvesting, as bamboo is easily sold locally.

Finally and importantly, bio-degradable solid waste can be used to generate bio-gas in the settlement [26, 37, 38]. Generation of bio-gas can help poor people to meet their energy demand for cooking and lighting [39]. This practice will not only help generate energy, but also help to reduce emission of carbon dioxide into the atmosphere [40, 41]. Biogas plants so constructed can work for about 30 years, i.e. in 30 years, 483,574 tones of CO_2 equivalent will be prevented from entering the atmosphere [40]. Of the several solutions proposed in this study, some would be easier to accomplish than others. Some, such as planting bamboo and locating a water source, are simple. Others, such as storing carbon or generating biogas, must be tackled as large-scale projects with support from outside. Some of these solutions seem almost impossible to achieve in the immediate future. However, some of the practices mentioned above can easily be commenced and the outcome determined. Positive achievements in these areas will significantly raise the standard of living in the settlements by promoting adaptation to the vicissitudes of climate change.

V. CONCLUSION

Examination of the situation and opinions of colony dwellers reveals the concern about environmental issues associated with water supply, flood control and sanitation. However, they can only provide "sweat equity". Planning and financial support will have to come from external sources, such as the Nepali government and NGOs. To summarize, the water problem is serious and is felt by most people living in the settlement. Finally, from the findings, one recommendation is generation of biogas, which will help to reduce solid waste, thus reducing CO_2 emission into the atmosphere. This could then be used to fuel a stove for 90 hours. Biogas plants so constructed can work for about 30 years, thus preventing about 483,574 tones of CO_2 equivalent from entering the atmosphere.

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