South Asian Network for Development and Environmental Economics

First Progress Report to IDRC

(Grant No. – 108283-001)

JANUARY 2018

Title of the project: Economic Analysis of Solid Waste Management and Drainage for Climate Resilient Cities in South Asia

Prepared by:	Mani Nepal, Principal Investigator
Report Type:	First Technical Report
Period covered by the report:	February – December 2017
Reporting Date:	January 31, 2018
Full Name of Research Institution:	South Asian Network for Development and Environmental Economics (SANDEE) at International Center for Integrated Mountain Development (ICIMOD).
Address of Research Institution:	Dhapakhel, Lalitpur, Nepal

Name of Researcher/ Members of Research Team:

1. Mani Nepal, Principal Investigator, SANDEE
2. A K Enamul Haque, Co-principal Investigator, ACD
3. E. Somanathan, Senior Researcher, ISI Delhi
4. Rajesh Rai, Researcher, SANDEE
5. Bishal Bhardwaj, Researcher, MOFLD, Nepal.
6. Muntaha Rakib, Researcher, ACD
7. Neelam Pradhananga, Researcher, Clean Up Nepal
8. Ismat Ara Pravin, Researcher, IWM
9. Madan Singh Khadayat, Researcher, SANDEE
10. Ganesh Dhakal, Researcher, NDRI and KU.

Contact Information of Researcher/ Research Team members:

Dr. Mani Nepal (PI)
Program Coordinator SANDEE and Lead Economist, ICIMOD
Dhapakhel, Lalitpur, Nepal
mani.nepal@icimod.org; manin@sandeeonline.org.

Tel: +977 1 5275223

Executive Summary

1.1. **Research Problem**

Amongst the many threats from climate change in South Asia, responding to flooding and extreme rain events is a priority for cities. The effects of climate-driven heavy rainfall and storm surges are exacerbated in urban centers because of inadequate drainage systems. Exposed cities are at risk from immediate costs from losses in life, assets and productivity and by the disease outbreaks from waterlogged drains and contaminated drinking water. To enable waste to be managed under circumstances of extreme or frequent flooding and heavy rainfall, cities will need to become more resilient. This research helps to increase the resilience of municipalities in three ways: a) identifying ways to reduce the quantity of waste per capita, b) enabling cities to improve their revenue collection so as to finance improved solid waste and drainage management systems; and c) enabling municipal staff to adapt to climate change by making better system-level decisions based on tools such as GIS and hydrological modeling.

1.2. **Research objectives**

This study is undertaking hydrolicmic modeling and economic analysis of solid waste and drainage management systems in two cities in South Asia: Bharatpur in Nepal and Sylhet in Bangladesh to:

i) identify the extent to which waste segregation and improved solid waste management can obviate the need for additional physical investments,
ii) understand what incentives and systems can be used to induce households and other establishments to consistently segregate waste, so as to reduce the collection burden on municipalities and enable more comprehensive and cost effective composting and recycling arrangements,
iii) identify how improvements to solid waste management systems can be financed in a sustained manner, and
iv) assess the staffing and financial requirements for cities to sustainably implement such changes.

1.3. **Research activities**

So far, we have completed a) inception workshop, b) stakeholders meeting, c) groups discussions, d) hydrological, land level and drainage network data collections, e) pre-testing and baseline data collection from TLOs and households, f) sensitization workshops, g)

securing secondary data and information including GIS map for the cities and meteorological data from different agencies, h) preliminary analysis of choice modeling, i) preliminary analysis of hydraulic modeling. Table 2 provides complete lists of activities, and their status.

1.4.**Summary of research findings**

The first half of 2017 research activities were mostly related to identifying and contracting researchers and partner organization. In the second half, we have been able to complete various surveys for collecting

i) Hydrological data, land level data and cross-section data of sorrunding rivers and canals for understanding flooding potential in two cities under different scenarios,
ii) Baseline data for socioeconomic analysis,
iii) Data collection for choice experiment, and
iv) Sensitization activatities in the field

Most of the analysis will be done 2018. From preliminary analysis, the major findings are:

a)

2. **Project Management**

The research project is managed and coordinated by SANDEE Secretariat based in ICIMOD, Kathmandu, Nepal. Year 2017 was critical for SANDEE as it went through institutional change. SANDEE became of part of ICIMOD since July 2017 and it was in transition phase for the next six months. Despite all these changes, SANDEE core team involved in the research project has been intact and we have been able to put the research team together in the first-half of 2017. Table xx shows the complete list of institutions and researchers involved in the research project.

The Bharatpur City is one of the partner organizations in Nepal where the research sites are located. The city has also gone massive institutional change after we started the research project. The city was Sub-Metropolitan when we developed the proposal and got research grants. After we started the research activities, the government of Nepal re-structured the political structure of all local bodies in Nepal, and Bharatpur became Metropolitan City. With the restructuring, the government also conducted local election in Nepal, with implication of larger city area, and new leadership in city administration. Earlier the city was run by the government officials. The City

got elected representative from August 2017, and it took a while for the research team to establish link with the city.

In order to take the newly elected representative on board and provide an opportunity to learn from other cities in Nepal, SANDEE organized a five-day study visit for the Mayor, Deputy Mayor and some of the elected ward chairmen and relevant officials of the BMC (January 9-13, 2018). We visited Dhankuta, Itahari, and Ilam and interacted with these municipalities on how they have been managing city wastes. Private contractors from BMC were also included in the team. We chose these cities as Dhankuta and Ilam have been managing their solid waste better than the rest of the municipalities in Nepal.

Asian Center for Development is coordinating with partners in Bangladesh. We managed to developed ToRs and get contracts to all partners (ACD, IWM, NDRI, Clean Up Nepal), and researchers (E. Somanathan, Bishal Bhardwaj, and Rishi Kattel). We also have signed Letter of Intent with Bharatpur Metro and Sylhet City Corporation for implementing the research activities in these cities. We had number of meetings with city officials and relevant stakeholders through out 2017. As of December 31, 2017, the research project is in track to meet the research objectives and we are making an excellent progress. The complete list of project activities are presented in Table 1.

Comment [MN1]: Enamda, please check this add more.

ACD Research Team had Meeting with Mayor of Sylhet

Professor Saleh Uddin, Prof Enamul Haque, Dr Muntaha Rakib and the research team members of the IDRC project had a meeting with the Mayor of Sylhet City Corporation Mr. Ariful Haque Chowdhury, CEO of the City Corporation and discussed strategies of implementing research activities in the city, They have agreed to develop awareness module to on waste segregation at source and have also agreed to conduct the research experiment in wards 1, 16, 18 and 22. They have agreed to conduct baseline in these wards and also develop awareness campaign on waste segregation at home to introduce community base composting of kitchen wastes.

The CEO of Sylhet City Corporation Mr. Enamul Habib was present at the meeting. From the Asian center Professor Saleh Uddin, Dr Muntaha Rakib, and Nabila Nazhat Hye were

present. They also discussed developing a mobile app using google map to promote the concept of sustainable cities.

The Mayor has agreed to introduce "Mayor's Green Award" to best 2-3 clubs in the for making the community environment friendly and to 2-3 houses in the clubs which will be part of the research experiment.

Left to right: Dr Muntaha Rakib (Researcher and Associate Professor, SUST), Dr. A.K. Enamul Haque (Executive Director ACD), Mayor Ariful Haque Chowdhury (Mayor), Prof Saleh Uddin (one of the Director of ACD), and Mr Enamul Habib (CEO)

3. **Variation in the original plan**
    1. *Dropping Kawasoti City*: In the original plan, we had included Kawasoti, another city in Nepal, for understanding how the involvement of private contractors help cities to manage their solid waste and also earn some income, instead of putting municipality's scare resources for managing solid waste. This plan didn't materialized as the municipality administration couldn't make decision on the landfill sites and without the provision of landfill site, the private sector couldn't participate in managing the city's solid waste. Therefore, we dropped Kawasoti and started working with the private sectors involved in Bharatpur.
    2. *Adding 'Mapping Solid Waste Management System'*: Clean Up Nepal, one of the partner organizations, has been working on Mapping Solid Waste Management System in Kathmandu city thought Nepal Waste Map. Since Clean Up Nepal is one of the research partner, we are adding this component in Bharatpur city.

Nepal Waste Map is web-based data dashboard and mobile application, to visualize, manipulate and analyze the data related to functions and operations of solid waste management. It serves as a fine open-data platform for government, private and civil society to work collaboratively and have a constructive dialogue and solve waste management problems synergistically. It establishes communication between government, private and citizens through announcements and reporting mechanism. (Municipalities could make announcements to citizens related to waste and citizens can report waste dumping and burning and learn about their collection schedules, etc). In Bharatpur, we have planned for piloting it in one of the wards. If the system helps the city in managing solid waste better, then they can implement it in other wards as well.

These changes will have no budgetary or activity related implications for the project as we moved the piloting part that was planned for Kawasoti to Bharapur.

4. Research Components

The main activities supported by the research project during 2017 are discussed below. So far, we are on track in all activities, and there is no change in the methodology. We have been able to collect most of the secondary and baseline primary data. Therefore, we don't have research findings yet except in few cases that are noted in this report.

4.1. Hydraulic modeling

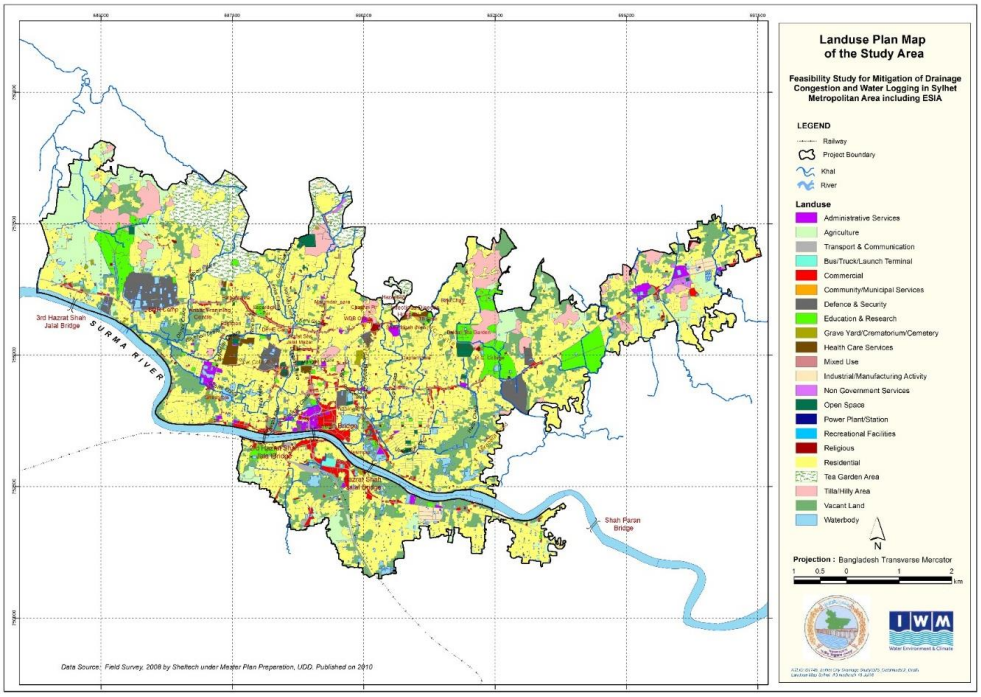
Cities in South Asia are experiencing significant storm water drainage problems due to a combination of various hydrological, socio-economic and climatic factors. Socio-economic development causing land use changes where low-lying areas are getting filled up for infrastructure development and impervious areas are reducing. Due to this reason, volume of runoff and the peak flow are increasing. Due to lack of proper solid waste management, people are dumping solid wastes in the drainage channels and these channels have been encroached as cities are expanding without proper planning. Solid waste dumping and encroachment are reducing the conveyance capacity of the drainage channels. As a result, the existing drainage channels fail to convey the storm water runoff even in normal condition. Consequently, the runoff spills into the surrounding areas causing widespread flooding and water logging. The changing climate is another issue of concern for South Asian cities. Due

to climate change, the frequency of shorter duration high intensity rainfall are expected to increase. This aggravates the drainage congestion further. Using hydraulic models of the drainage systems in Sylhet (Bangladesh) and Bharatpur (Nepal), in this research we investigate the impact of socio-economic changes, solid waste management, encroachment and the changing climate on the future flooding potential in these cities.

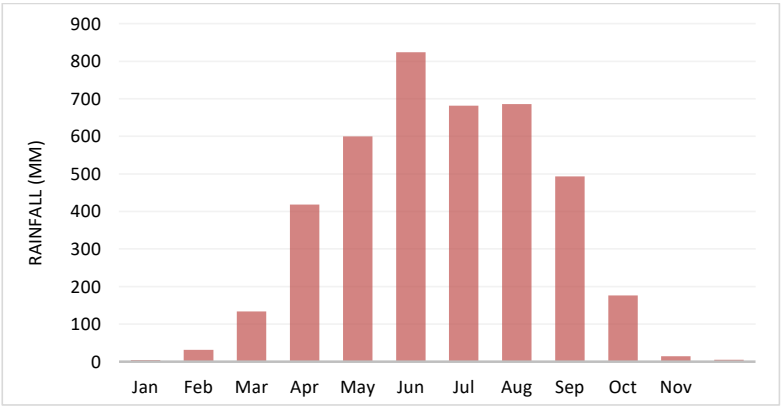
For both cities, secondary and primary data collection for has been completed. Primary data collection includes survey activities for (i) rainfall data (ii) hydrometric data (water level & discharge) (iii) drainage canal cross sections (iv) observe sediment deposition in the canal bed by measuring cross section weekly at some particular points. For Bharatpur city all data has been collected in National Datum in Nepal (NDN). The rainfall data is collected for 2017 monsoon at Bharatpur.

Several temporary bench mark (TBM) at different location had been established based on the existing BM of Bangladesh Water Development Board (BWDB) during the survey campaign for *Feasibility Study for Mitigation of Drainage Congestion and Water Logging in Sylhet Metropolitan Area including ESIA* project. Those TBM has been used while collecting data for Sylhet city. TBM has also been established during the survey work for Bharatpur city. Detail map on TBM for Bharatpur will be developed and incorporated in the Second Progress Report as data processing of the survey campaign is still going on.

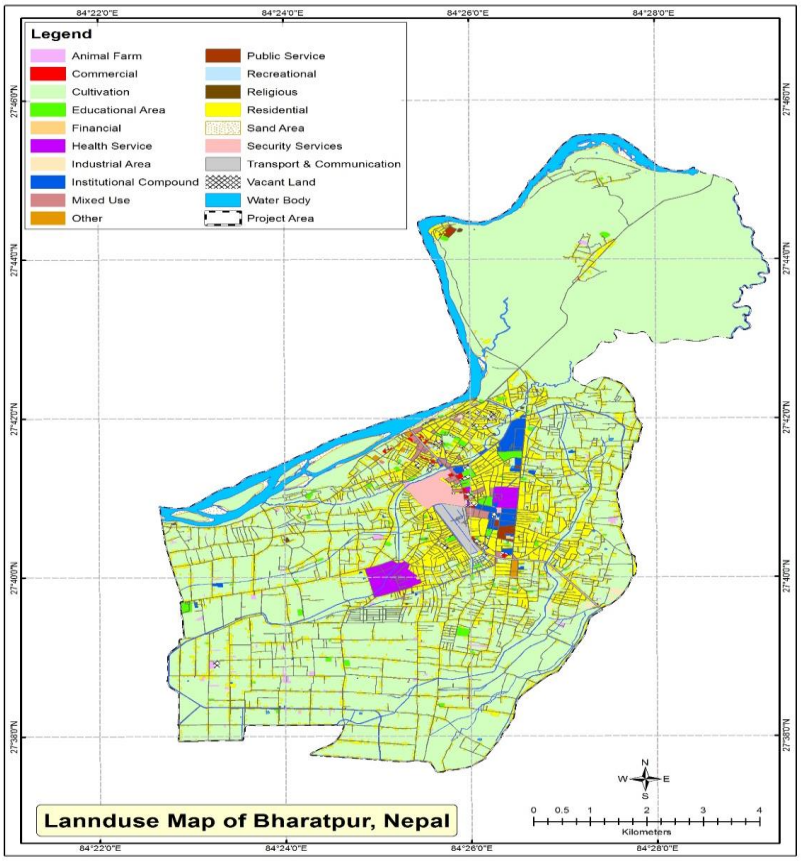
Some of the basic information collected from the study sites are presented below.



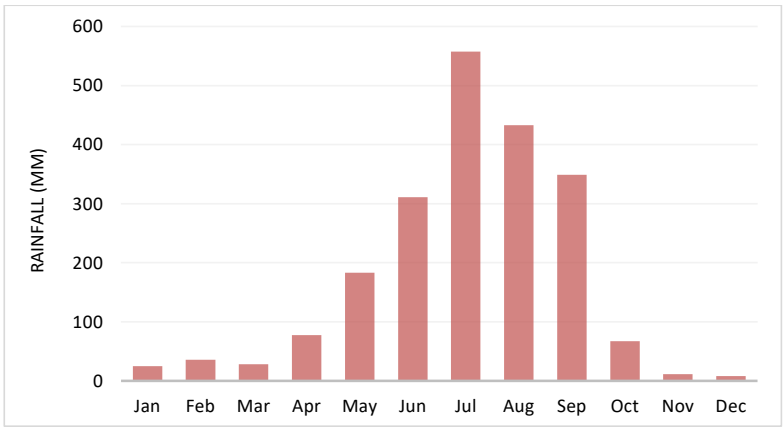
Land use map of Sylhet, Bangladesh



Monthly average rainfall in Sylhet



Land use map of Bharatpur, Nepal



Monthly average rainfall in Bharatpur

Drainage congestion due to uncrolled dumping of solid wastes in Sylhet, Bangladesh

Solis waste dumping: Pungi canal

Vegetable in drains: Bosini chalk

Solis waste dumping: Kerunga canal

Siltation: Srejani chalk

Drainage congestion due to unrolled dumping of solid wastes in Bharatpur, Nepal

In 2018 we will focus on modeling part once we finish cleaning the primary data and aligned with secondary data for modeling. We plan to examine different scenarios, including: (1) the baseline scenario of 2016-17, (2) business-as-usual socio-economic scenarios in 2030 and 2050, (3) business-as-usual socio-economic scenario in 2030 and 2050 plus the climate change impacts. A set of mitigation and adaptation scenarios will be examined that include (1) engineering options for reducing the peak storm water runoff and its volume from the urban catchment, (2) management of solid waste, and (3) adaptation option to manage higher intensity shorter duration rainfall as a result of climate extremes. We will estimate costs for various interventions and scenarios.

The preliminary findings show that engineering options may give short-term solutions but may not be sustainable in the long-term. The engineering solutions need to be integrated with socio-economic issues like solid waste management and awareness building as adaptation measures of urban flooding.

4.2. **Randomized Controlled Trials**

The main problem the cities that we are studying face is how to segregate household solid wastes at the source so that they can reduce their expenses in collection, transportation and landfill costs. We conduct controlled trials, randomized at the neighborhood level, that include raising awareness about the link between waste management and waterlogging, and provision of public bins in the neighborhood. Out of 350 Tole Lane Organizations in Bharatpur core city area, we randomly selected 150 TLOs, and 50% of them assigned treatment and the rest is kept as control. So far, we have collected baseline data from 150 TLOs (interviewed 150 TLO executive committee member – Chairmen or responsible officer) and 1050 households. After the baseline, we also conducted awareness campaigns in the 75 TLOs (treatment TLOs) on managing household solid wastes better including segregating at source and composting at home, wherever possible. We are now planning to install small public bins in the street to help the city dwellers to put their solid wastes. After the installation of the bins, we will conduct a follow up survey in order to understand the impact of awareness campaigns and public bins in cleanliness of the city and improvement of the solid wastes management.

4.2.1 Sylhet: The Baseline Household Survey in Sylhet City Corporation

This section presents the summary findings of the socioeconomic survey on solid waste management in Sylhet City Corporation. The study examines the types and methods of solid waste generation and their disposing; possibility of segregation; level of awareness and knowledge of solid waste disposal and management; causes, problems and solution of illegal disposal; the gender perspective of household waste management, the willingness of households to pay for solid waste management in the study area.

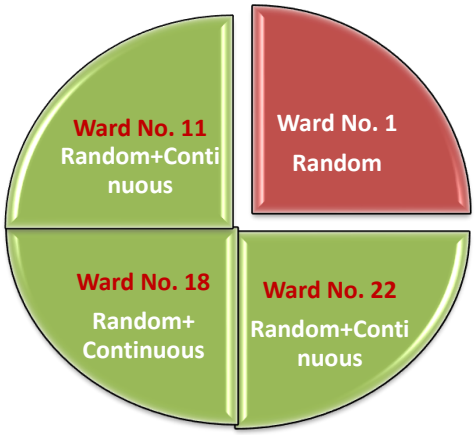
The Sampling Plan

According to the project plan, to conduct controlled trials randomized at the neighborhood level, 4 Wards (listed above) were selected to survey after consulting with the Mayor, CEO and Chief Executive Engineer of Sylhet City Corporation (SCC). The ward numbers are - 1, 11, 18 and 22 among which Ward number 1 was the control ward. From the list of clubs of the selected wards, one club from each ward (11, 18, and 22) was randomly selected. The names of the clubs are Kolokakoli Club (Ward no. 11), Jhorna Torun Songho (Ward no. 18) and F-Block Unnaya Songstha (Ward no. 22). 100 data were randomly collected from the control ward while both random and continuous data were collected from the treatment Wards.

Data collection method

Enumerators were engaged in the survey since September 22 to 27, 2017. A total of 723 households provided responses to the elaborate questionnaire which consists of detail question on solid waste management and segregation, willingness to pay, perception and household and individual specific questions. The questionnaires were administered using 15 field enumerators, who were trained on collection of data using mobile devices. For continuous sampling, enumerators went to first 100 households under the randomly selected club. On an average a club consists of 100 to 130 households. For random sampling, Rosters were maintained among the enumerators and they went to the selected wards and used systematic random sampling framework to select the household for the random survey. Every tenth houses in a locality on one side of the road was selected for the survey. In some cases, more than one households bearing same house number were surveyed and therefore 723 households were surveyed in total.

Figure 2: The Sample Plan



Descriptive statistics is presented to identify the types of waste generated, the methods of disposing solid waste in SCC, awareness and willingness of households' to pay for solid waste disposal and relation to waste management behavior with major socioeconomic indicators.

Profile of the sample households

Table 1, 2 and figure 3, 4, 5 present household and individual specific characteristic of the sample households.

Table 1: Household and individual specific characteristics of the respondents

Variable	Random sample	Continuous sample	Unit
Male headed Household	89	90	Percent
Age of HHH	51.54	50.87	Years
Establishment of HH	1.49	1.45	Years
House owner	52	54	Percent
Household size	6	6	Number
Number of male per HH	2.87	2.89	Number
Number of female per HH	3.04	3.08	Number
Number of male income earner	92.65	91.45	Percent
Number of female income earner	14.93	13.49	Percent
Monthly expenditure of HH	34753	29642	BDT
Average monthly rent per HH	10304	8772	BDT

Table 1 shows that only 11 percent and 10 percent of the households are headed by a female in random and continues sample respectively while no female income earner exists in around 84% of the families in the survey. Average monthly expenditure for the households in random sample is 34753 taka and 29642 taka in continuous sample. Average monthly rent is around 10304 taka and 8772 taka respectively for the sample types shown in Table 1.

Table 2: Income distribution of household members by sample type

Family income/earning (monthly)	Random	Continuous
Less than 5000	0.24	0
5001 - 10000	1.43	5.61
10001-20000	11.67	15.18
20001-40000	38.33	40.59
40001-50000	25.95	19.8
50001-100000	18.33	15.84
100001 and above	4.05	2.97
Total	100	100
n	420	303

Average monthly income is about 20,000 taka to 50,000 taka for near about 64% of the randomly selected households while around 60% for the continuous sample (Table 2).

Solid Waste Management in Sylhet

Like many other cities in Bangladesh, households pay directly to the garbage collector for their service to collect daily garbage from their doors to a secondary collection point. From the secondary collection points, SCC uses their dump trucks to transport them to the city dumpsites which are located outside the city. Total collection mechanism is illustrated in the following schematic diagram.

Figure 6: Garbage Management System in Sylhet

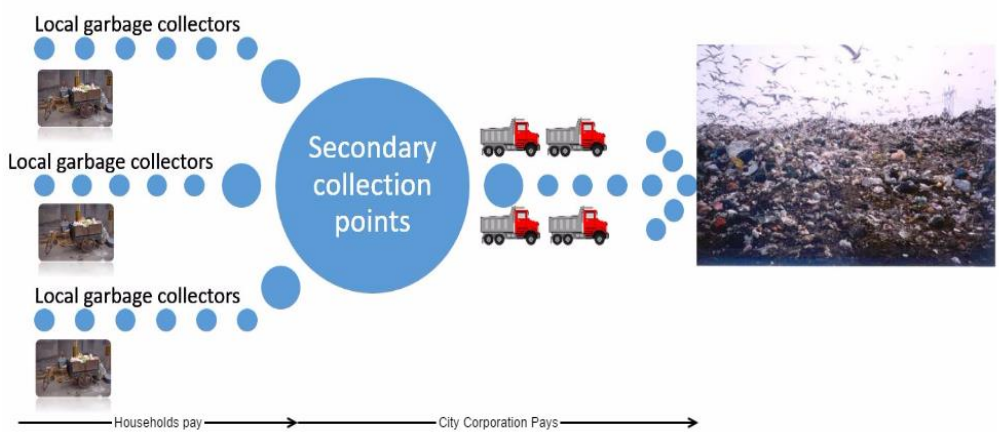


Figure 6 illustrates the process through which household garbage ultimately reach its final destination, the garbage site. However, at each stage there are leakages because of which a large portion of the city solid waste ends up in the city drains causing water-logging during heavy rainfalls. In order to understand how the city dwellers understand this and how they manage the waste within the household, the survey questionnaire had detailed questions on garbage and its disposal process. The result is summarized below.

Table 4 shows the possible segregation of the types of solid waste by the respondents. Randomly selected households are more responsive to segregate different types of wastes in general. Sweeping waste, sanitary and medical waste and glasses are lowest possible to segregate according to the respondents.

Table 4: Possible Segregation by the HH

	RANDOM (%)	CONTINUOUS (%)
None	2.38	6.27
Dry waste of sweeping	25.48	17.82
Sanitary and medical	45.00	39.60
Glasses/Bulb	45.48	42.57
Metal	64.52	62.05
Bottle	79.52	78.88
Organic or food waste	87.38	82.51
Paper	87.38	84.16
Plastic	89.29	87.46

Disposal of solid wastes

Error! Reference source not found. summarizes the garbage disposal behavior of the city dwellers. It shows that about 89% of the randomly selected respondents give their daily regular waste to the local garbage collector which is 84% for continuous sample., about 48% sell part of their garbage, 11% and 14% (in random and continuous sample respectively) throw some of their garbage. Composting and burning as a dumping method is only around 8% and 3% respectively in both sample type.

Table 5: Pattern of Disposal System of Daily Garbage

Disposal System of Daily Garbage	RANDOM SAMPLING	CONTINUOUS SAMPLING
Give to garbage collectors	**89.29**	**84.16**
Sell aluminum/iron/glass/bottle	**47.86**	**47.52**
Throw Away	**10.71**	**13.53**
Compost it in my compound	**8.33**	**7.92**
Burn	**3.10**	**2.64**
Donate to someone	**0.95**	**0.33**
Others	**0.48**	**0.33**

In Sylhet as well as in many parts of Bangladesh market for certain wastes exist. This is true for plastics, bottles, and metals. Therefore, there is likelihood that households might sell some of their solid wastes that have a ready-made market.

Awareness about 'at home' segregation

In most of the developed countries households segregate their garbage at home. This reduces the cost of transportation of garbage to dumpsites, reduces health hazards of rat pickers because garbage is not mixed up with organic wastes, and also improve recycling of many wastes. **Error! Reference source not found.**12 shows that nearly 53% and 57% of the households are aware of segregation, among which 28% and 34% are practicing segregation at home by sample type while more than 80% are willing to segregate waste at home.

Table 12: Aware, practice and willing to segregate waste at home

	Aware of Segregation	Practice Segregation	Willing to segregate
Random	53.33	28.4	86.43
Continuous	56.77	33.99	83.17

Based on the baseline survey results, it shows that households are not fully aware of 'at source segregation' of wastes. As such ACD is currently developing awareness campaign materials for administering the RCT survey. The campaign materials include house-to-house campaign and also a 'citizen's platform' using a mobile-device based App through which the campaign for "CLEAN SYLHET" will begin.

4.3. **Hedonic Price Modeling and Choice Experiment**

In order to establish the public benefits from improved drainage and solid waste collection systems, we plan to estimate citizen's willingness to pay for better solid waste management as well as other amenities. To this end, we are working on hedonic property price analysis (Rosen, 1974; Hill, 2013) using baseline survey. This information will be supplemented by nationally representative urban household surveys data (secondary data) to estimate household demand for better drainage and improved solid waste management. The analysis is plan for 2018.

We supplement the hedonic analysis in Nepal for estimating households' willingness to pay for amenities with choice experiments. By conducting choice experiments in the treatment and control TLOs of the randomized controlled trials described above, we intend to assess whether willingness-to-pay for improved amenities increases with awareness of the link between waste management and waterlogging/flooding as well as experience of better

service. We have completed the survey for Choice Experiment. A preliminary analysis has been conducted and it will be refined while developing a manuscript.

Table 1: Selected attributes and their levels

Attributes	Description	Levels
Frequency of collection	Number of trip of door-to-door waste collect service per week. This service is a trip per day.	1. As much as now 2. Less frequent than now 3. More frequent than now
Timing of collection	Waste collection door-to-door vehicle service time in the concern TLO or business area. Currently, it is determined by the availability of the vehicle.	1. As per now 2. As per convenient
Street cleaning	MSW collection service provides both waste collection and street cleaning. Currently, street cleaning service is occasional.	1. As per now 2. Dedicated sweeper to clean the street 3. 10 liter bin at the street 4. Both sweeper and bin
Additional Tariff	Currently, municipal households and business community pays monthly tariff based on the frequency of collection determined by their respective TLO.	1. 10% less 2. 10% more 3. 20% more 4. 30% more

For the choice experiment, these attributes are chosen after having several focus discussions with the city officials, waste collectors, households and TLO members.

Figure 2: An example of a choice set

कृयाकलापहरु	विकल्प १	विकल्प २	वर्तमान अवस्था
फोहोर संकलन गर्ने दिन 	अहिले भन्दा लामो अन्तरालमा (हप्ता मा कम पटक आउने)	अहिले भन्दा छोटो अन्तरालमा (हप्ता मा धेरै पटक आउने)	अहिलेको जस्तै
फोहोर संकलन गर्ने समय 	टोलको निर्णय वमोजिम समय तोक्ने	अहिलेको समयमा (साबिक)	अहिलेको समयमा (साबिक)
सडक सरसफाई 	अहिलेको जस्तै	सडकमा २० लि को वाल्टिन राख्ने 	अहिलेको जस्तै
अतिरिक्त शुल्क 	१०% कम 	३०% बढी 	अहिलेको जति 
कुनै एक विकल्प छनौट गर्नुहोस (√)			

This figure shows one of the choice set that responded were shown to make their preferred choice. This analysis will help cities evaluate different property tax rates and collection fees and design Solid Waste Management (SWM) services taking into account trade-offs between attributes of SWM services made by households. We will then estimate the potential revenue that the cities could generate for financing solid waste and drainage management based on public preference on attributes of the SWM program.

Our preliminary finding suggests that households prefer fixed timing of door-to-door service and cleaning of the street as the main services of the private contractor. Almost all households (95%) are participating in the waste collection service, and more than a half (53%) are not satisfied with the service. The daily solid waste production is about 5.9 kg per household, of which 73 percent is degradable waste. Regarding organic waste majority of the households (54%) make compost and 32 percent feed to animal. In the case of non-degradable waste, 73 percent send with municipal waste collection vehicle. Women are the main actor participating in waste collection and disposal at household level. The preliminary results of the choice analysis suggest that households prefer improvement in waste collection time and want to have bins at street for pedestrians; and households have willingness to pay for these improvements. On the other-hand, households are satisfied with the waste collection frequency, which was determined in the consultation with respective Tole Lane Committees. This study also suggest that municipal waste collection can be improved by involving Tole Lane Committees in designing the service of their choice.

4.4. **Examining the possibility of imposing additional tariff on plastic imports at the central level:**

Taxes on commodities such as plastic can be used to cover the cost of proper and comprehensive waste management. The centrally collected revenue can be shared with cities within the existing system in which central governments in both countries make fiscal transfers to local governments. In the new legal setting, local government in Nepal can design and implement different taxes to generate revenue and manage the cities. Analyzing plastic import data at national level, existing tax rates, and stakeholders interviews, one of the researchers has been working on understanding the scope of putting extra-tariffs on plastics materials, that may encourage recycling and reducing the waste at the landfill sites. Obtaining secondary data from government sources has been completed, In 2018, we plan to conduct interview with relevant stakeholders (government officials who work in review department, city officials, business houses, and fiscal experts, etc) in order to understand the possibility of using additional tax on plastic as an instrument to reduce plastic wastes in the landfill.

4.5. **Examining the supply/value chain of plastic wastes**

Another component of the study is looking at the composition of the household wastes, understanding the recycling markets and reviewing policy gap for better managing plastic related waste. This study is just started towards the end of 2017. We are currently developing primary survey instrument for piloting. This study will be conducted in three cities including Bharatpur. We added two more cities in order to widen the scope of the findings so that a meaningful policy recommendation can be drawn. For this study, two cities, Hetauda and

Butwal, are added. This addition will increase the scope of the study and makes it more representative of Urban Nepal in Terai but we will manage to do it within our budgetary limit.

4.6 Market chain and value chain of Solid Wastes

This study mainly focused on the present status of recyclable waste in Sylhet city. Both qualitative and quantities data is collected through field observation, FGD with stakeholders and market survey. Secondary information has been collected from various researches, Journal, Articles. Information includes amount of inorganic waste, market and value chain, transportation system, storage system, stock duration. Primarily the study identifies the recycle product market in Sylhet City Corporation.

Objective of this study

The primary objective of this research is to develop solid waste management and recycling process on Sylhet City Corporation, through this study we are going to comprehend;

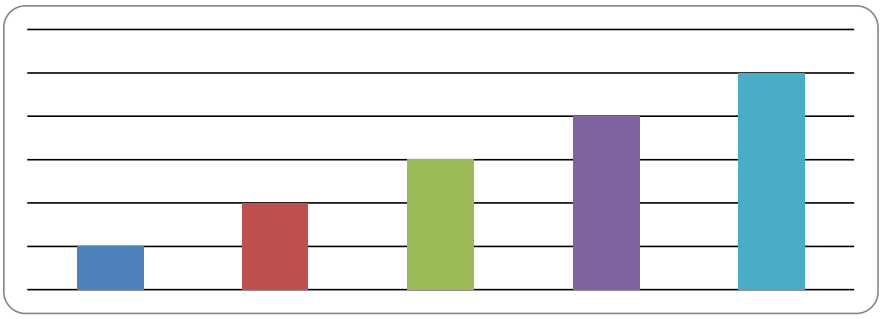
1. To identify the source and market of recyclable products
2. To investigate the stake holders, market chain and value chain of recyclable product
3. To discuss about the public perception and participation in recyclable waste

Solid waste management and recyclable garbage in Sylhet City

Solid waste management is one of the major challenges of city management. Every day Sylhet city produced 220 metric ton waste from various source (Household, business clinical etc)1. Among these, 67% of the solid waste is organic waste and rest of the wastes are inorganic includes plastic, paper plastic bottles, polyethylene, metal.2 Solid wastes are generated from 27 wards of different sources like residential, commercial, construction, clinical and municipal. There is only one dumping ground for Sylhet City Corporation which is located in Lalmatia (parirchokh) with 1 vacuum tanker, 4 water tanker, 150 van which collect waste from different points of the city.[3]

[1] Presentation-On-Sylhet-City-Corporation-Solid-Waste.
[2] Municipal Solid Waste Management In Sylhet City, Bangladesh, Md. Ashraful Islam.
[3] Municipal Solid Waste Management In Sylhet City Bangladesh

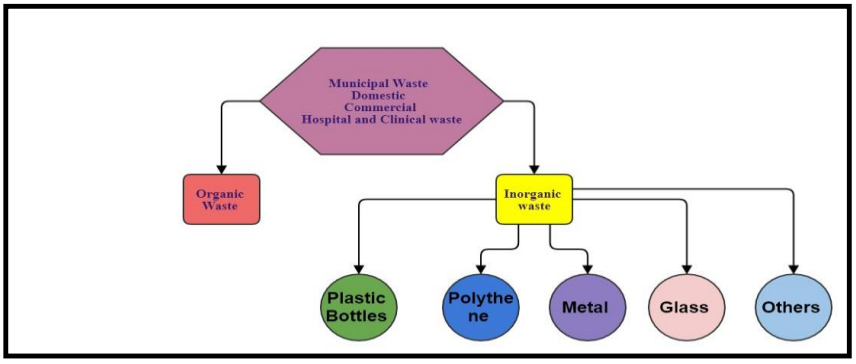
Figure 8: Waste generation increasing with time. ([Ifterkhar Enayetullah et. Al.,2005)



The pattern of solid waste generation shows that its number has doubled from last 10 years as we can see the figure 8. In 2004, it was 100 ton per day and in 2016 the number has more than doubled to 250 ton waste per day.

The present findings suggest that multi-stored buildings generate more waste than any other types of building. Where two stored building generate 2.2 kg waste per day, 6+ stored buildings generate double waste which is 4.9 kg per day. Particularly, multi-storied building generates more organic waste than 2 stored buildings.[4]

Figure 9: Category of Municipal waste



Municipal wastes are categorized in two major types - organic waste and inorganic waste. The major categories of inorganic wastes are– i) paper and cardboard, ii) Plastics and

[4] The Economics Of Solid Waste Management And Drainage : Sustainable Approach To Making South Asian Cities Climate- Resilient

rubber, PET bottles, UPVC/PVC materials and LDPE/HDPE materials. iii) Metals iv) Glass - clear glass, green glass, brown glass and other colored glass etc.

Market Chain of Recyclable Product

A market chain is a chain of the linked entities that bring a specific product from production to consumer sales. Longer market chains often result in a lower share of revenue generated by the product as the work and the reward are spread out among many. Recycling has always been a major priority for waste management. Not only does recycling help save valuable landfill space, it also helps protect the health of the environment and surrounding community. Hence, market chain for recyclable product is as important for the environment and as it is for the business or economy. In Sylhet City Corporation, there are more than 12 types of recyclable product we found from our FGD survey.

Table 15: Type of recyclable product

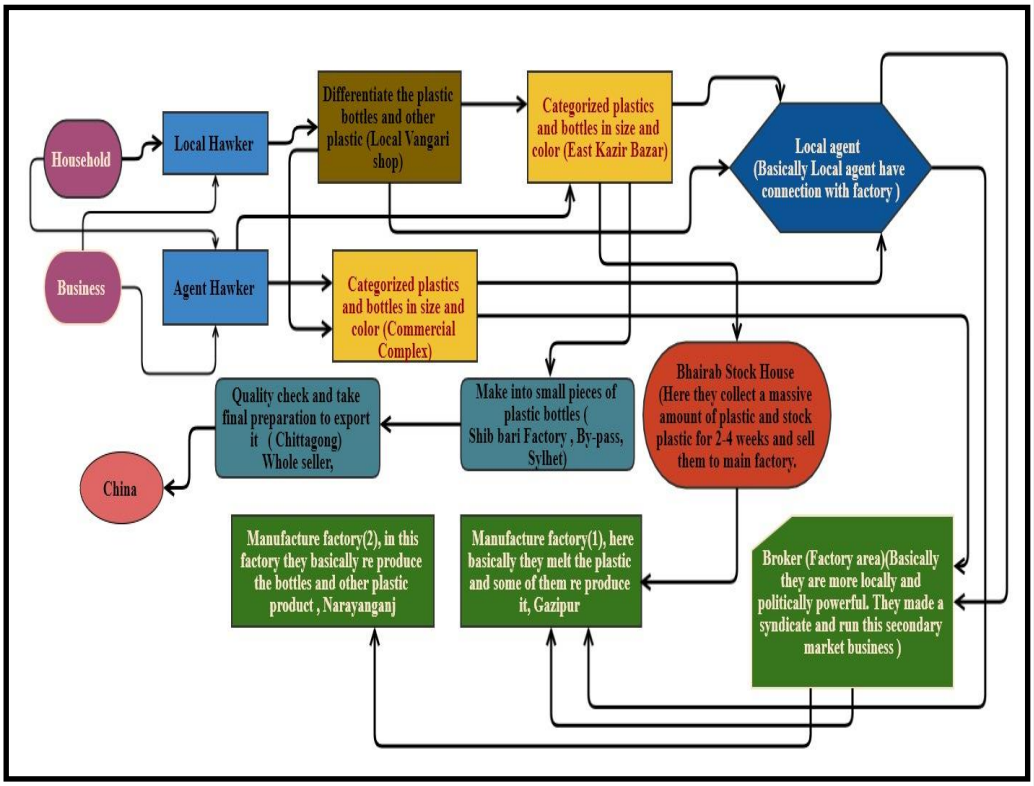
SL	Product Name	SL	Product Name
1	Plastic(Bottles)	7	Poultry Feed Bag
2	Metal	8	Oil Container
3	Polythene	9	Carton
4	Paper	10	Cement Bag
5	Glass	11	Drum
6	Cement Bag	12	Plastic(broken)

Major products are polythene, plastic bottles, paper (different kinds), metal, glass bottles. These products are usually collected from household and business and some part of recyclable products are also collected from clinical waste (like Injection and saline bag which amount is very low).

Figure-10 demonstrates the market chain of waste produced by house hold and business in Sylhet City Corporation. Households and business sell their waste to local hawkers or agent hawkers, sometimes to both hawkers. Local hawkers primarily prefer to sell their product to local Vangari shop and in this particular section they differentiate the amalgamate waste and others plastic. Local Vangri shop collect products from various source including local

hawker and then categorized plastic bottles and sell them to whole seller. However, some agent hawkers are basically permanent employee for whole seller and they only collect recyclable product for their own whole seller. They differentiate the recyclable waste by themselves.

Figure 10: Market Chain for Recyclable product (Plastic bottle)



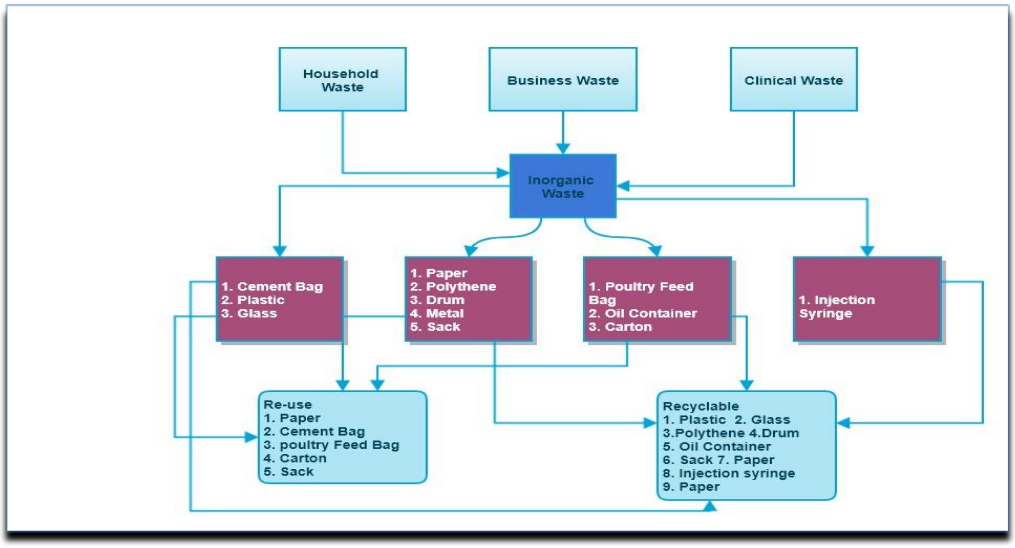
Local agents buy the waste from local Vangri Shop and whole sellers. Brokers also buy the waste from whole seller. Brokers, then sell them to manufacturing factory (1 & 2). Bhairab Stock House collects categorized plastic from whole sellers and sells them to manufacturing factory. In Sylhet there are some small factories collecting plastic bottles from whole sellers

and cut the plastics into small pieces and sell them to exporters at Chittagong. Exporters check the quality of waste and process the final operation to export them to china.

Value Chain of Recyclable Product

Value chain analysis examines the full range of activities required to bring a product or service from its conception to its end use, actors that perform those activities along the value chain and final consumers for the product or service (Vermeulen et al. 2008)[5]. To analyze, inorganic waste recycling process, this report uses Value Chain Method (VCM). VCM is a multilevel structural framework, explains every single business entity in an interlinked framework including their business functions, interrelation and supply chain position.

Figure 11: Classification of recycle waste by household and business (Re-Use and Recycle)



VCM also used as an analytical tool for the deep study of price mechanism, product process & collection period including amount, market influence, information passing and exploring different value addition by entities. From the field survey and FGD almost 12 recyclable

[5] Value Chain Analysis: The Insight Of Aluminium Recycling

products have identified in SCC. This can be classified into three major sections in terms of source. Household, Business and Clinical inorganic wastes are the major sections. Cement bags and plastic are clustered as household inorganic waste. Poultry feed bag, Oil container and carton are business wastes. But mostly a major share of these waste reaches at local market from the outside of SSC. In clinical waste section, only injection syringe comes in local market for recycling. Paper, Polythene, Drum, Metal and Sack are considered as a joint inorganic waste of business and household.

The core objective of this report is to explain SSC inorganic waste recycling process with the line detailing the price mechanism, collection method, duration, transportation, stakeholders and final processing of recyclable products. The components of value chain are explained in figure 12 in a simple diagram.

Primary Source: Primary source basically indicates major sources of waste (household, business, clinical). Either they store it at their place for short period for selling or dump it.

Medium: These are the small business entity or individuals that collect waste from door to door or dumping zone and sell it to wholesaler. Usually they do not hold the waste. They are fast sellers and regular buyers.

Whole Seller: They usually collect, stock and classify waste and hold for a short period. The time-period is based on the demand and collection of product. They maintain the price of medium with recycling factories. Often, they sell it in local market with or without any modification. They sell it either by brokers or directly to the recycling factories.

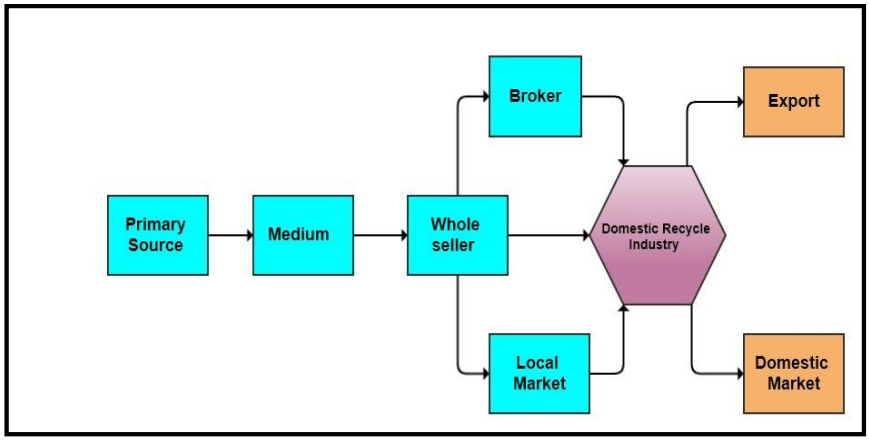
Broker: The work in this chain is mostly for commission. They are the intermediary person who works as an agent of factory.

Recycle Industry: They collect waste from all over Bangladesh. Their main purposes are bulk collection, process and send it to local or international market.

Local Market: The geographical location of this market is near and inside of SSC or all over Bangladesh.

Export: Exporting product outside of country.

Figure 12: VCM Diagram of inorganic waste recycling

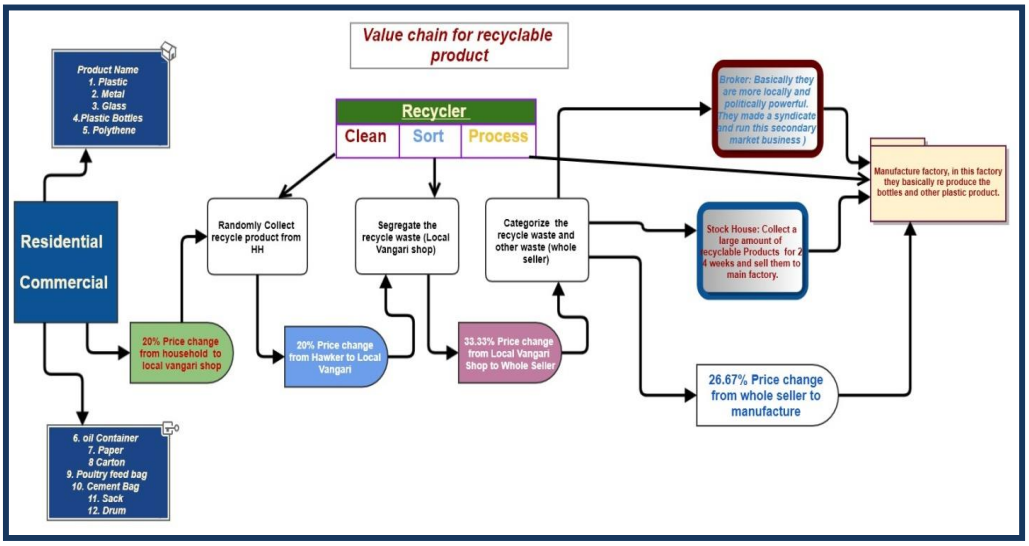


In market value chain management, the operation of 'RECYCLING' is an intricate process which starts with the disposal of waste items and ends with the re-use of a value-added material to deliver a set of customer benefits. The identical recyclable item, which changes from being a 'waste problem where it's a direct cost to the end-of-life disposer, has be re-produce as a 'product' which has a market value when fully recycled and re-used. The skill for the recycler is to be aware of how to preserve the value in the material as it moves through the whole, complex process[6]. Waste recycling is the process where recycle waste can be reused in products after its re-production. It has a number of key environmental and economic benefits.

In Figure we illustrate the value chain process in SCC (particularly is plastic product). Initially recyclable products are coming from residential and commercial sector. Then local/agent hawker purchases it where we can see that 20% value change and in this section they collect recyclable product randomly. The local/agent hawker sells it to the local vangari shop where the value change by 20% again and their work is to identify the product and segregate them.

[6] Understanding The Plastics Recycling Industry Value Chain By *Keith Freegard, Axion Recycling Ltd*

Figure 13: Value chain change in percentage for recyclable product



Whole seller purchase product from local vangari shop and also collect it from agent hawker. In this section whole seller categorize the recycle product into major categories (plastic, plastic bottles etc.) and value change by 33.33%. Finally manufacturing industry purchase it and convert this waste to re-useable product and the total value change is 26.6% change here. So from this diagram we can see that from household to manufacture the value of recycle product change exactly 100%. The waste which has a cost and also a mass problem for SCC , it covert into product and it has a market value now.

4.6. **Gender and Equity Considerations**

Better segregation of waste at source will reduce the hazards faced by poor rag-pickers, mostly women and children, who have to sort waste in dumps in order to find recyclable materials. By investigating avenues for financing waste disposal and collection that are not based on fee-for-service models, we are moving towards the possibility of universal waste collection that is not based on ability to pay. This will greatly benefit poor households who are disproportionately female-headed. To the extent that the project succeeds in reducing problems of waterlogging and flooding, this will benefit the poor most because they tend to live in neighborhoods subject to these

problems. For obvious reasons, those who are better off buy or rent homes in areas that are not prone to these problems. One of the team members is working on this issue in Bharatpur.

In Sylhet, the baseline survey results indicate that it is mostly female members in the household who are involved with waste management and segregation (if any). Table 11 shows the role of male and female within the household in managing waste, throwing waste, managing compost and segregating waste. All through the sample female are more involved with all types of garbage management than other members.

As such providing awareness on how to handle wastes at home and how to segregate properly will help women to protect them from unwanted risks of handling wastes.

Table 11: Gender role in household waste management

	Waste manage		Throws waste		Compost manage		Segregation	
	Random	**Cont.**	**Random**	**Cont.**	**Random**	**Cont.**	**Random**	**Cont.**
Female member	44.76	48.18	53.81	64.36	68.57	75	63.03	76.47
Maid	46.19	37.95	51.9	40.59	42.86	37.5	58.82	40.20
Male member	28.33	32.67	33.57	32.67	37.14	54.17	39.50	30.39
Boy/ Security	1.67	0.33	5.24	2.97	2.86	0	8.40	2.94
Every member	17.14	13.2	-	-	--	-		

5. **Project Activities**

The main activities related to the research project are summarized in Table 2 below.

Table 2: Management of Solid Waste and Drainage in Bharatpur Metro City Chitwan and Sylhet City Bangladesh

Activities	**Research sites**	**Status**	**Remarks**
Feasibility and partners consultation visit, July 2016	Kawasoti, Nawalparasi Bharatpur, Chitwan	Completed	Proposal stage visits
Consultation meeting with stakeholders, Feb. 1&2, 2017	Kawasoti, Nawalparasi Bharatpur, Chitwan	Completed	First meeting after receiving the grant
Inception workshop of the research project, March 3-	Bharatpur, Chitwan	Completed	With inception workshops, we also visited sites. Team

5, 2017.			members include research team from Bangladesh (IWM, ACD and Sylhet City). Bhagalpur city. Bangladesh team was also there.
Focus group and stakeholder consultation April 9-11, 2017	Bharatpur, Chitwan	Completed	
Data collection regarding TLO from 14 ward of BMC, placing level gages in Pungi, Kerunga, Rapti and Narayani rivers, June 12-15, 2017	Bharatpur, Chitwan	Completed	With partner Team NDRI and team Bangladesh
Level gauge installment including inside the compound of Metro office. June 15-30, 2017.	Bharatpur, Chitwan	Completed	With partner Team NDRI
Enumerator training and questionnaire piloting, August 7-9, 2017	Bharatpur, Chitwan	Completed	
HH & TLO survey for data collection, August 9 – Sept. 16, 2017	Bharatpur, Chitwan	Completed	
Data collection of rainfall and water level in Pungi, Kerunga, Rapati and Narayani river, June-September, 2017	Bharatpur, Chitwan	Completed	With partner Team NDRI

Stakeholder consultation for HH waste management awareness in study area, Nov. 6-8, 2017	Bharatpur, Chitwan	Completed	With partner Clean-Up Nepal
TOT for Sensitization workshop, 16 & 17 Dec., 2017	Bharatpur, Chitwan	Completed	With partner Clean-Up Nepal
Sensitization workshop in selected 75 TLO, Dec. 17-25, 2017	Bharatpur, Chitwan	Completed	With partner Clean-Up Nepal
Study tour of selected municipality for learning and sharing knowledge, Jan. 9-13, 2018	Dhankuta, Itahari and Ilam municipalities	Completed	Team Bharatpur Metro including Mayor, Deputy mayor, ED and private partners**,**

5.1. **Feasibility and partners consultation visit, July 2016**

The research team visited Kawasoti and Bharatpur in Nepal in July 2016. This visit was mainly focused in identifying issues that needs research. During the visit, we met officials from the Bharatur and Kawasoto cities, and other stakeholders, community leaders and private sectors involved in collecting and managing cities' wastes.

5.2. **Stakeholders meeting, Feb 1-2, 2017**

The study team visited both cities in Nepal after receiving research grant. This visit was the key for establishing the contact with different stakeholders including the city officials, community leaders, and private sector that manages the solid wastes in the cities.

5.3. **Inception Meeting, March 3-5, 2017**

We organized an inception meeting in Bharatpur, Nepal inviting all stakeholders, partners and the city officials. Research partners and city officials from Bangladesh were also present in the meeting. Some

30+ participants attended the three workshop. During that time, we visited the study sites and developed methodology for surveying drainage network, and collecting water level data from different rivers, and canals surrounding Bharatpur City. The team observed that the main causes of drainage congestion in Bharatpur are:

i) Siltation along the drainage canal & at culvert mouth
ii) Inefficient conveyance capacity
iii) Solid waste dumping in the canal
iv) Encroachment, and
v) Absence of drainage system in some area

Inception meeting, Bharatpur, March 3, 2017

5.4. **Focus group and stakeholder consultation, April 9-11, 2017**

For understanding the key issues on solid waste management, the study team visited Bharatpur on 9-11 April 2017. This visit was useful in understanding how the SW is managed in the cities, role of private sector, and the city in managing the solid wastes. During the visit, we also identified attributes and levels for designing the choice experiment, and the type of intervention that households and TLOs preferred.

Focus group discussion with the local business community in Bharatpur

5.5. **Field visit for drainage network and hydrological data collection, 12-15 June 2017**

A joint team of SANDEE, NDRI and IWM visited Bharatpur for identifying places for installing level gages, ARG, and providing technical training to the field based staffs on land

level, water level and drainage network related data collection. The field data collection on land level, water level and drainage network continued after the training. The land level and drainage network data collection was completed by July 15th and the water level data collection continued till the end of monsoon season (September end, 2017).

Measuring land level and cross-section of Rapti Revier near Sauraha, Chitwan.

5.6. **Review meeting (Kathmandu), July 4-5, 2017**

SANDEE, in collaboration with the Asian Center for Development (ACD), Bangladesh, and Integrated Water Modeling (IWM), Bangladesh, organized a two-day review workshop of the ongoing research in Kathmandu during July 4-5, 2017. The main objectives of this workshop were to:

- Exchange ideas on the joint research between SADNEE, ACD and IWM with partners and stakeholders
- Review the progress made so far, and
- Review/revise the planned activities

Some 30 participants from 10 partner organizations and stakeholders attended the two-day review meeting in Kathmandu, Nepal. The notable attendees were IDRC's Senior Program Officer, Chief Executive Officer (CEO) of Bharatpur Metro and two other participants from the office, two representatives from the Ministry of Federal Affairs and Local Development (MoFA&LD), and a representative from the Solid Waste Management Technical Support Center. Representative of partner organization (ACD, IWM, Clean Up Nepal, and NDRI) made presentation on the work that they have been involved. This workshop was critical for having common understanding of the research and related activities in all sites.

Review meeting participants at Kathmandu, July 4-5, 2017

5.7. **Baseline Household Survey**

Figure 1: Sampled Tole Lane Committees for Household and Community survey, Bharatpur, Nepal

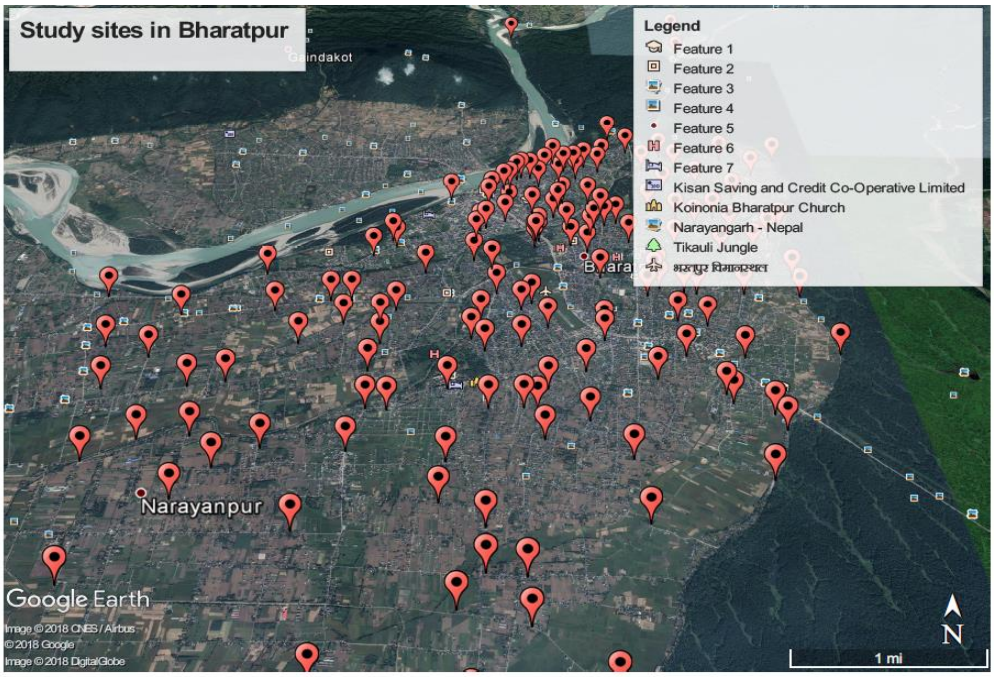


Figure 1, shows the main study sties in Bharatpur. We obtained names of the entire communities (TLOs) from BMC, and stratified the study areas into 14 segments (wards of the municipality). From each ward, we then randomly selected 75 TLOs (group A). from the remaining TLOs from the 14 wards, we gain randomly selected 75 TLOs (group B). In group A and B, we tried to drop TLOs with common border to reduce the contamination of the control group from intervention (awareness rising and installing public bins in the streets). From these two groups, we randomly assigned treatment for one group and the second group was kept as control. While drawing the sample TLOs randomly, we invited representatives from BMC and community mobilisers, and we asked them to draw the lotteries for sample TLOs.

From each TLO, we then randomly selected 7 households, making the household sample 1050. We conducted the baseline survey of 1050 households and 150 TLOs during August – October 2017. The questionnaire was first developed based on the input received from the FGDs and field visits, and feedback received on research proposal during inception meeting. The draft questionnaire was revised and translated into local language and pre-tested twice outside the study area just to make sure not to contaminate the main survey. We developed two separate sets of questionnaires for the TLOs and households. For managing data with minimal errors, the questionnaire were then designed in KOBO Toolbox, an electronic data collection platform, and installed in the tablets. Data were collected electronically which allowed the research team to monitor the field work, check for errors or any inconsistency on the spot on day to day basis. A dedicated data collection supervisor monitored the entire data collection process.

Before launching the baseline survey, we trained six enumerators in Bharatpur. Enumerators were selected from among the community mobilizers of Bharatpur Metro who were familiar with study area and speak the local language. A two-day training was organized for training the enumerators both in workshop setting in the field to make sure that they were ready to launch the survey. The research team worked with the enumerators for first few survey to make sure that the interview process was corrected conducted without technical problem in collecting data electronically.

5.8. **Sensitization workshops**

We carried out sensitization workshops in the selected 75 TLOs (intervention group) during 17-24 December 2017 Before the sensitization workshops, 16 trainers were trained first on how to conduct the workshop. The main objective of the sensitization workshops were to interact with the households and provide enough information on waste segregation and managing household wastes. The participants were TLO executive members, and households from the intervention TLOs. The trainers were divided into teams of five with three trainers in each team. Each team was assigned 15 TLOs to facilitate the sensitization workshop. Each day, each team visited two TLOs and conducted the workshops. Each workshop was of duration of 3 hours. The sensitization workshop emphasized on the components of waste management: current practices of waste management, waste segregation, 3Rs (reduce, reuse and recycle) composting and impacts of waste burning. The participants were from the sampled households and TLO members. In total, the sensitization workshop was facilitated to 1800 plus participants.

Sensitization workshop with stakeholders

CUNP trainer introducing waste segregation

Trainers practicing waste segregation (TOT)

Introducing 3Rs to the participants

Baikuntha TLO's head distributing resources

Tiger Chowk's TLO head explaining in do's/don'ts Tamang language

Shantipath TLO's head explaining

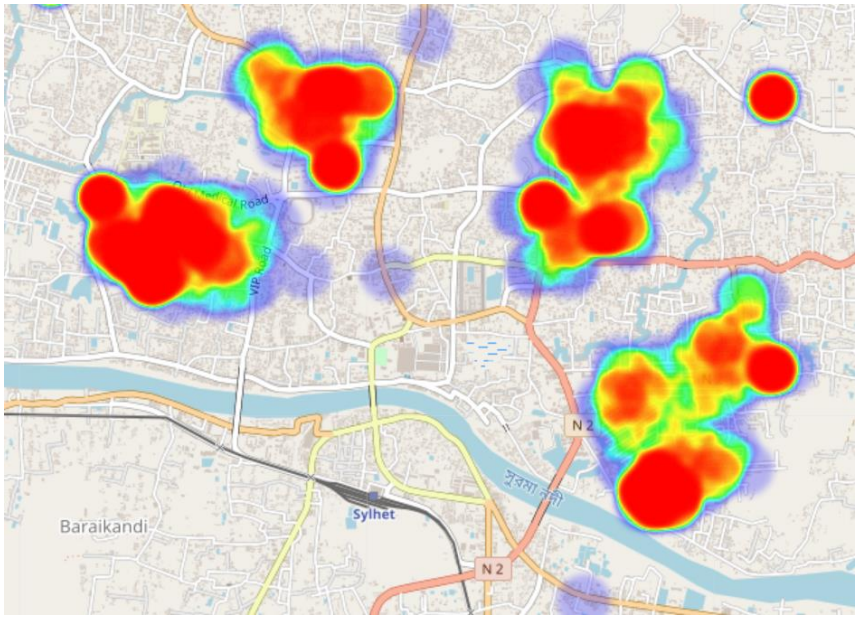
Glimpse of TOT at Chitwan and sensitization workshops

6. PROJECT ACTIVITIES IN SYLHET, BANGLADESH

Baseline Survey

A total of 723 households were surveyed in Sylhet to have a clear understanding on the strategies to provide an effective intervention on management of solid waste at the household level. The survey collected information on:

a. Household's garbage disposal behavior
b. Household's garbage recycling behavior
c. Household's garbage management behavior
d. Household's level of awareness on segregation



Map showing survey areas in Sylhet City Corporation.

Scholarship for Research on Wastes

Asian Center for Development as a part of its scholarship program provided Scholarships to Nabila Nuzhat Hye and Syed Fakhrul Islam (of Shahjalal University of Science and Technology) to conduct their research during their MSS in Economics. They are currently using the data collected during the Baseline survey to complete their research report.


CLEAN SYLHET App to engage citizens to clean up throw-away garbage

After completion of the survey and after analyzing the results of the survey, ACD is currently working with an APP developer to design a web-based android APP to promote citizen's engagement with garbage cleaning. The App will provide weekly feedback from citizens with photographs to ensure that garbages are cleaned up from the streets and from drains.

The strategy has been discussed with the CEO of the Sylhet City Corporation and will be used to design awareness campaign in Sylhet.

7. RESEARCH CAPACITY BUILDING

The research project is multi-disciplinary. The research team has strong presence of economists, engineers/hydrologists, urban planners, gender experts, survey experts, and governance expert. We have at least 12 researchers involved in this research from nine different institutions and different disciplines.

Table: Researchers and organizations involved directly in the research project

Organization	**Researcher**	**Role**	**Date of involvement**	**Activities/Tasks**
SANDEE	Mani Nepal	**PI**, Env. Economist	Proposal phase	Leading all management and technical activates
SANDEE	Rajesh Rai	Researcher, Env. Economist	Proposal phase	Field work and data analysis
SANDEE	Madan Khadayat	Research Associate, economist	January 2017	Field work and data management
ISI Delhi	E. Somanathan	Senior Researcher, climate change expert	Proposal phase	Technical support for designing survey instrument and guidance
Asian Center for Development (ACD) & East-West University	AK Enamul Haque	**Co-PI,** climate change expert	Proposal phase	Leading all management and technical activities in Sylhet, Bangladesh
Shahjalal University of Science & Technology	Muntaha Rakib	Researcher, gender & SWM expert	January 2017	Field work, data management and analysis
Integrated Water Management	Ismat Ara Pravin	Hydrologist	March 2017	Developing hydrodynamic and drainage network modeling
Integrated Water	H. Karim	Hydrologist & Surveyor	March 2017	Collecting hydrological data and supporting Nepal team for

Management				collecting similar data in Nepal
Clean Up Nepal	Neelam Pradhananga	Gender expert and urban planner	April 2017	Filed based activities (sensitization workshops, and installing public bins for WSM in Bharatpur, Nepal), and working on gender and social inclusion in SWM.
Nepal Development Research Institute (NDRI) & KU	Ganesh Dhakal	GIS Expert and Surveyor	May 2017	Hydrological data collection and drainage network survey, Bharatpur
Ministry of Federal Affairs and Local Development, Nepal	Bishal Bhardwaj	Researcher, Governance Specialist	May 2017	Examining the taxes and surcharges in plastics related materials in order to see the potential of using tax instruments for controlling plastic waste
Agriculture and Forestry University	Rishi Ram Kattel	Researcher, SWM Specialist	September 2017	Examining the waste generation and plastic recycling market in Nepal

We have been trying to put more women in the research team. There are three women researchers in the core research team. All enumerators in the baseline survey were female and in sensitization workshop, the main trainers were also women. We will have one separate paper in gender and social inclusion.

The research team consists of senior as well as junior researchers and the research project is helping junior researchers to enhance their research capacity. For example, Madan S Khadayat, a research associate with MPhil degree, has been working on designing online survey tool (KOBO Toolbox) and without his involvement; he will not be able to learn this research tool. Similarly, Ganesh Dhakal, an engineer by training and GIS expert, has been involved in collect primary data on hydrology, land level and river cross-section. SANDEE designed the study in such as way that Nepali engineers' team working with Bangladesh engineers in Bhagalpur in order to conduct the field survey for hydrological and related data collection. None of the team members (engineers) from Nepal was involved in this kind of study before and they have been appreciating the research opportunity. Ganesh Dhakal, the leader of the engineering team from Nepal will co-author a paper with other team members. Similarly, Muntaha Rakib from Bangladesh has been involved in this study in Bangladesh and she has been learning research skills while working in this project. There are few masters students that are directly involved in Bangladesh part

of this study. In Nepal's part, several enumerators were trained for conducting household survey and students from Kathmandu University were involved in collecting engineering data. In plastic supply chain and plastic tax study, we plan to use graduate students from different universities as enumerators. Their involvement will surely help them to learn more on field level data collection when the do their own thesis.

The research project has been very helpful in SANDEE's transition from hosted research capacity building organization to a part of ICIMOD. Since July 2017, SANDEE is now integrated with ICIMOD. During the transition phase, the IDRC research project helped SANDEE to keep its human resources and SANDEE network intact.

8. INVOLVEMENT OF THE CITIES

From the proposal development stages, we have been working with both of the cities (Sylhet and Bharatpur). During this period, there has been lot of changes in terms of institutional structure of Bharatpur City. However, core team of the city involved with us has been intact and we have been closely working with the city officials since the start of the project, Example of joint activates:

1. Bharatur city officials have been invited and involved in all meetings (inception workshop in March, and review workshop in July).
2. We have singed Letter of Intent (LoI) with the city for smoothly conducting the research and collaborate thought out the process.
3. City officials are involved in selecting the TLOs for study and providing support to the research team.
4. The baseline survey was completed using City's social mobilizers as enumerators.
5. We have installed automatic rain gauge in Bharatpur Metro premises and after collecting one season rainfall data, the ARG is handed over to the city for their regular.
6. We recently organized a study tour to BMC officials (Mayor, Deputy Mayor, Chief Administrative Officer, Elected Ward Chairpersons, relevant city officials) for understanding how other cities are managing their solid wastes.
7. Elected ward chairpersons are now onboard after the city got elected officials in August 2018. We are have been working with the respective ward chairperson in order to identify the places for installing bins for public use. The TLOs and ward chairpersons are

committed to collaborate with us for the research and willing to take the research outcomes in their future planning.

Plan for 2018