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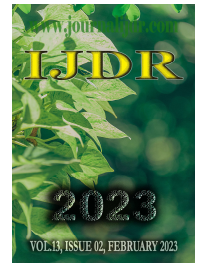
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RESEARCH ARTICLE

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DEVELOPING AN EFFECTIVE SOLID WASTE MANAGEMENT SYSTEM TO MINIMIZE ADVERSE ENVIRONMENTAL IMPACT ON WETLAND ECOSYSTEM IN PHOBJIKHA VALLEY, WANGDUE PHODRANG, BHUTAN

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ABSTRACT

The effectiveness and sustainable waste management consist of addressing all the vital aspects: economic, social, environmental, technological efficiency, and political willingness. In this study, the focus has been made to understand the economic, social, and environmental aspects of the Phobjikha valley waste management system in Bhutan through the use of statistical tools to analyze the data obtained through field surveys, visits, and literature reviews. The result establishes the positive evidence to support the initial understanding that there is a systemic flaw in the Phobjikha valley waste management system specifically the economic, social, and environmental aspects of the effective waste management system.

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INTRODUCTION

Today, the world is passing through a dramatic phase whereby the increasing inhumane human activities in pursuit of materialism and individual gains have led to an economic, social, and environmental crisis at the global level (Dorji, 2015). With accelerating population growth and urbanization, safe and secure disposal of solid waste is now becoming a major problem for most developing countries (Mohsin and Chinyama, 2016). Bhutan being in the phase of rapid development, with no exception is confronted with waste management problems. Waste management is a serious issue in Bhutan due to limited awareness, illegal dumping, and lack of segregation and disposal of waste (Shrestha, 2018). Phobjikha valley endowed with natural beauty is one of the most favored tourist destinations in the country and is home to around 5387 population (Dzongkhag, 2021) sustaining their livelihood on potato farming and forest resources. In addition, the vast high-altitude wetland is the largest winter habitat for over 500 endangered Black-necked Cranes. On the other hand, Phobjikha valley is witnessing an increasing trend of solid waste generation over the years putting at risk the sustained provision of wetland ecosystem services. There is a record of 72 metric tons of solid waste generated in 2019 from households, hotels, and institutions due to inefficient management was a big concern (Dema, 2019).

The ecological footprint in Phobjikha is growing rapidly, making the valley vulnerable to water pollution, land, wetland, and watershed degradation, and a threat to human health. Royal Society for Protection of Nature (RSPN)¹ has been implementing waste management programs in the valley since 2003 to safeguard the natural ecosystem (RSPN, 2016). But the trend of solid waste generation in the valley is worrying, and there will be serious impacts on the ecosystem, and human health; therefore, effective timely intervention is necessary. Thus, exploring possible solutions to sustainable waste management through stakeholder engagement is essential to understanding the source, types, and adverse impacts. The study on 'developing an effective solid waste management system to minimize adverse environmental impact in Phobjikha valley' (refer to figure 7) was initiated from mid of March till the end of May 2022. This study has examined the sources and types of waste, causes of inefficient waste management, and its negative impacts, and explored the possibilities of establishing a sustainable solid waste management system in Phobjikha valley. The findings of the study will benefit 756 households, 16 hotels, and 21 institutions in the valley in the sustainable waste management (Dorji, 2021). In particular, in

¹ Oldest non-profit environmental organization established in 1987 with the command of Fourth King to supplement the Royal Government of Bhutan to conserve the rich natural ecosystem.

Phobjikha valley, one of the RAMSAR² sites in Bhutan, the findings of the study are expected to contribute to achieving the convention's wetland management principle of wise use of wetlands and maintaining the health of the wetland ecosystem with efficient waste management.

STUDY OBJECTIVES

The goal of the study is to enhance the state of the environment of Phobjikha valley by reducing pollution of water, wetland ecosystem, local environment, and farmland, which are resulted from indiscriminate littering or dumping of solid waste. The specific objectives are to:

- Study the waste generation sources and their impacts;
- Examine the causes of inefficient waste management in the valley;
- Develop an efficient and viable waste management system; and
- Apply sustainable community waste management in the Phobjikha valley.

Significance of the study: This study is typically significant in exploring *solutions to sustainable solid waste management through stakeholder engagement* conducted for the first time. Therefore, it will empirically and authentically add to the information needed by any organization or individual trying to study the emerging solid waste trend in the valley. Furthermore, to the organizations, the result findings of the study will provide more reliable in-depth information on the factors that affect waste management. This will help to develop an efficient and sustainable solid waste management mechanism practically implementable by RSPN and other agencies in collaboration with stakeholders. To the stakeholders, the findings of the study are expected to provide answers to the fundamental questions of what are the major causes of inefficient management and what is the trend of negative impacts, why is the trend of solid waste increasing annually and where the situation will reach if not control; and these questions will further suggest answers to how and what would be the best possible solutions. And finally, to future researchers, the outcome of the study will serve as baseline information for further research on the topic.

METHODOLOGY

The study used a combination of quantitative and qualitative methods: desk review of secondary information through past reports and literature; and collection of primary data via a face-to-face interview. All the data were collected by myself with the support of Black-necked Crane Education Center (BNCEC) Staff in Phobjikha. Prior to the data collection, the questionnaire was drafted and presented to the technical team of the RSPN. The primary data were collected during the third week of May 2022. Structured key informant interviews were conducted with key stakeholders such as Gups (Block Head), Administrative Officers, Government Sector heads, and representatives of hotels, shopkeepers, and selected communities. In addition, a day-long focus group discussion and cleaning campaign was conducted involving stakeholders and forestry students of the College of Nature Resources (CNR) to determine the trend and types of solid waste. The data were recorded, clustered, grouped, summarized, and analyzed qualitatively using Microsoft Excel and Word 2010-version, and are presented descriptively and graphically.

RESULTS AND DISCUSSIONS

Challenges and best practices of waste management in Bhutan: The history of sustainable waste management in Bhutan is relatively a new subject; however, waste management is linked to the culture and

lifestyle where many Bhutanese have been using their kitchen and farm wastes for making compost as early as the 1960s during the times of the green revolution (Rai, 2015). Currently, municipalities, District and sub-District have landfills either constructed by the government or relevant agencies, and even the rural villages have a waste collection system enforced. However, due to the unavailability of proper landfills and isolated settlements, it is a common practice in the villages either burn the garbage inside the pits or dispose of it in open areas. There is a record of the country's total solid waste generation in a day was 172.16 metric tons and the per capita waste generation 0.23 kilogram a day (NEC, 2019). Despite the numerous public regulations, awareness, training, existence of volunteers, Civil Society Organizations (CSOs), and private firms, problems of waste management are emerging both in municipalities and rural areas of Bhutan due to a mismatch between the increased waste generation and the infrastructures, and services to ensure sound waste management (NEC, 2013). There are few private firms, companies, and CSOs coming up with plans for waste management. The first of its kind is the Greener Way, a private firm owned by Mr. Karma Yonten, which started in 2010. The increasing trend of plastic waste and the challenges to curbing the problem encouraged Mr. Karma to turn plastics into an economic value, which has a positive impact on the community, environment, and the firm in terms of economy. The waste recovery center in Ngabiphu in Thimphu segregates high and low-density polyethylene plastic among the heaps of waste and recycles it into plastic poles for socio-economic and environmental paybacks (Wangmo, 2019). In turn, the plastic poles replace the wooden poles used for electric fencing to reduce pressure on forest resources. Wangmo (2019) stated that the current practice of electric fencing didn't succeed because the wood got damaged whereas plastic poles can last about 15 years, and can withstand mesh and barbed wires. About 3 to 12 kilograms of plastic waste is used for producing a single pole depending on the size and shape of the poles. The firm also produced reflective poles that can be used as road markers along the highway and has plans to import plastic waste from neighboring districts to make plastic furniture to curb the problem of plastic waste in the coming years.

The Samdrup Jongkhar Initiative, CSO based in Samdrup Jongkhar is into making crafts work from waste as the zero-waste management initiative. It involves training rural women on making mats, carry bags, and baskets from plastic waste. During the last three years, the creative craft initiative used over 1,200 kilograms of plastic waste recycled into beautiful products; however, the demand for recycled products remains negligible in Bhutan (Wangchuk, 2017). Likewise, Clean Bhutan, a CSO based in Thimphu with the vision of "Zero Waste Bhutan by 2030" has cleaned major towns, rivers, and most of the prominent tourist trek and hike routes in Bhutan, and is also actively advocating behavioral changes among the people (Zangmo, 2015). In addition, Green Road, a construction company based in Thimphu with the aim to reduce the amount of plastic waste going to landfills by 30% to 40% has been using discarded plastics to blacktop the roads. Green Road used around 520 metric tons of plastic waste from landfills to construct 80 kilometers of roads blacktopped using plastic in Thimphu, Paro, Haa, and Phuntsholing in the last seven years (Dema, 2021). Further, Dema (2021) indicated that using plastic-coated aggregate and bitumen increases the life span of the road, offers better resistance to abrasion, wear and tear, and increases the load withstanding property. The rapid assessment of environmental issues during the NEC-UNDP-ICIMOD Joint Training Program on Climate Change Vulnerability Assessment in Punakha from March 23-25, 2021, as part of the National Adaptation Plan (NAP) Readiness Project found that waste is a major issue in Bhutan except in the Districts of Gasa, Haa and Lhuntse (*refer to figure 1*). Further, the participants from 20 Districts during the meeting expressed that the trend of waste in Bhutan is expected to increase in the coming years whereby a sustainable waste management system is urgent.

Annual generation and types of solid waste in Phobjikha valley: Figure 2 indicates that there is a sudden increase in solid waste with 72 metric tons in 2019, which is a worrying trend in a place with

² A wetland site designated for international importance under the RAMSAR Convention, an intergovernmental environmental treaty established in 1971 by UNESCO.

around 5387 population. But the trend dropped in 2020 due to no tourist visits and a decrease in local visitors owing to the COVID-19 pandemic. However, it was observed that the trend of waste in the valley has increased in 2021 with the opening of the valley to visitors. The annual record of the waste is maintained by the BNCEC of RSPN.



Figure 1. Rapid Assessment of Environmental Issues in Bhutan

Waste generation sources and their negative impacts: The wastes in the valley are categorized into four major types as per the criteria set by Gangtey-Phobjikha Environment Management Committee (GPEMC)³. Common wastes with 60% are recorded as the highest followed by recycled wastes at 20%, and non-recycled and organic wastes at 10% respectively. Likewise, the major source of the waste is hotels followed by shops and households. The homestays and institutions produced the least and are associated with common, recycled, and organic wastes (refer to table 1).

Table 1. Types, sources, and percentage of solid waste in Phobjikha

Types	In %	Sources
Common wastes: paper, plastic, chips, noodle packets, gum-boots, slippers, sneakers, leather shoes, rags, diapers, etc	60	Households, shops, hotels and institutions
Recycle wastes: beer bottles, cane beer, plastic bottles, cartoons, etc	20	Shops, hotels, homestays.
Non-recycle wastes: wax, wine & whiskey bottles, broken bottles	10	Households, hotels and shops
Organic wastes: kitchen and farm wastes, etc.	10	Hotels, households, homestays, institutions

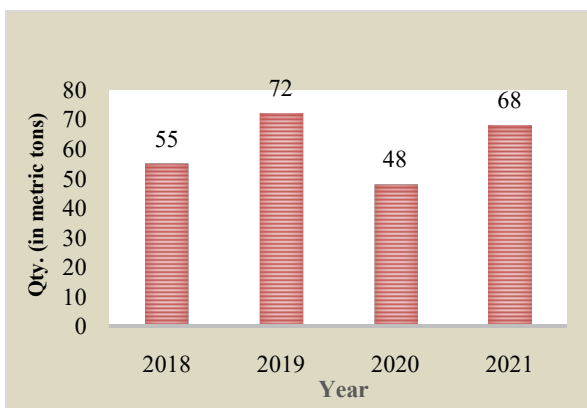


Figure 2. 4 Years Solid Waste Trend in Phobjikha valley

Figure 3 shows that inefficient solid waste management has resulted in significant negative impacts on the ecosystem in the valley. Water

and wetland are impacted the most with 44%, followed by impacts to the natural environment at 28% and farmland at 20% respectively. However, the respondents currently perceived insignificant impacts to public health at 5% and air at 3% respectively due to the pristine environment and the trend of hazardous waste being very minimal in the valley.

Causes of inefficient waste management in Phobjikha valley: About 20% of the negative response are connected to poor waste management facilities such as a lack of collection bins, transportation trucks, and no dedicated individual and agency to coordinate and manage waste. Further, 30% responded that lack of awareness and in-depth knowledge of waste by the people has led to no segregation and open dumping of waste. It is also indicated that 16% responded is on open littering by increasing visitors. About 12% responded that the lack of adequate plans and policies, and poor waste management facilities have resulted in inefficient waste management. About 5% of the respondents indicated that the generation of solid waste by increasing tourists and developmental activities has led to ineffective solid waste management in the valley (refer to figure 3).

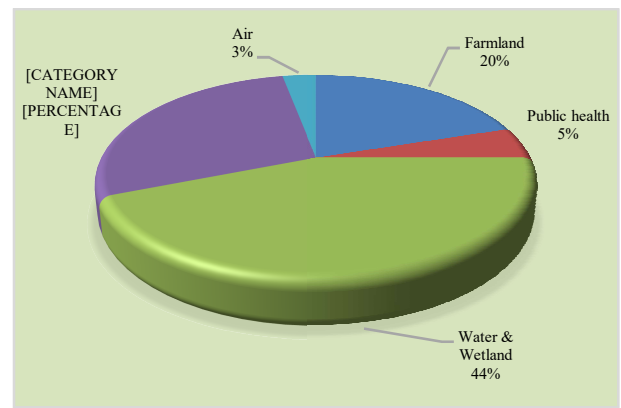


Figure 3. Negative impacts in %

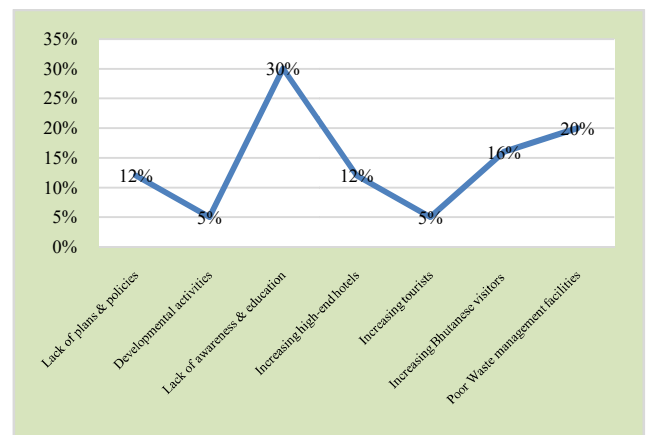


Figure 4. Inefficient Management in %

FINDINGS

The study has identified four major problems both through the survey analysis as well as the field visits and literature. The statistical analysis has shown that there is a sudden increase in solid waste in the valley in 2019, which is a worrying trend. It is associated with the indecent dumping of solid waste by increasing Bhutanese visitors from other places, and high-end hotels. Likewise, in-depth knowledge and awareness of waste and its value as a resource is lacking in the general population of the valley, which is a vital part of the efficient and sustainable waste management system. Other variables such as poor waste management facilities such as dedicated individuals and agencies to coordinate and manage, collection bins and trucks from the source to landfill, and lack of enabling plans and policies are the major setback to sustainable solid waste management in the valley.

³ Is an unregistered and apolitical body consisting of representatives from local government, local communities, cultural institutions, schools, relevant sectors, civil society organizations and community-based organizations effective for the purpose of Phobjikha valley conservation and community development.

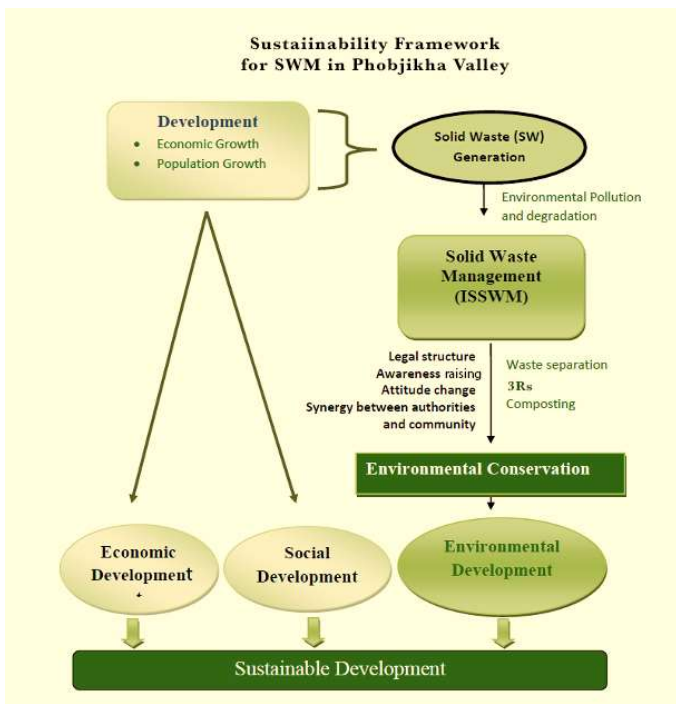


Figure 5. Solid Waste Management Framework for Phobjikha Valley

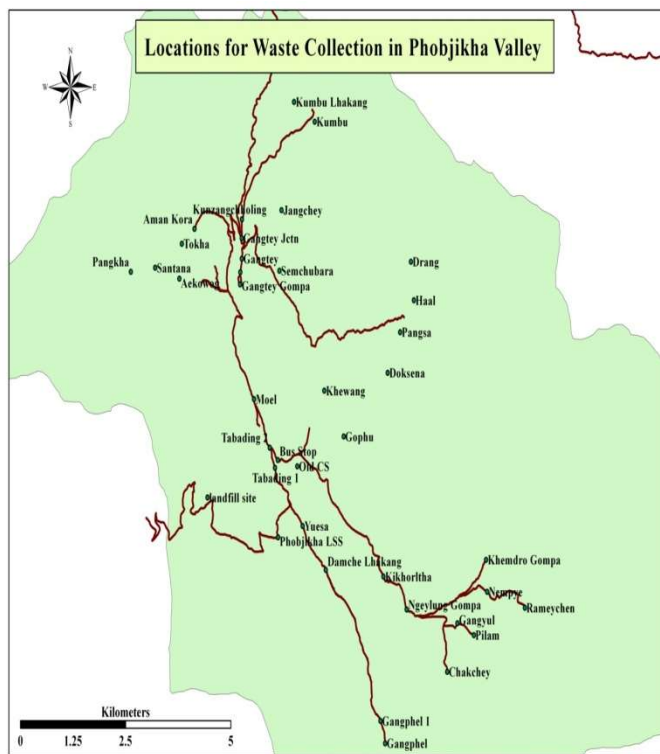


Figure 6. Map of Waste Collection Locations

In turn, inefficient waste management has substantially negatively impacted water and wetland, the natural environment, farmland, and public health.

RECOMMENDATIONS AND CONCLUSION

The recommendations for possible improvement of sustainable waste management in Phobjikha are the provision and fixation of bins at each waste collection location and the provision of a transportation truck. In the past, waste management was mainly concentrated in two commercial areas of Gangtey and Tabiding, but solid waste generation is at an increasing trend even in the villages. Therefore, the

map was developed to locate the possible viable routes and points for the collection of waste (refer to figure 6), and it is expected to facilitate a systematic and sustainable waste management system in Phobjikha. Likewise, continued awareness and education on the negative impacts of waste and management on the general population of the valley are important. This will enhance the people's understanding, concern, attitude, and action toward promoting sustainable waste management. Instituting a community-based waste management guideline and enforcement is essential to enable and facilitate regular communication for coordination and encourage stakeholder and community participation for sustainable solid waste management in the valley. The guideline is also expected to form a legal basis to enforce strict monitoring of solid waste management by households, hoteliers, institutions, and visitors starting from source to dumping at the landfill. In addition, the appointment of a regular landfill In-charge and waste collection driver would play a vital role in effective coordination, information dissemination, timely collection, and proper dumping of waste in the landfill. Also supporting start-up financial support to youths interested in starting a waste recycling business in the valley.

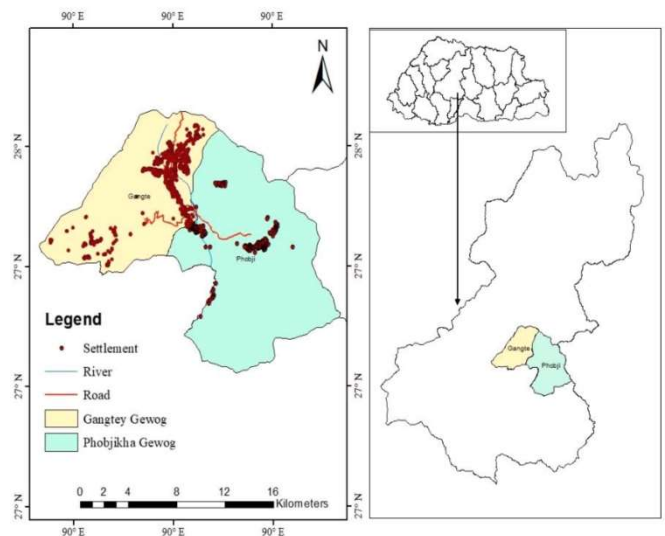


Figure 7. Map of Phobjikha Valley Study Site

This, in turn, is expected to enhance awareness and instill a sense of waste and its value as a resource whereby people will segregate the waste, sell and earn an income out of the trash, which will have positive impacts on society, the economy, and environment in the long-run. Finally, since this study has focused only on one aspect of the sustainable and effective waste management system, that is social and environmental; other aspects such as economical, technological, and political has to be linked after adequate research in the respective area for sustainable and effective solutions in the future. It is concluded that the waste management system in Phobjikha valley is not adequately addressing the vital aspect of an effective waste management system; social, technological, and policy aspects, which was deduced through this study based on the knowledge, perception, and attitude of people to waste and waste system. It would be necessary to strengthen these aspects along with other aspects such as more awareness of the importance of waste management, encouragement and incentives to individuals to take up waste-related activities, and general public participation in the waste management system. It would be necessary to strengthen these aspects along with other aspects such as more awareness of the importance of waste management, encouragement and incentives to individuals to take up waste-related activities, and general public participation in the waste management system.

LIMITATIONS

Understanding research limitations and the possible impact on the results and conclusions are necessary for a better understanding of the

problems studied. Therefore, the expected limitations of this study are as follows:

- There is very limited secondary information about the solid waste of Phobjikha valley; therefore, the information gathered through this study may not be sufficient to produce representative results.
- Information can be biased since the findings and observations are made purely based on the respondent's answers.
- The study was initiated within a short duration, and the information may not be accurate and complete.

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