नेपाल सरकार
सङ्घीय मामिला तथा सामान्य प्रशासन मन्त्रालय

स्थानीय विकास प्रशिक्षण प्रतिष्ठान
(स्थानीय विकास प्रशिक्षण प्रतिष्ठान ऐन, २०४९ द्वारा स्थापित)
Local Development Training Academy
(Established under the Local Development Training Academy Act, 2049)
"An Autonomous, Professional, Client Centered, Gender Responsive National Institute of Excellence in the area of Local-Self Governance."
LDTA>>>

प्रशिक्षकका लागि

स्थानीय तहका लागि तयार पारिएको प्रशिक्षण सामग्री

फोहोरमैला व्यवस्थापन तथा वातावरण व्यवस्थापन

प्रशिक्षण सामग्रीको बनावटः

१. प्रशिक्षण मार्गदर्शन
२. प्रशिक्षण योजना
३. सत्र योजना (अभ्यास पत्र समेत)
४. प्रस्तुति सामग्री (पावरप्वाइन्ट स्लाइड)
५. सहभागीका लागि अध्ययन सामग्री
६. मूल्याङ्कनका औजारहरू

मोड्युल १३

नेपाल सरकार
सङ्घीय मामिला तथा सामान्य प्रशासन मन्त्रालय

स्थानीय विकास प्रशिक्षण प्रतिष्ठान
Local Development Training Academy

प्रशिक्षकका लागि

स्थानीय तहका लागि तयार पारिएको प्रशिक्षण सामग्री

फोहोरमैला व्यवस्थापन तथा वातावरण व्यवस्थापन

२०७८ असार

मोड्युल १३

प्रकाशक:

सर्वाधिकार:

प्रकाशन: २०७८ असार

प्रशिक्षण सामाग्री निर्माणमा संलग्न सदस्यहरू

श्री पीतकुमार श्रेष्ठ, स्थानीय विकास प्रशिक्षण प्रतिष्ठान, ललितपुर

श्री योग माया सापकोटा, स्थानीय विकास प्रशिक्षण प्रतिष्ठान, ललितपुर

लेखन तथा प्राविधिक सहयोग

श्री किशोर शाक्य, परामर्शदाता

भाषा सम्पादन:

सम्पर्कका लागि:

मन्तव्य

दुई शब्द

स्थानीय तहहरुमा क्षमता विकासका लागि आवश्यकता पहिचान गरिएका क्षेत्रहरुमध्ये फोहोर मैला ब्यवस्थापन एक हो । सुन्दर शहरको महत्वपूर्ण सूचक फोहोर मैला तथा वातावरण ब्यवस्थापन हो । शहरी विकासको एक प्रमुख चुनौतिको रुपमा पनि फोहोर मैला तथा बातावरण ब्यवस्थापन रहेको छ ।

फोहोरलाई मोहरमा बदल्न सकिने नाराका साथ विगतमा काम भएका पनि छन् । तर यसलाई व्यापक रुपमा स्थानीय तहहरुमा प्रयोग गर्नका सबै स्थानीय तहहरुमा क्षमता विकासका लागि प्रशिक्षण संचालन गर्न आवश्यक देखिएको छ । तसर्थ स्थानीय तहहरुमा यस सम्वन्धी देखिएका ज्ञान, सीप र प्रवृत्तिगत पक्षहरुलाई मध्यनजर गरी नेपाल सरकार संघीय मामिला तथा सामान्य प्रशासन मन्त्रालयको नेतृत्वमा स्थानीय विकास प्रशिक्षण प्रतिष्ठानले प्रादेशिक तथा स्थानीय शासन सहयोग कार्यक्रमको सहयोगमा स्थानीय तहहरुको लागि **फोहोरमैला व्यवस्थापन तथा वातावरण व्यवस्थापन प्र**शिक्षण मोड्युल तयार गरेको छ । यस मोड्युलमा प्रशिक्षण मार्गदर्शन, प्रशिक्षण योजना, सत्र योजना, प्रस्तुती सामाग्री, सहभागीका लागि अध्ययन सामाग्री तथा प्रशिक्षण मुल्यांकन औजारहरु समावेश गरिएको छ ।

यस प्रशिक्षणबाट स्थानीय तहका कर्मचारीहरुमा **फोहोरमैला व्यवस्थापन तथा वातावरण व्यवस्थापन** सम्वन्धमा ज्ञान र सीपमा अभिवृद्धि हुने अपेक्षा गरिएको छ । विशेष गरेर फोहोरमैलाको वर्गीकरण, पुन प्रयोग, फोहोरमैलाको ब्यवस्थापनका लागि नीतिनियम, ल्याण्डफिल र सुधारिएको विधिबाट फोहोरमैला विसर्जनको उचित ब्यवस्थापनको सैद्धान्तिक तथा व्यवहारिक ज्ञान र सीप अभिवृद्धि गर्ने उद्देश्य पुरा गर्ने गरी यस पाठ्यक्रम तयार गरिएको छ । यस पाठ्यक्रमको कार्यान्वयनबाट नगरपालिकाहरु र गाउँपालिकाहरुमा फोहरमैला तथा बातावरण व्यवस्थापनमा योगदान पुग्नेछ ।

यस प्रशिक्षण मोड्युलबाट हुने प्रशिक्षणले ७५३ वटै स्थानीय तहमा एउटै संदेश दिने अपेक्षा लिइएको छ । अन्त्यमा, यस प्र्रशिक्षण मोड्युल तयारी तथा प्रकाशनका लागि सहयोग उपलब्ध गराई यो महत्वपूर्ण कार्य सम्पन्न गराउन सहयोग गर्नुभएकोमा प्रादेशिक तथा स्थानीय शासन सहयोग कार्यक्रमलाई र यस कार्यमा संलग्न विज्ञ श्री किशोर शाक्य र प्रतिष्ठानका कर्मचारीहरु सबैमा धन्यवाद ज्ञापन गर्दछु ।

पीतकुमार श्रेष्ठ
कार्यकारी निर्देशक
स्थानीय विकास प्रशिक्षण प्रतिष्ठान

विषयसूची

प्रशिक्षण मार्गदर्शन

प्रशिक्षण सामग्रीबारे

स्थानीय विकासको कार्यसँग सम्बन्धित स्थानीय तहहरूको प्रशासनिक एवं व्यवस्थापनसम्वन्धी दक्षता अभिवृद्धि गर्ने उद्देश्यले त्यस्ता निकायहरूमा संलग्न जनप्रतिनिधिहरू एवम् कार्यरत कर्मचारीहरूलाई योजनाबद्ध तरिकाले उच्चस्तरीय प्रशिक्षणको व्यवस्था गरी स्थानीय स्तरमा ती निकायहरूको संस्थागत विकासमा सघाउ पुर्याउन स्थानीय विकास प्रशिक्षण प्रतिष्ठान ऐन २०४९ अन्तर्गत वि.सं. २०५० सालमा स्थापना भएको यो एक स्वशासित र सङ्गठित संस्थाका रूपमा रहेको छ । प्रतिष्ठानको मुख्य उद्देश्य प्रशिक्षण स्थानीय विकास कार्यसँग सम्बन्धित स्थानीय तहका व्यक्तिहरूका लागि आवश्यक पर्ने प्रशिक्षणको व्यवस्था गर्ने, प्रशिक्षण केन्द्रद्वारा सञ्चालन गरिने प्रशिक्षण कार्यक्रमसम्बन्धी अनुसन्धान गर्ने र प्रशिक्षण केन्द्रद्वारा सञ्चालन गरिने प्रशिक्षण कार्यक्रमलाई बढी उपयोगी तुल्याउन तथा प्रशिक्षण सामग्री तयार गर्नका लागि समस्यामूलक अनुसन्धान, परामर्श सेवा तथा सूचना सेवासम्बन्धी कार्यक्रमहरू सञ्चालन गर्ने रहेको छ ।

यो प्रशिक्षण सामग्री सङ्घीय मामिला तथा सामान्य प्रशासन मन्त्रालयको निर्देशनमा स्थानीय विकास प्रशिक्षण प्रतिष्ठानबाट तयार पारिएको हो । यस **५ दिने** प्रशिक्षण सामग्रीले **फोहोरमैला व्यवस्थापन तथा वातावरण व्यवस्थापन** प्रशिक्षणलाई प्रभावकारी बनाउन प्रशिक्षकहरूलाई महत्त्वपूर्ण मार्गदर्शन हुने अपेक्षा गरिएको छ ।

प्रशिक्षण सामग्रीको उद्देश्य

यस प्रशिक्षण सामग्रीको उद्देश्य गाउँपालिका/नगरपालिकाहरूमा कार्यान्वयन गरिने **फोहोरमैला व्यवस्थापन तथा वातावरण व्यवस्थापन** प्रशिक्षण कार्यलाई प्रभावकारी र गुणस्तरीय बनाउनुका साथै प्रशिक्षण कार्यमा एकरूपता ल्याई प्रशिक्षणलाई सहभागितामूलक बनाउनु हो ।

प्रशिक्षण सामग्रीको बनावट

यस प्रशिक्षण सामग्रीलाई चार खण्डमा विभाजन गरिएको छ । पहिलो खण्डमा प्रशिक्षण सामग्री र यसको प्रयोग गर्ने तरिका (Instsruction to user) उल्लेख गरिएको छ । दोस्रो खण्डमा प्रशिक्षण योजना, प्रशिक्षण तालिका समावेश गरिएको छ । तेस्रो खण्डमा प्रशिक्षणका प्रत्येक सत्रका विषयवस्तुहरूको पाठयोजना, पावरप्वाइन्ट स्लाइडहरू र विषयवस्तुसँग सम्बन्धित अध्ययन सामग्री समेटिएको छ भने अन्तिम खण्डमा प्रशिक्षण मूल्याङ्कनका औजारहरू समावेश गरिएको छ । यसका विषयवस्तुहरूलाई सङ्क्षिप्तमा तल उल्लेख गरिएको छ ।

१. प्रशिक्षण सामग्रीको प्रयोग गर्ने तरिका (Instsruction to User)

यसमा प्रशिक्षण सामग्रीको पृष्ठभूमि, यसको उद्देश्य, प्रशिक्षण सामग्रीमा समावेश गरिएका विषयवस्तुहरू, प्रशिक्षण सामग्री प्रयोग गर्ने तरिका, प्रशिक्षणका विधिहरू र तिनको सञ्चालन प्रक्रिया, अध्ययन सामग्री, प्रशिक्षण मूल्याङ्कनका औजारहरू, प्रशिक्षणका प्रयोगकर्ता आदि समावेश गरिएको छ ।

२. प्रशिक्षण योजना

प्रशिक्षण योजना प्रशिक्षण सञ्चालनका लागि तयार पारिएको प्रशिक्षणको समग्र खाका हो । यसमा प्रशिक्षणका साधारण र निर्दिष्ट उद्देश्य, प्रशिक्षणका विषयवस्तु, प्रशिक्षण सञ्चालन विधि र प्रशिक्षण सामाग्री उल्लेख गरिएको छ ।

३. प्रशिक्षण दैनिक तालिका

प्रशिक्षण दैनिक तालिकामा हरेक दिनका क्रियाकलाप र विषयवस्तु र तिनका लागि आवश्यक समय उल्लेख गरिएको छ ।

४. पाठयोजना

पाठयोजना हरेक सत्र सञ्चालनका लागि मार्गदर्शन हो । यसमा सत्रका साधारण र निर्दिष्ट उद्देश्य, सत्रका विषयवस्तु, प्रशिक्षण क्रियाकलापको विस्तृत विवरण, प्रशिक्षण विधि, प्रशिक्षण सामग्री र आवश्यक समय उल्लेख गरिएको छ । यसमा सत्रका निर्दिष्ट उद्देश्य हासिल भए वा भएनन् थाहा पाउनका लागि सत्र मूल्याङ्कन विधिसमेत उल्लेख गरिएको छ ।

५. पावरप्वाइन्ट स्लाइड

प्रशिक्षण सत्र सञ्चालनका लागि आवश्यक पावरप्वाइन्ट स्लाइडहरू यस सामग्रीमा क्रमबद्ध रूपमा समावेश गरिएका छन् । सत्रका साधारण र निर्दिष्ट उद्देश्य, सत्रका विषयवस्तुहरू, समूह कार्य वा अभ्यास र सो अभ्यास सञ्चालनका लागि गर्नुपर्ने क्रियाकलाप पनि पावरप्वाइन्ट स्लाइडमा उल्लेख गरिएको छ ।

६. अध्ययन सामग्री

प्रशिक्षणका विषयवस्तु र प्रस्तुतीकरणसँग सम्बन्धित सामग्रीहरूको विस्तृत विवरण अध्ययनसामग्रीका रूपमा यस सामग्रीभित्र समावेश गरिएको छ । यी सामग्रीहरूलाई प्रशिक्षण सत्रका आधारमा छुट्याई क्रमबद्ध रूपमा व्यवस्थित गरिएको छ ।

७. प्रशिक्षण मूल्याङ्कनका औजारहरू

प्रशिक्षणको प्रभावकारिता मापनका लागि निम्नलिखित औजारहरू समावेश गरिएका छन् ।

(क) प्रशिक्षणपूर्व र प्रशिक्षणपश्चात् जानकारी

यसअन्तर्गत प्रशिक्षणका विषयवस्तुहरूमा सहभागीहरूको बुझाइको अवस्था थाहा पाउन प्रशिक्षणका विषयवस्तुहरूसँग सम्बन्धी प्रश्नहरू निर्धारण गरी प्रशिक्षणको सुरुमा पूर्व जानकारी र अन्तमा पश्चात् जानकारी लिइन्छ । यसले प्रशिक्षणका कारण सहभागीहरूको ज्ञान र सिपमा आएको परिवर्तन मापन गर्न सहयोग गर्दछ ।

(ख) दैनिक पृष्ठपोषण फाराम

हरेक दिनको अन्तमा दिनभरि भएका छलफलहरूमा सहभागीहरूको सिकाइ थाहा पाउन दैनिक पृष्ठपोषण फारामको प्रयोग गरिन्छ । यसबाट सहभागीहरूले सिकेका र सिकेका कुरालाई कहाँ र कसरी प्रयोग गर्ने भन्ने बारेमा र प्रशिक्षणलाई अझ प्रभावकारी सुधार गर्नुपर्ने सुझाव पाउन सकिन्छ ।

(ग) प्रशिक्षण सुधारका लागि प्रश्नावली

यो प्रश्नावली प्रशिक्षणको अन्त्यमा सहभागीलाई वितरण गरी उनीहरूको प्रतिक्रिया लिन प्रयोग गरिन्छ । यसबाट (१) प्रशिक्षणको समग्र मूल्याङ्कन, (२) सहजकर्ताप्रतिको दृष्टिकोण, (३) प्रशिक्षणमा उपलब्ध गराइएका पाठ्यसामग्रीको प्रभावकारिता, (४) प्रशिक्षणका विषयवस्तुको उपयुक्तता र (५) प्रशिक्षणमा प्रयोग भएका प्रशिक्षण विधिहरूको सान्दर्भिकता जाँच गरिन्छ ।

प्रशिक्षण कार्यक्रमको मूल्याङ्कन

प्रशिक्षण कार्यक्रमको प्रभावकारितालाई मुख्यतः चारवटा तहमा मूल्याङ्कन गरिनुपर्दछ । सहभागीहरूको प्रशिक्षणप्रतिको प्रतिक्रिया, उनीहरूको सिकाइको स्तर, प्रशिक्षण कार्यक्रमले सहभागीहरूको दैनिक व्यवहार र उनीहरूको दैनिक कार्यसम्पादनमा ल्याएको परिवर्तन र सो परिवर्तनको परिणामस्वरूप समग्र संस्थाको कार्यसम्पादनमा आएको परिवर्तनलाई प्रशिक्षण प्रभावकारिता मूल्याङ्कनका आधार बनाइनु पर्दछ ।

प्रशिक्षण सामग्रीको प्रयोग विधि

फोहोरमैला व्यवस्थापन तथा वातावरण व्यवस्थापन प्रशिक्षणको प्रस्तुतिलाई व्यवस्थित र पूर्ण गराउनका लागि पाठयोजनाको अनुसरण गर्नुपर्दछ । यस सामग्रीमा व्यवस्था गरिएको पाठयोजनालाई अनुसरण गरी सहज तरिकाले सत्र सञ्चालन गर्न क्रियाकलाप शीर्षकअन्तर्गत विषयवस्तुलाई विस्तृत रूपमा प्रस्तुत गरिएको छ । विषयप्रस्तुति अगाडि विषयप्रति रुचि जगाउने, विषयको महत्त्व दर्साउने जस्ता कार्य प्रशिक्षक आफैँले विकास गरी सत्र सञ्चालन गर्न सक्ने छन् । प्रशिक्षकले विषयवस्तुको अध्ययन सामग्री राम्रोसँग अध्ययन गरी विषयको प्रभावकारी प्रस्तुतीकरणका लागि आवश्यक दृश्य सामग्रीको तयारी/सङ्कलनसमेत गर्न सक्ने छन् । यसका साथै प्रशिक्षकले प्रशिक्षण सामग्रीमा उल्लेख गरिएका पावरप्वाइन्ट स्लाइड र अध्ययन सामग्रीमा समावेश गरिएका चित्र, चार्ट, ग्राफ आदिलाई आवश्यकताअनुसार तिनको आकार विस्तार गरी प्रस्तुत गर्न सक्ने छन् । सत्रहरूको प्रस्तुतीकरणका लागि सिलसिलेबार रूपमा पावरप्वाइन्ट स्लाइडहरू समावेश गरिएको छ । प्रशिक्षणको प्रभावकारिता र प्रशिक्षण प्रभावकारिताको मापनका लागि प्रशिक्षण मूल्याङ्कनका औजारहरूसमेत सामग्रीमा समावेश गरिएका छन् । तिनलाई उपयुक्त तरिकाले प्रयोग गरिनु आवश्यक छ ।

अध्ययन सामग्री

प्रस्तुत सामग्रीमा समावेश गरिएका अध्ययन सामग्रीहरू **फोहोरमैला व्यवस्थापन तथा वातावरण व्यवस्थापन** प्रशिक्षणसँग सम्बन्धित विभिन्न निकायहरूका प्रकाशन, प्रशिक्षण सामग्री, नेपाल सरकारले गरेका नीतिगत व्यवस्थाहरू आदिलाई आधार मानी तयार गरिएको छ । यी अध्ययन सामग्रीहरू केवल सन्दर्भ सामग्री मात्र हुन् । यिनलाई समय समयमा अद्यावधिक गराउनु पर्दछ ।

प्रशिक्षण सामग्रीको प्रयोगकर्ता

यो प्रशिक्षण सामग्री **फोहोरमैला व्यवस्थापन तथा वातावरण व्यवस्थापन** प्रशिक्षणमा रुचि राख्ने जोसुकैका लागि उपयोगी हुने छ । यो विशेष गरी **फोहोरमैला व्यवस्थापन तथा वातावरण व्यवस्थापन** प्रशिक्षण सहजकर्ताहरूलाई ध्यानमा राखी तयार पारिएको छ तर यस सामग्रीको उपयुक्तताको ठहर गर्ने जोसुकैले पनि यसको प्रयोग गर्न सक्ने छन् । यसका प्रयोगकर्ताले यसमा उल्लिखित विधि, प्रक्रिया, समय, सामग्री जस्ता पक्षहरूलाई हुबहु उतार्नुभन्दा यसमा उल्लिखित मार्गदर्शन र स्थानीय परिवेशअनुसार यसलाई सहयोगी सामग्रीका रूपमा बुझेर प्रयोग गर्नु उपयुक्त हुने छ । स्थानीय परिवेशअनुसार यस निर्देशिकाको मूल मर्मलाई ध्यानमा राखी सहजकर्ता/प्रशिक्षकले अन्य रचनात्मक गतिविधिसमेत अँगाल्न सक्ने छन् ।

प्रशिक्षण विधि र प्रयोग तरिका

प्रशिक्षकको सहजीकरणलाई व्यवस्थित गर्नका लागि पाठयोजनामा प्रशिक्षण विधिहरू उल्लेख गरिएका छन् । प्रशिक्षण कार्यक्रमलाई सहभागितामूलक र प्रभावकारी बनाउन निम्न विधिहरू प्रयोग गर्न सकिने छ ।

क) समूह छलफल

सहभागितामूलक प्रक्रियाबाट प्रशिक्षण सञ्चालन गर्नका लागि समूह छलफल एक महत्त्वपूर्ण विधि हो । समूह छलफलका लागि निम्न प्रक्रिया अपनाउनुपर्ने हुन्छः

- समूह विभाजन गर्दा सकभर सहभागी सङ्ख्या बराबर बनाउने, सहभागीको स्तरलाई ध्यान दिने ।
- समूह छलफलका लागि विषयवस्तु किटानी गर्ने ।
- छलफलको विषयअनुसार स्थान र समय निर्धारण गर्ने ।
- सहजकर्ताले छलफल प्रक्रिया बताउने । जस्तैः
    - समूहमा संयोजक, प्रतिवेदक चयन गर्ने ।
    - समूहमा सबैको भनाइ समेटिनुपर्ने ।
    - समूहको निचोड ठुलो कागजमा तयार गर्ने ।
    - संयोजकले समूहकार्य प्रस्तुत गर्ने आदि ।
- समूहमा खुल्ला छलफल चलाउन प्रेरित गर्ने ।
- सहजकर्ताले छलफलको सन्दर्भ र विषयवस्तुलाई आधार मानी आफ्नो निष्कर्ष दिने ।

ख) खेल

खेल विधिले विषयवस्तुलाई सजिलै प्रस्ट पार्न सहयोग गर्दछ । खेल विधिबाट सिकेका सिकाइहरू चिरस्थायी हुन्छन् ।

सञ्चालन प्रक्रिया

- खेलको प्रकृतिअनुसार सहभागी सङ्ख्या छनोट गर्ने । शारीरिक शक्ति प्रयोग गर्नुपर्ने खेल भए शारीरिक रूपमा अशक्त व्यक्तिलाई उसको अनुमतिमा बाहिर राख्ने ।
- लैङ्गिक संवेदनशीलताका पक्षमा ध्यान दिने ।
- समय निर्धारण गर्ने । खेललाई २० मिनेटभन्दा बढी समय दिनु उपयुक्त हुँदैन ।
- खेलमा पालना गर्नुपर्ने नीतिनियम प्रस्ट पार्ने ।
- खेलका लागि आवश्यक सामग्री तयार गर्ने ।
- खेल सकिएपछि खेलबाट भएका सिकाइहरू छलफल गर्ने ।
- खेलका लागि सबैलाई धन्यवाद दिने ।

ग) प्रश्नोत्तर

कुनै विषयवस्तुबारे सहभागीहरूको बुझाइ थाहा पाउनका लागि प्रश्न गर्ने, उत्तर लिने र सोअनुसार सहजकर्ताले विषयवस्तु प्रस्ट पार्ने प्रक्रिया नै प्रश्नोत्तर विधि हो । यसले सहभागीहरूको ध्यान विषयवस्तुप्रति आकर्षित गर्न मदत गर्दछ । सहजकर्ताले प्रश्नोत्तर सिपमा विशेष ध्यान पुर्‍याउनु पर्दछ ।

घ) साना समूह छलफल

यो विधि प्रशिक्षण कार्यका सन्दर्भमा छिट्टै छलफल गरी तत्कालै विषयवस्तुको निष्कर्षमा पुऱ्याउन उपयोगी हुन्छ । २/३ जना सहभागीबिच बसेकै स्थानमा आमनेसामने भई यो विधिमार्फत विषयवस्तुको निचोड निकाल्न सकिन्छ । यस विधिले सिकाइलाई मूर्त रूप दिन मदत गर्दछ ।

सञ्चालन प्रक्रिया

- सहजकर्ताले छलफलको विषय र समय निर्धारण गर्ने ।
- नजिकैका २/३ जना सहभागीलाई आमनेसामने बस्न भन्ने ।
- छलफल गर्न लगाउने । छलफलका मुख्य कुरा टिपोट गर्न भन्ने ।
- छलफलको निचोडलाई मेटाकार्ड दिई लेख्न लगाउने ।
- छलफल सकिएपछि क्रमिक रूपमा सहभागी समूहलाई आफ्नो निचोड प्रस्तुत गर्न लगाउने, छलफल गर्ने, कार्ड सफ्ट बोर्डमा टास्ने ।
- सहभागीको प्रस्तुतिपश्चात् सहजर्ताले विषयवस्तुको सन्दर्भ र तात्पर्य मिलाई निष्कर्ष निकाल्ने ।

ङ) मस्तिष्क मन्थन

सहभागीले आफ्नो विचार मन्थन गरी विषयवस्तुलाई निर्णयमा पुऱ्याउने विधि नै मस्तिष्क मन्थन विधि (Brainstorming) हो ।

सञ्चालन प्रक्रिया

- छलफलको विषय / प्रश्न प्रस्ट रूपमा राख्ने ।
- सोच्नका लागि समय दिने ।
- सहभागीहरूका विचारलाई सङ्गठित गर्दै टिपोट गर्ने, छलफल चलाउने ।
- भनाइलाई निष्कर्षमा पुर्‍याउने ।

च) अभ्यास

सहभागीको प्रत्यक्ष संलग्नतामा सिकाइ आर्जन गर्न यो विधि महत्त्वपूर्ण हुन्छ । यो विधि जीवन र जगतसँग सम्बन्धित घटनामा आधारित कुराहरू प्रस्ट पार्न प्रयोग गरिन्छ ।

सञ्चालन प्रक्रिया

- सहजकर्ताले घटना वा सवाल समूहबिच राख्ने ।
- विषयअनुसार समय निर्धारण गर्ने ।
- सवालका निष्कर्ष निकाल्न लगाउने ।
- अभ्यासबाट निकालिएको निष्कर्षलाई सहजकर्ताले छलफल चलाई अन्तिम निष्कर्ष निकाल्ने ।

ज) लघु प्रवचन

यो प्रशिक्षणको सबैभन्दा महत्त्वपूर्ण विधि हो । यसमार्फत विषयवस्तुलाई सहभागीहरूसमक्ष सहज रूपमा प्रस्तुत गर्न सकिन्छ । नामअनुसार नै यो विधिमार्फत गरिने प्रस्तुतीकरण छोटो र सहभागितामूलक हुनु पर्दछ । प्रशिक्षकले एकोहोरो रूपमा लामो समयसम्म प्रस्तुतीकरण गर्नु हुँदैन । प्रस्तुतीकरणका सिलसिलामा सहभागीहरूलाई पनि संलग्न गराउँदै जानु पर्दछ ।

प्रशिक्षकलाई प्रश्नः

१. सत्रका विषयवस्तुको राम्ररी अध्ययन गर्नुभएको छ ?
२. सत्र सञ्चालनका लागि पाठयोजनाको अध्ययन गर्नुभएको छ ?
३. सहभागीहरूको पृष्ठभूमि तथा स्तरका बारेमा सोच्नुभएको छ ?
४. सत्रका लागि चाहिने आवश्यक प्रशिक्षण सामग्रीहरू जुटाउनुभएको छ ?
५. प्रस्तुतीकरणका बुँदाहरूको राम्ररी अध्ययन गर्नुभएको छ ?
६. प्रस्तुतीकरणमा बढी महत्त्व दिनुपर्ने बुँदाहरूको निर्क्योल गर्नुभएको छ ?
७. प्रस्तुतीकरणमा विशेष जोड दिनका लागि आवश्यक उदाहरणहरूको चयन गर्नुभएको छ ?
८. प्रशिक्षण सारांशका बुँदाहरू तय गर्नुभएको छ ?
९. सत्रप्रति रुचि जगाउन तथा सहभागिता बढाउन आवश्यक पर्ने विधिहरूको चयन गर्नुभएको छ ?
१०. समयभित्र सत्र पूरा गर्न राम्ररी योजना गर्नुभएको छ ?
११. सत्र सञ्चालनका लागि आवश्यक पर्ने भौतिक सामग्रीहरू, जस्तैः सेतो पाटी, फ्लिपचार्ट, खैरो कागज, मेटाकार्ड, मार्कर, मास्किङ्ग टेप, कागज, कलम, कैँची, चित्रहरूको व्यवस्था गर्नुभएको छ ?
१२. प्रशिक्षण हल, बसाइ व्यवस्थापन, कोठाको तापक्रम, हावा, प्रकाश इत्यादिका बारेमा सोच्नुभएको छ ?

प्रशिक्षण योजना

प्रशिक्षण योजना

मोडुल÷विषय	**फोहोरमैला व्यवस्थापन तथा वातावरण व्यवस्थापन**
मिति	
स्थान	नगरपालिका गाँउपालिका
सहजकर्ता	

लक्षित सहभागीहरुः

- गाउँपालिका तथा नगरपालिकाका कर्मचारीहरु

साधारण उद्देश्य

- स्थानीय तहमा सहभागीहरुको फोहोरमैला र वातावरण व्यवस्थापनका विभिन्न पक्षहरुको बारेमा ज्ञान र सीपमा अभिवृद्धि गरी सक्षम बनाउनु हो ।

निर्दिष्ट उद्देश्यहरुः यस प्रशिक्षणको अन्तमा सहभागीहरुले निम्न कार्यहरु गर्न सक्नेछन् ।

- फोहोरमैलाको वर्गीकरण र यसको विशेषता पहिचान गर्न सक्नेछन् ।
- फोहोरमैलाको पुनः प्रयोगको अवधारणा बुझ्न सक्नेछन् ।
- स्थानीय स्तरमा फोहोरमैला ब्यवस्थापनको लागी नीति र नियमहरु बुझ्न र फोहोरमैला व्यवस्थापन शुल्क निर्धारण गर्न सक्नेछन् ।
- ल्याण्डफिल, खतरनाक फोहोरमैला र लीचेट सम्वन्धी अवधारणा बुझ्न सक्नेछन् ।
- सुधारिएको विधिद्धारा फोहोरमैला विसर्जनको उचित व्यवस्थापन गर्न सक्नेछन् ।

विधिः

- मष्तिस्क मन्थन, समुह अभ्यास, लघुप्रवचन, प्रश्नोत्तर आदि । हरेक दिनको अन्तमा दिनभर छलफल भएका विषयवस्तुको संक्षेपीकरण गर्ने ।
- दोस्रो दिन पहिलो दिन संचालन भएका गतिविधिको पुनरावलोकनबाट सत्र शुरुवात गर्ने ।
- व्यवहारिक अभ्यासको लागि आवश्यक फाराम अभ्यास सिटहरु तयार गर्ने ।

आवश्यक समाग्री, उपकरण र स्रोत साधनः

- ल्यापटप, एलसिडी प्रोजेक्टर, ह्वाईट वोर्ड, स्क्रिन, प्वाइन्टर, पिन बोर्ड, क्यामरा, प्रिन्टर, फारामहरु, हाजिरी रजिष्टर

आवश्यक प्रशिक्षण सामाग्रीः

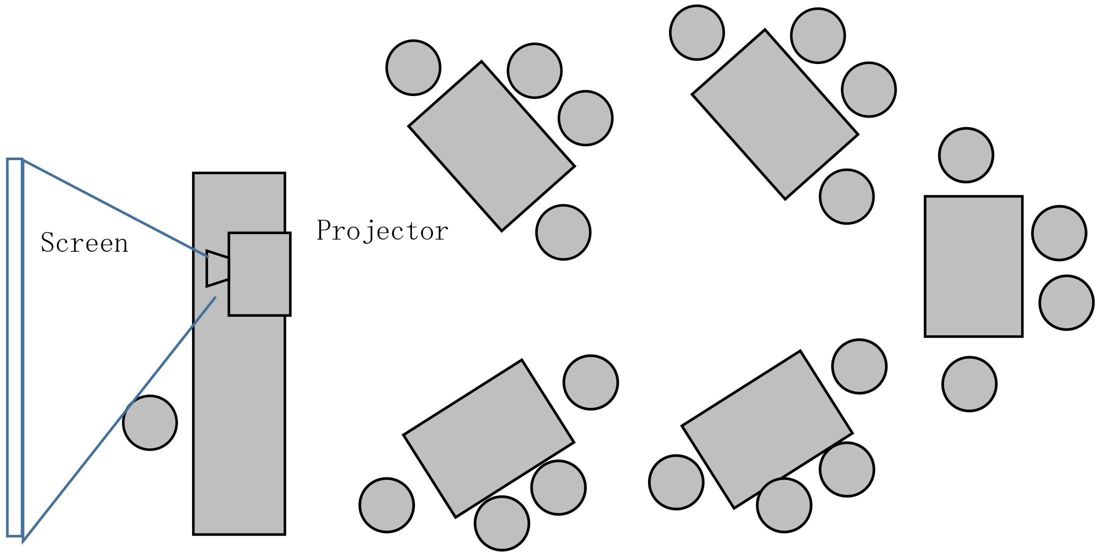
१. सहभागीहरुको लागि आवश्यक सामाग्री

नोटबुक, डटपेन, रेकर्ड फाईल, पेन्सिल, कटर, अध्ययन सामाग्री

२. प्रशिक्षणका लागि आवश्यक सामाग्री

ब्राउनसिट, न्यूजप्रिन्ट, वोर्ड मार्कर, परमानेन्ट मार्कर, मेटा कार्ड, ग्लु, मास्किङ टेप, कैंची, स्केल, स्टापलर, पुस पिन, पेपर क्लीप, सादा कागज, चकलेट आदि ।

सहभागिहरुको प्रशिक्षण हलमा वसाइ ब्यवस्था **(Training Hall Layout)** :



कैफियतः

१. प्रभावकारी प्रशिक्षण संचालन गर्नका लागि आवश्यक सूचना संकलन तथा अन्य सम्पुर्ण कामको जिम्मेवारी आवश्यकता अनुसार निर्धारण गर्ने ।

२. प्रशिक्षण हलको उपलव्धता र सहभागी संख्याको आधारमा सहभागीहरुको वसाई व्यवस्था मिलाउने । समूहकार्य गर्न सहज हुने गरी टेवलको व्यवस्थापन गर्ने ।

३. केही प्रस्तुतीकरण सामग्री अंग्रेजीमा भएपनि नेपाली भाषामा बुझाइन्छ । व्याख्यान दिने र अभ्यास र छलफल सञ्चालन गर्दा सहभागीहरूको पृष्ठभूमि र चासोलाई ध्यान दिइ संचालन गरिनेछ ।

फोहोरमैला व्यवस्थापन तथा वातावरण व्यवस्थापन प्रशिक्षण

कार्यतालिका

समय	पहिलो सत्र	१०: ३० – १०: ४५	दोश्रो सत्र	१२: १५ – १३: १५	तेश्रो सत्र	१४: ४५ – १५: ००	चौथो सत्र
मिति	०९: ०० – १०: ३०		१०: ४५ – १२: १५		१३: १५ – १४: ४५		१५: ०० – १६: ३०
पहिलो दिन	प्रशिक्षण कार्यक्रम शुभारम्भ, परिचय, समूह मान्यता निर्धारण, अपेक्षा संकलन, प्रशिक्षण विधि, उद्देश्य र विषयवस्तुको स्पष्टता पूर्व जानकारी	चिया	फोहोरमैला व्यवस्थापन र यसको महत्त्व	खाना	फोहोरमैला व्यवस्थापनको सङ्कलन, ढुवानी र स्थानान्तरणका आधारभूत अवधारणा	चिया	नगरपालिकाको फोहोरमैला पुन: चक्रण/फोहोरमैला विसर्जन
दोश्रो दिन	फोहोरमैला व्यवस्थापनको लागि नीति तथा नियमावली (फोहोरमैला ऐन, २०६८) र कार्यान्वयन रणनीति		जैविक फोहोरमैला प्रशोधन		एकीकृत दिगो फोहोरमैला व्यवस्थापन		फोहोरमैला व्यवस्थापनमा पात्र र सरोकारवालाहरू
तेश्रो दिन	सार्वजनिक-निजी साझेदारी		जनचेतना र फोहोरमैला व्यवस्थापन		विषाक्त फोहोरमैला व्यवस्थापन		सेनेटरी ल्याण्डफिल व्यवस्थापन
चौथो दिन	सेनेटरी ल्याण्डफिल स्थलमा सतहको पानी बग्ने नाली र Leachate व्यवस्थापन		काठमाडौं उपत्यकाको नगरपालिकाको फोहोरमैला व्यवस्थापन र विसर्जन – एक मामिला अध्ययन		फिल्ड भ्रमण		फिल्ड भ्रमण
पाँचौ दिन	फोहोरमैला थुपार्नाले वातावरण प्रदूषण		फोहोरमैलाबाट ऊर्जा		विभिन्न नगरपालिकाको मामिला अध्ययन र सिकाइको बारेमा अनुभव आदानप्रदान		प्रशिक्षण मूल्यांकन, पूर्व जानकारी र समापन

सत्र योजना

सत्र योजना

मोडुलः फोहोरमैला व्यवस्थापन तथा वातावरण व्यवस्थापन सत्रः १

समय ९० मिनेट

विषयः शुभारम्भ, परिचय, उद्देश्य, अपेक्षा सङ्कलन, समूह मान्यता, प्रशिक्षण पूर्व जानकारी

साधारण उद्देश्यः यस सत्रको अन्तमा सहभागीहरू प्रशिक्षणको उद्देश्यबारे प्रष्टहुनेछन्।

निर्दिष्ट उद्देश्यः सत्रको अन्तमा सहभागीहरू

- एक आपसमा परिचित हुनेछन्।
- प्रशिक्षण अवधिमा छलफल गरिने मुख्य विषयवस्तुको वारेमा जानकारी पाउनेछन्।
- विषयवस्तु वारेमा पूर्व जानकारीको अवस्था उपलब्ध हुनेछ।

सत्रका मुख्य विषयवस्तुः

- प्रशिक्षणको शुभारम्भ
- प्रशिक्षणको उद्देश्य
- परिचय
- अपेक्षा सङ्कलन
- प्रशिक्षणका विषयवस्तु, आधारभूत नियम, जिम्मेवारी आदि
- प्रशिक्षण पूर्व जानकारी

प्रशिक्षण – सिकाई क्रियाकलाप	अवधि	प्रशिक्षण – सिकाई सामाग्री	कैफियत
क्रियाकलाप १ शुभारम्भ ▪ सहभागीहरु र अतिथिहरुको उपस्थितिसंगै राष्ट्रियगानका लागि अनुरोध गर्नुहोस् । ▪ स्वागतसहित कार्यक्रमको उद्देश्यबारे प्रकाश पार्नुहोस् । ▪ प्रमुख अतिथिबाट ब्यानर पढी कार्यक्रमको औपचारिक शुभारम्भ गर्नुहोस् । ▪ अतिथिहरुबाट कार्यक्रमको सफलताको शुभकामना मन्तव्यका लागि अनुरोध गनुहोस् । ▪ कार्यक्रमको अध्यक्षबाट शुभारम्भ मन्तव्यसहित सत्र विसर्जनका लागि अनुरोध गर्नुहोस् ।	२५मिनेट	मेटाकार्ड, ब्यानर,	अतिथिहरू र अतिथिहरूको मन्तव्य व्यवस्थापन अवश्यकता अनुसार गर्नुहोस् ।
क्रियाकलाप २ परिचय ▪ सबै सहभागी, सहजकर्ता (प्रशिक्षक) र अन्य उपस्थित व्यक्तिहरुलाई आफ्नो नाम, ठेगाना, पद, संक्षिप्त कार्य अनुभवसहित आफ्नो परिचय दिन लगाउनुहोस् ।	१५ मिनेट		
क्रियाकलाप ३ अपेक्षा सङ्कलन ▪ सहभागीहरूलाई प्रशिक्षणबाट गरिएको अपेक्षालाई मेटाकार्डमा लेख्न लगाउनुहोस् । ▪ मेटाकार्डहरुलाई एक एक गरी पढ्दै ब्राउन पेपर वा बोर्डमा टाँस्नुहोस् । ▪ आएका अपेक्षालाई एकै किसिमका आसय भएका कार्डलाई एकै ठाँउमा राख्नुहोस् । ▪ प्रशिक्षणको विषयवस्तु र सहभागीको अपेक्षा मिलान गर्नुहोस् । ▪ सहभागीहरुबाट आएका अपेक्षाहरु के कति हदसम्म यस प्रशिक्षणले सम्बोधन गर्न सक्छ भन्ने प्रष्ट पार्नुहोस ।	१५ मिनेट	मेटाकार्ड, मार्कर, पुस पिन, ग्लु स्टीक, मास्किङ टेप, ब्राउन पेपर	यदि सहभागीबाट विषयवस्तु भन्दा भिन्न अपेक्षाकार्ड आएमा अलग राख्नुहोस् ।

प्रशिक्षण – सिकाई क्रियाकलाप	अवधि	प्रशिक्षण – सिकाई सामाग्री	कैफियत
क्रियाकलाप ४ विषयवस्तुको जानकारी ▪ सहभागीहरुले ल्याएका अपेक्षाहरुलाई मिलान गर्दै प्रशिक्षणमा छलफल गरिने विषयवस्तुहरु जानकारी गराउनुहोस ।	५ मिनेट	ब्राउन पेपर, मार्कर, न्यूजप्रिन्ट पेपर	
क्रियाकलाप ५ समुह मान्यता, जिम्मेवारी आदि ▪ प्रशिक्षण प्रभावकारीताको लागि हरेक दिनको प्रशिक्षण अवधिमा समूह मान्यतालाई सहभागीहरुसंग छलफल गरी न्यूज प्रिन्टमा लेख् िपालना गर्न लगाउनुहोस । ▪ आवश्यकता परेमा विभिन्न जिम्मेवारी बाँडफाँड (रिपोटिङ, समय व्यवस्थापक, मनोरञ्जनकर्ता आदि) गराउनुहोस् ।	५ मिनेट	ब्राउन पेपर, मार्कर, न्यूजप्रिन्ट पेपर, पावरप्वाइन्ट स्लाइड	
क्रियाकलाप ६ प्रशिक्षण पूर्व जानकारी ▪ सहभागीहरुलाई प्रशिक्षण पूर्व जानकारी फाराम वितरण गर्नुहोस् । ▪ उक्त फाराम कसरी भर्ने सबैलाई स्पष्ट पार्नुहोस् । ▪ सबै सहभागीहरुबाट फाराम संकलन गरी सकेपछि यसबाट आएको नतिजालाई हामी प्रशिक्षणको अन्तमा गरिने पश्चात जानकारीको नतिजासँग तुलना गर्नेछौं भन्नुहोस ।	१० मिनेट	प्रशिक्षण पूर्व परीक्षण फाराम	
क्रियाकलाप ७ प्रशिक्षणको साधारण उद्देश्य, निर्दिष्ट उद्देश्यहरु, प्रशिक्षण विधि र प्रशिक्षण तालिका ▪ प्रशिक्षकले प्रशिक्षणको बारेमा फ्लीप चार्टमा तयार पारेको प्रशिक्षणको साधारण उद्देश्य, निर्दिष्ट उद्देश्यबारे बताउनुहोस् । ▪ प्रशिक्षणका विधिहरु जानकारी गराउनुहोस् । ▪ प्रशिक्षण तालिकाको जानकारी तथा तालिका वितरण गर्नुहोस् ।	१० मिनेट	ब्राउन पेपर, फ्लीप चार्ट, प्रशिक्षण तालिका	

प्रशिक्षण – सिकाई क्रियाकलाप	अवधि	प्रशिक्षण – सिकाई सामाग्री	कैफियत
क्रियाकलाप ८ सत्र संक्षेपीकरण र अग्रसम्वन्ध ▪ समग्र प्रशिक्षण सहभागितामूलक ढंगबाट अगाडि बढ्ने कुराको अवगत गराउनुहोस् । ▪ दोश्रो सत्र सम्वन्धी जानकारी गराउनुहोस् ।	५ मिनेट		

सत्रः २	**फोहोरमैला व्यवस्थापन र यसको महत्त्व**
समयावधि:	**९० मिनेट**
नमुनाको उद्देश्य	▪ फोहोरमैला र यसको वर्गीकरण को अवधारणा बुझ्न ▪ आवश्यकता र दुबैको सामग्रीको बारेमा स्पष्ट अवधारणाहरु
मुख्य शिर्षकहरु	▪ फोहोरमैलाको परिचय ▪ फोहोरमैलाको किसिमहरू ▪ फोहोरमैलाको उत्सर्जन ▪ फोहोरमैलाको असर ▪ फोहोरमैला व्यवस्थापन

सत्र सामग्री	अपेक्षित शिक्षा परिणाम **(ELO)**	समय	
		Pr	**Th**
फोहोरमैलाको परिचय	EOS: ▪ फोहोरको परिभाषा ▪ फोहोरको प्रकार		१५ मिनेट
फोहोरमैलाको किसिमहरू	EOS: ▪ ठोस फोहोरको अवधारणा ▪ ठोस फोहोरको विभिन्न प्रकार बुझ्न ▪ फोहोरको स्रोतहरु		३० मिनेट
फोहोरमैलाको उत्सर्जन	EOS: ▪ फोहोरमैलाको बनौट ▪ निश्कासन गर्ने स्थलहरुको विवरण		१५ मिनेट
फोहोरमैलाको असर	EOS: ▪ फोहोरको प्रभावको बारेमा विवरण ▪ प्रभावको प्रकारहरु ▪ फोहोरबाट हुने विभिन्न रोगहरु		१५ मिनेट
फोहोरमैला व्यवस्थापन	EOS: ▪ फोहोर व्यवस्थापनको परिभाषा ▪ फोहोर व्यवस्थापनको विवरण		१५ मिनेट

सत्र ३	फोहोरमैला व्यवस्थापनको सङ्कलन, ढुवानी र स्थानान्तरणका आधारभूत अवधारणा
समयावधिः	**९० मिनेट**
सत्र उद्देश्यहरू	▪ ठोस फोहोर व्यवस्थापनको अवधारणा बुझ्न ▪ फोहोरमैला व्यवस्थापन रणनीति लन प्रणाली र स्थानान्तरण स्टेशन बुझ्न
प्रमुख विषयहरु	▪ फोहोरमैलाको उचित व्यवस्थापन ▪ फोहोरमैला सङ्कलन व्यवस्था ▪ यातायात र स्थानान्तरण स्टेशन

सत्र सामग्री	अपेक्षित शिक्षा परिणाम **(ELO)**	समय	
		Pr	**Th**
फोहोरमैलाको उचित व्यवस्थापन	EOS: ▪ ठोस फोहोर व्यवस्थापनको अवधारणा ▪ एकीकृत फोहोरमैला व्यवस्थापन ▪ एकीकृत फोहोरमैला व्यवस्थापन रणनीति		३० मिनेट
फोहोरमैला सङ्कलन व्यवस्था	EOS: ▪ नगरपालिकामा फोहोर संकलन प्रणाली ▪ फोहोरमैला सङ्कलन संयन्त्र		३० मिनेट
यातायात र स्थानान्तरण स्टेशन	EOS: ▪ ढुवानी र अन्तिम विसर्जन ▪ स्थानान्तरण केन्द्र ▪ स्थानान्तरण केन्द्रमा फोहोरमैला जम्मा गर्दाको फाइदाहरू ▪ स्थानान्तरण केन्द्रका प्रकार		३० मिनेट

सत्र ४	नगरपालिकाको फोहोरमैला पुन: चक्रण/फोहोरमैला विसर्जन
अवधि	**९० मिनेट**
सत्र उद्देश्यहरू	▪ पुन: चक्रणको अवधारणा बुझ्न ▪ फोहोरको प्रकारको रीसाइक्लिंग गर्नको लागी बुझ्न ▪ फोहोर निपटानको अवधारणा बुझ्न
प्रमुख विषयहरु	▪ पुनर्चक्रण को अवधारणा ▪ पुन: प्रयोज्य फोहोर ▪ फोहोरमैला विसर्जनका विधिहरू

सत्र सामग्री	अपेक्षित शिक्षा परिणाम **(ELO)**	समय	
		Pr	**Th**
पुन: चक्रणको अवधारणा	EOS: ▪ पुन: चक्रणको परिचय ▪ पुन: चक्रणको स्रोतहरु		१५ मिनेट
पुन: प्रयोज्य फोहोर	EOS: ▪ आवासीय फोहोरमैला ▪ व्यावसायिक फोहोरमैला ▪ औद्योगिक फोहोरमैला ▪ अन्य फोहोरमैलाहरू ▪ पुन: चक्रणको अवसर		४५ मिनेट
फोहोरमैला विसर्जनका विधिहरू	EOS: ▪ ल्याण्डफिल ▪ भस्मीकरण ▪ फोहोरमैला संघनन ▪ जैविक ग्याँस उत्पादन ▪ प्राङ्गारिक मल ▪ गड्याउले प्राङ्गारिक मल		३० मिनेट

सत्र ५	फोहोरमैला व्यवस्थापनको लागि नीति तथा नियमावली (फोहोरमैला ऐन, २०६८) र कार्यान्वयन रणनीति
अवधि	**९० मिनेट**
सत्र उद्देश्यहरू	▪ ठोस फोहोर उत्पादन, संकलन, निर्वहन, स्थानान्तरण स्थल र ल्याण्डफिलमा प्रावधान बुझ्न ▪ ठोस फोहोर र सेवा शुल्कको ब्यवस्थापनमा निजी र सामुदायिक क्षेत्रको संलग्नताको समझ ▪ प्रदूषण नियन्त्रण र ठोस फोहोर व्यवस्थापनको अनुगमनमा प्रावधान बुझ्न ▪ ठोस फोहोर व्यवस्थापन परिषद, प्राविधिक सहयोग केन्द्रको प्रावधान बुझ्न ▪ ठोस फोहोर व्यवस्थापनमा अपराध र सजायको प्रावधान बुझ्न
प्रमुख विषयहरु	▪ फोहोरमैला उत्सर्जन, सङ्कलन र विसर्जनको प्रावधान ▪ फोहोरमैला व्यवस्थापनमा निजी तथा सामुदायिक क्षेत्रको सहभागिता ▪ प्रदूषण नियन्त्रण र फोहोरमैला व्यवस्थापन कार्यको रेखदेख गर्ने प्रावधान ▪ फोहोरमैला व्यवस्थापन परिषदको प्रावधान ▪ दण्ड सजाय ▪ विविध ▪ फोहोरमैला व्यवस्थापन शुल्क/नगरपालिका क्षेत्रमा महसुल निर्धारण

सत्र सामग्री	अपेक्षित शिक्षा परिणाम **(ELO)**	समय	
		Pr	**Th**
फोहोरमैला उत्सर्जन, सङ्कलन र विसर्जनको प्रावधान	EOS: ▪ फोहोरमैला व्यवस्थापनमा स्थानीय सरकारको जिम्मेवारी ▪ फोहोरमैला व्यवस्थापनको लागि जिम्मेवारी		१० मिनेट
फोहोरमैला व्यवस्थापनमा निजी तथा सामुदायिक क्षेत्रको सहभागिता	EOS: ▪ सञ्चालनको लगि प्रमाण-पत्रको प्रावधान ▪ फोहोरमैला व्यवस्थापन निजी क्षेत्रले गर्ने सक्ने ▪ प्रतिस्पर्धाको आधारमा व्यवस्थापन गर्न स्वीकृत दिने		१० मिनेट

	▪ ल्याण्डफिल स्थल निर्माण र सञ्चालन गर्न अनुमति दिने ▪ सार्वजनिक-निजी-साझेदारीमा फोहोरमैला व्यवस्थापन गर्न दिने		
प्रदूषण नियन्त्रण र फोहोरमैला व्यवस्थापन कार्यको रेखदेख गर्ने प्रावधान	EOS: ▪ प्रदूषण नियन्त्रण ▪ फोहोरमैला व्यवस्थापनको रेखदेख ▪ वित्तीय, सामाजिक विकास र वातावरण संरक्षणको प्रावधान		१० मिनेट
फोहोरमैला व्यवस्थापन परिषदको प्रावधान	EOS: ▪ परिषदको विधान ▪ परिषदको काम, कर्तव्य र जिम्मेवारी ▪ परिषदको बैठक र निर्णयहरू		१० मिनेट
दण्ड सजाय	EOS: ▪ दण्ड ▪ सजाय ▪ सेवा तथा सुविधाहरू रोक्ने ▪ सुनुवाइको व्यवस्था		१० मिनेट
विविध	EOS: ▪ स्वास्थ्यसँग सम्बन्धित फोहोरमैलाको व्यवस्थापन ▪ रासायनिक विषको प्रावधान ▪ फोहोरमैला व्यवस्थापनमा सम्लग्न स्थानीय संस्था तथा निकायहरूको अभिलेख राख्ने ▪ सूचना उपलब्ध गराउने ▪ अधिकारको निक्षेप गर्ने ▪ नेपाल सरकारसँग सञ्चार गर्ने ▪ पुरस्कारको व्यवस्था गर्ने ▪ नियम विनियमहरू तयार गर्ने ▪ निर्देशिका तयार गर्ने ▪ ऐनलाई समय सापेक्ष गराउने ▪ रद्द र बचावट		१० मिनेट

फोहोरमैला व्यवस्थापन शुल्क/नगरपालिका क्षेत्रमा महसुल निर्धारण	EOS: ▪ बजारको वर्तमान प्रवृत्तिमा छलफल ▪ समूह कार्य ▪ समुदायको महसुल तिर्ने चाहना ▪ भुक्तानी सङ्कलन प्रक्रिया ▪ नगरपालिकामा शुल्क वा महसुल निर्धारण		३० मिनेट

सत्र ६	जैविक फोहोरमैला प्रशोधन
अवधि	**९० मिनेट**
सत्र उद्देश्यहरू	▪ जैविक फोहोर र यसको वर्गीकरणको अवधारणा बुझ्न ▪ जैविक फोहोरको उपचार विधि बुझ्न ▪ कम्पोस्टि free मुक्त टेक्नोलोजी बुझ्न ▪ कम्पोस्टि free मुक्त उपकरण बुझ्न
प्रमुख विषयहरु	▪ जैविक फोहोर र यसको वर्गीकरण को अवधारणा ▪ जैविक फोहोरमैलाको प्रकार ▪ प्रशोधन विधिहरू ▪ प्राङ्गारिकमुक्त प्रविधि

सत्र सामग्री	अपेक्षित शिक्षा परिणाम **(ELO)**	समय	
		Pr	**Th**
जैविक फोहोर र यसको वर्गीकरण को अवधारणा	EOS: ▪ जैविक भनेको के हो? ▪ प्राङ्गारिक भनेको के हो?		२० मिनेट
जैविक फोहोरमैलाको प्रकार	EOS: ▪ औद्योगिक जैविक फोहोरमैला ▪ दैनिक जैविक फोहोरमैलाहरू ▪ कृषि, वन र पशुधन		२० मिनेट
प्रशोधन विधिहरू	EOS: ▪ परिचय र बेफाइदाहरू ▪ भस्मीकरण ▪ ल्याण्डफिल ▪ प्राङ्गारिक ▪ छिटो किण्वीकरण ▪ जैविक ग्याँस		२० मिनेट
प्राङ्गारिकमुक्त प्रविधि	EOS: ▪ अवधारणा र Theory ▪ कार्बन भण्डारण		३० मिनेट

	▪ प्राङ्गारिकमुक्त उपकरण ▪ स्ट्यान्डर्ड ढाँचा: छिटो प्रशोधन ▪ व्यावसायिक ढाँचा ▪ द्वितीय प्रदूषण नहुने		

सत्र ७	एकीकृत दिगो फोहोरमैला व्यवस्थापन
अवधि	**९० मिनेट**
सत्र उद्देश्यहरू	▪ एकीकृत ठोस फोहोर ब्यवस्थापनको अवधारणा र योजनाको प्रक्रिया लाई बुझ्न ▪ संग्रह र यातायात प्रणाली बुझ्न ▪ कम्पोस्टिंग र सेनेटरी ल्याण्डफिलको अवधारणा बुझ्न
प्रमुख विषयहरु	▪ एकीकृत ठोस फोहर व्यवस्थापनको अवधारणा ▪ सङ्कलन र ढुवानी ▪ एकीकृत फोहोरमैला व्यवस्थापन बहाव प्रक्रिया

सत्र सामग्री	अपेक्षित शिक्षा परिणाम **(ELO)**	समय	
		Pr	**Th**
एकीकृत ठोस फोहर व्यवस्थापन को अवधारणा	EOS: ▪ परिभाषा ▪ एकीकृत फोहोरमैला व्यवस्थापन – योजना तर्जुमा प्रक्रिया		२० मिनेट
सङ्कलन र ढुवानी	EOS: ▪ सङ्कलन तथा ढुवानी व्यवस्था ▪ स्रोतमानै विभाजन/छुट्टाउने र यसको महत्त्व ▪ प्राथमिक सङ्कलन र ढुवानी ▪ द्वितीय सङ्लन तथा ढुवानी ▪ स्थानान्तरण केन्द्र ▪ तेस्रो ढुवानी		४५ मिनेट
एकीकृत फोहोरमैला व्यवस्थापन बहाव प्रक्रिया	EOS: ▪ प्राङ्गारिक ▪ सेनेटरी ल्याण्डफिल ▪ Refuse Derived Fuel ▪ साधारण विशेषताहरू - RDF		२५ मिनेट

सत्र **८**	फोहोरमैला व्यवस्थापनमा पात्र र सरोकारवालाहरू
अवधि	**९० मिनेट**
सत्र उद्देश्यहरू	▪ SWM को हितधारकहरुको हुन् बुझ्ने ▪ ठोस फोहोर ब्यवस्थापनमा उनीहरुको भूमिका बुझ्न
प्रमुख विषयहरु	▪ फोहोरमैला व्यवस्थापनमा विभिन्न सरोकारवालाहरू ▪ फोहोरमैला उत्सर्जनकर्ताहरू ▪ सङ्कलनकर्ताहरू: निष्कासन/सङ्कलन/ढुवानी

सत्र सामग्री	अपेक्षित शिक्षा परिणाम **(ELO)**	**समय**	
		Pr	**Th**
फोहोरमैला व्यवस्थापनमा विभिन्न सरोकारवालाहरू	EOS: ▪ फोहोरमैला उत्सर्जनकर्ताहरू ▪ सङ्कलनकर्ताहरू ▪ सरकार ▪ सामुदायिक अगुवाहरू/नेताहरू ▪ सामाजिक संघ संस्थाहरू ▪ व्यापारी र फोहोरमैला प्रोसेसर ▪ सञ्चार/मिडिया		१५ मिनेट
फोहोरमैला उत्सर्जनकर्ताहरू	EOS: ▪ व्यक्तिगत – नागरिक ▪ घरधुरी ▪ सूचनामूलक, शिक्षात्मक र सञ्चार सामाग्री ▪ संस्थागत ▪ व्यावसायिक ▪ थोक फोहोरमैला उत्सर्जनकर्ताहरू ▪ सार्वजनिक स्थल/धार्मिक स्थल		६० मिनेट
सङ्कलनकर्ताहरू: निष्कासन/सङ्कलन/ढुवानी	EOS: ▪ सङ्कलन र ढुवानी ▪ व्यापारी र फोहोरमैला Processors ▪ अनुकूल वातावरण		१५ मिनेट

सत्र ९	सार्वजनिक-निजी साझेदारी
अवधि	**९० मिनेट**
सत्र उद्देश्यहरू	▪ सार्वजनिक निजी साझेदारीको अवधारणा बुझ्न ▪ नेपालमा सार्वजनिक निजी साझेदारीको अवधारणा बुझ्न ▪ सार्वजनिक निजी साझेदारी को लाभ बुझ्न ▪ सार्वजनिक निजी साझेदारी को अवसर र चुनौतिहरु बुझ्न
प्रमुख विषयहरु	▪ फोहोरमैला व्यवस्थापन ▪ सार्वजनिक-निजी क्षेत्र साझेदारी

सत्र सामग्री	अपेक्षित शिक्षा परिणाम **(ELO)**	समय	
		Pr	**Th**
फोहोरमैला व्यवस्थापन	EOS: ▪ परिचय ▪ फोहोरमैला व्यवस्थापनमा तहगत् प्रणाली ▪ फोहोरमैला व्यवस्थापनमा फोहोर न्यूनीकरण ▪ नेपालमा फोहरमैला व्यवस्थापन प्रणाली		३० मिनेट
सार्वजनिक-निजी क्षेत्र साझेदारी	EOS: ▪ परिचय- सार्वजनिक-निजी क्षेत्र साझेदारी ▪ नेपालमा फोहोरमैला व्यवस्थापन ▪ नेपालमा सार्वजनिक-निजी क्षेत्र साझेदारी (PPP) ▪ चुनौतीहरू ▪ निकास ▪ अवसर ▪ मामिला अध्ययन		६० मिनेट

सत्र १०	जनचेतना र फोहोरमैला व्यवस्थापन
अवधि	**९० मिनेट**
सत्र उद्देश्यहरू	▪ अलगावको महत्व बुझ्न
प्रमुख विषयहरु	▪ फोहोरको पृथकीकरण

सत्र सामग्री	अपेक्षित शिक्षा परिणाम **(ELO)**	समय	
		Pr	**Th**
फोहोरको पृथकीकरण	EOS: ▪ फोहोरको पृथकीकरण ▪ भिजेको र सूखा फोहोरमैला ▪ फोहोरमैला छुट्टाउन किन आवश्यक छ? ▪ पुन: चक्रणका केही तथ्यहरू ▪ फोहोरमैला न्यूनीकरण		९० मिनेट

सत्र ११	विषाक्त फोहोरमैला व्यवस्थापन
अवधि	**९० मिनेट**
सत्र उद्देश्यहरू	▪ अवधारणा खतरनाक फोहोर र यसको स्रोत बुझ्न ▪ कसरी भण्डारण र खतरनाक फोहोर ढुवानी गर्नको लागी बुझ्न ▪ खतरनाक फोहर व्यवस्थापनको रणनीति बुझ्न
प्रमुख विषयहरु	▪ विषाक्त फोहोरमैलाको परिभाषा र स्रोतहरू ▪ विषाक्त फोहोरमैलाको ढुवानी र भण्डारण

सत्र सामग्री	अपेक्षित शिक्षा परिणाम **(ELO)**	समय	
		Pr	**Th**
विषाक्त फोहोरमैलाको परिभाषा र स्रोतहरू	EOS: ▪ परिभाषा ▪ स्रोतहरू ▪ विषाक्त फोहोरमैला वर्गीकरण ▪ विषाक्त फोहोरमैला सम्बन्धीको नीति नियमहरू ▪ विषाक्त फोहोरमैला व्यवस्थापन रणनीति		४५ मिनेट
विषाक्त फोहोरमैलाको ढुवानी र भण्डारण	EOS: ▪ फोहोरमैला न्यूनीकरण ▪ प्रशोधन विधि ▪ भस्मीकरण ▪ ठोस वा स्थिरीकरण ▪ विसर्जन विधि		४५ मिनेट

सत्र १२	सेनेटरी ल्याण्डफिल व्यवस्थापन
अवधि	**९० मिनेट**
सत्र उद्देश्यहरू	▪ ल्याण्डफिल र यसको विशेषताको अवधारणा बुझ्न ▪ ल्याण्डफिल को महत्व बुझ्न ▪ ल्याण्डफिल को डिजाइन र संचालन बुझ्न ▪ ल्याण्डफिल निपटान प्रक्रिया बुझ्न
प्रमुख विषयहरु	▪ ल्याण्डफिल व्यवस्थापनको परिभाषा ▪ ल्याण्डफिल – डिजाइन र सञ्चालन ▪ ल्याण्डफिल व्यवस्थापनको लाभ र हानि ▪ सार्वजनिक, वातावरण र स्वास्थ्य सम्बन्धी चासो

सत्र सामग्री	अपेक्षित शिक्षा परिणाम (ELO)	समय	
		Pr	**Th**
ल्याण्डफिल व्यवस्थापनको परिभाषा	EOS: ▪ सेनेटरी ल्याण्डफिल भनेको के हो? ▪ सिद्धान्त ▪ ल्याण्डफिलका विशेषताहरू ▪ ल्याण्डफिलको लागि आवश्यकताहरू ▪ ल्याण्डफिल प्रक्रियाका महत्त्वपूर्ण पक्षहरू ▪ निर्माण स्थल छनौट प्रक्रिया ▪ ल्याण्डफिलको अवयवहरू		४० मिनेट
ल्याण्डफिल – डिजाइन र सञ्चालन	EOS: ▪ योजना तर्जुमा चरण ▪ निर्माण चरण ▪ सञ्चालन चरण (५-२० वर्ष) ▪ सम्पन्न चरण (२०-१०० वर्ष) ▪ Final storage phase		३० मिनेट
ल्याण्डफिल व्यवस्थापनको लाभ र हानि	▪ ल्याण्डफिलका फाइदाहरू ▪ ल्याण्डफिलका बेफाइदाहरू		१० मिनेट
सार्वजनिक, वातावरण र स्वास्थ्य सम्बन्धी चासो	▪ सार्वजनिक, वातावरण र स्वास्थ्य सम्बन्धी चासो		१० मिनेट

सत्र १३	सेनेटरी ल्याण्डफिल स्थलमा सतहको पानी बग्ने नाली र **Leachate** व्यवस्थापन
अवधि	९० मिनेट
सत्र उद्देश्यहरू	▪ ल्याण्डफिल लीचेटको अवधारणा बुझ्न ▪ संग्रह र उपचार बुझ्दै ▪ Leachate Recirculation बुझ्न
प्रमुख विषयहरु	▪ ल्याण्डफिलको परिचय ▪ Leachate को अवधारणा

सत्र सामग्री	अपेक्षित शिक्षा परिणाम (ELO)	समय	
		Pr	**Th**
ल्याण्डफिलको परिचय	EOS: ▪ ल्याण्डफिल ▪ ल्याण्डफिलको वर्गीकरण		३० मिनेट
Leachate को अवधारणा	EOS: ▪ ल्याण्डफिल Leachate ▪ ल्याण्डफिलमा Leachate को बनौट ▪ ल्याण्डफिलमा ग्याँस ▪ जैविक-रियाक्टरको परिभाषा ▪ ल्याण्डफिललाई Bioreactor को रूपमा किन सञ्चालन गरिन्छ?		६० मिनेट

सत्र१४	काठमाडौं उपत्यकाको नगरपालिकाको फोहोरमैला व्यवस्थापन र विसर्जन – एक मामिला अध्ययन
अवधि	**९० मिनेट**
सत्र उद्देश्यहरू	▪ काठमाडौंमा वर्तमान SWM बुझ्न ▪ ठोस फोहोर न्यूनीकरणको अवधारणा बुझ्न
प्रमुख विषयहरु	▪ काठमाडौंमा फोहोरमैला व्यवस्थापनको वर्तमान अवस्था ▪ फोहोरमैला न्यूनीकरण ▪ ल्याण्डफिलको संचालन प्रवाह

सत्र सामग्री	अपेक्षित शिक्षा परिणाम **(ELO)**	समय	
		Pr	**Th**
काठमाडौंमा फोहोरमैला व्यवस्थापनको वर्तमान अवस्था	EOS: ▪ का.म.पा. को फोहोरमैला उत्सर्जन र सङ्कलन ▪ फोहोरमैला संरचना ▪ सङ्कलन र ढुवानी ▪ काठमाडौंमा फोहोरमैला व्यवस्थापनको वर्तमान अवस्था ▪ फोहोरमैला सङ्कलन वाहनहरू		२० मिनेट
फोहोरमैला न्यूनीकरण	EOS: ▪ प्राङ्गारिक मल ▪ गड्याउले प्राङ्गारिक मल ▪ प्राङ्गारिक मल ▪ अन्तिम विसर्जन		२० मिनेट
ल्याण्डफिलको संचालन प्रवाह	EOS: ▪ ल्याण्डफिल स्थलमा सञ्चालन बहाव ▪ ल्याण्डफिल स्थलमा वाहनहरूको व्यवस्थापन ▪ सामाजिक पक्ष ▪ वित्तीय पक्ष ▪ आम शिक्षा ▪ व्यवस्थापकीय पक्ष ▪ संस्थागत सबलीकरण र संस्थागत प्रबन्ध ▪ प्रभावहरू		५० मिनेट

सत्र १५ र १६	फिल्ड भ्रमण
अवधि	**१२० मिनेट**
सत्र उद्देश्यहरू	▪ **क्षेत्र भ्रमण**
प्रमुख विषयहरु	▪ नजिकैको ल्यान्डफील र स्थानान्तरण केन्द्रको भ्रमण

सत्र सामग्री	अपेक्षित शिक्षा परिणाम **(ELO)**	समय	
		Pr	**Th**
नजिकैको ल्यान्डफील र स्थानान्तरण केन्द्रको भ्रमण	EOS: ▪ नजिकको ल्याण्डफिल स्थल वा स्थानान्तरण केन्द्रको भ्रमण ▪ अध्ययन क्षेत्रको विभाजन ▪ ल्याण्डफिल वा स्थानान्तरण केन्द्रको व्यवस्थापन ▪ छलफल		१२० मिनेट

सत्र १७	फोहोरमैला थुपार्नाले वातावरण प्रदूषण
अवधि	९० मिनेट
सत्र **उद्देश्यहरू**	▪ अनुचित SWM को कारण नकारात्मक वातावरण को प्रभाव बुझ्न ▪ SWM को लागी रणनीति
प्रमुख विषयहरु	▪ अव्यवस्थित फोहोरमैला विसर्जन गर्नाले वातावरणमा पर्ने नकारात्मक असरहरू ▪ फोहोरमैला व्यवस्थापन रणनीति

सत्र सामग्री	अपेक्षित शिक्षा परिणाम **(ELO)**	समय	
		Pr	**Th**
अव्यवस्थित फोहोरमैला विसर्जन गर्नाले वातावरणमा पर्ने नकारात्मक असरहरू	EOS: ▪ अनुचित Dumpsite ▪ फोहोरमैला थुप्रिनाले नाली बन्द हुने ▪ पेशागत खतरा ▪ खुला रूपमा फोहोरमैला ▪ खुला रूपमा ट्रकमा फोहोरमैला सङ्कलन ▪ फोहोरमैला सङ्कलन गर्नाले		६० मिनेट
फोहोरमैला व्यवस्थापन रणनीति	EOS: ▪ वातावरणीय जिम्मेवारीहरू – पुन प्रयोग, पुन: चक्रण, र न्यूनीकरण ▪ प्रभावकारी फोहोरमैला विसर्जन र व्यवस्थापन ▪ नियन्त्रण र ल्याण्डफिलको अनुगमन ▪ फोहोरमैलाको रूपान्तरण योजना ▪ अव्यवस्थित फोहोरमैला विसर्जनको लागि दण्ड ▪ जनचेतना ▪ उपयुक्त नीति तथा कानुन		३० मिनेट

सत्र १८	फोहोरमैलाबाट ऊर्जा
अवधि	**९० मिनेट**
सत्र उद्देश्यहरू	▪ अपशिष्ट को ऊर्जा को अवधारणा बुझ्न ▪ फोहोर उपयोग को अवधारणा बुझ्न ▪ प्रविधिको मूल्यांकन बुझ्ने
प्रमुख विषयहरु	▪ फोहोरमैलाको उपयोग ▪ प्रविधि अवलोकन ▪ फोहोरमैलाको उपयोगको फाइदा र बेफाइदा

सत्र सामग्री	अपेक्षित शिक्षा परिणाम **(ELO)**	समय	
		Pr	**Th**
फोहोरमैलाको उपयोग	EOS: ▪ यसको अर्थ ▪ फोहोरमैलाको उपयोग ▪ एकीकृत र दिगो ठोस तथा तरल फोहोरमैला व्यवस्थापन (अन्तरसम्बन्ध)		३० मिनेट
प्रविधि अवलोकन	EOS: ▪ प्रविधिको पुनरावलोकन ▪ प्रविधिको छनौट ▪ Mass र ऊर्जा सन्तुलन ▪ प्रविधिहरूको लेखाजोखा ▪ मूल्याङ्कन जाँच सूची ▪ WTE प्रविधिहरूको छनौटको लागि मापदण्ड		५० मिनेट
फोहोरमैलाको उपयोगको फाइदा र बेफाइदा	EOS: ▪ फाइदा ▪ बेफाइदा		१० मिनेट

सत्र १९	विभिन्न नगरपालिकाको मामिला अध्ययन र सिकाइको बारेमा अनुभव आदानप्रदान
अवधि	**९० मिनेट**
सत्र **उद्देश्यहरू**	▪ विभिन्न नगरपालिकाको मामिला अध्ययन र सिकाइको बारेमा अनुभव आदानप्रदान
प्रमुख विषयहरु	▪ विभिन्न नगरपालिकाको मामिला अध्ययन र सिकाइको बारेमा अनुभव आदानप्रदान

सत्र सामग्री	अपेक्षित शिक्षा परिणाम **(ELO)**	समय	
		Pr	**Th**
विभिन्न नगरपालिकाको मामिला अध्ययन र सिकाइको बारेमा अनुभव आदानप्रदान	EOS: ▪ समूह विभाजन ▪ मामिला अध्ययन उपलब्ध गराउने ▪ मामिला अध्ययनलाई अध्ययन गरी प्रश्न उत्तर ▪ प्रत्येक समूहको प्रस्तुतीकरण ▪ छलफल		९० **मिनेट**

सत्र योजना

मोडुलः फोहोरमैला व्यवस्थापन तथा वातावरण व्यवस्थापन सत्रः २०

समय ९० मिनेट

विषयः कार्य योजना, प्रशिक्षण मूल्याङ्कन तथा समापन

साधारण उद्देश्यः यस सत्रको अन्तमा सहभागीहरुले सिकेका कुरालाई आफ्नो कार्यक्षेत्रमा कसरी कार्यान्वयन गर्ने बारे कार्ययोजना तयार भएको हुनेछ ।

निर्दिष्ट उद्देश्यः सत्रको अन्तमा सहभागीहरुले

- सिकाई कार्यान्वयन गर्ने बारे कार्ययोजना तय गर्न सक्नेछन् ।
- समग्र प्रशिक्षणको सिकाई उपलव्धी मूल्याकङ्न गर्न सक्नेछन् ।
- प्रशिक्षण कार्यक्रमको औपचारिक रुपमा समापन हुनेछ ।

सत्रका मुख्य विषयवस्तुः

- कार्य योजना तयार
- प्रशिक्षण अपेक्षा पुनरावलोकन
- प्रशिक्षणको संक्षेपीकरण
- प्रशिक्षण पश्चात जानकारी
- प्रशिक्षण मूल्याङ्कन
- प्रशिक्षण समापन

प्रशिक्षण – सिकाई क्रियाकलाप	अवधि	प्रशिक्षण – सिकाई सामाग्री	कैफियत
क्रियाकलाप १ सहभागीहरुको ध्यानाकर्षण ▪ सहभागीहरु सवैलाई उठ्न लगाउनुहोस् । ▪ सवैलाई ताली वजाउन लगाउनुहोस् र ध्यानाकर्षण गर्नुहोस् ।	५मिनेट		

प्रशिक्षण – सिकाई क्रियाकलाप	अवधि	प्रशिक्षण – सिकाई सामाग्री	कैफियत
क्रियाकलाप २ सत्रको नाम, उद्देश्य र विषयवस्तु • सत्रको नाम, उद्देश्य, विषयवस्तु र समय अवधि वताउनुहोस् ।	५मिनेट	स्लाइड प्रस्तुति	पावर प्वाइन्ट स्लाइड
क्रियाकलाप ३ विषयवस्तु सम्बन्धी सहभागीहरुको बुझाई • सहभागीहरुलाई तपाईहरुले कार्य योजना तयार गर्नुभएको छ कि छैन भनी सोध्नुहोस् । • कार्य योजनामा के के राख्नुपर्छ भनी सोध्नुहोस् । • सहभागीहरुबाट आएका कुराहरुलाई मिलान गर्दै विषयवस्तु अगाडि बढाउनुहोस् ।	५मिनेट	प्रश्न उत्तर	
क्रियाकलाप ४ कार्ययोजना तयारी ▪ सहभागीबाट आएको बुँदालाई समेट्दै अव हामी कार्य योजना वनाउंछौ भनी कार्य योजनाको फाराम प्रस्तुत गर्नुहोस् । ▪ प्रत्येक सहभागीले आ आफ्नो कार्ययोजना तयार गर्न लगाउने । ▪ कार्य योजना वनाउंदा कम्तिमा ६ महिनाको लागि गर्न सकिने योजना वनाउनुहोस भनी भन्नुहोस् । ▪ यस कार्य योजनाको अनुगमन हुने छ भनी वताउनुहोस् ।	१५मिनेट	समूह छलफल	न्यूज प्रिन्ट, मार्कर, मास्किङ टेप, कार्ययोजना फाराम (अभ्यास पत्र)
क्रियाकलाप ५ कार्ययोजना प्रस्तुतिकरण • कार्ययोजना प्रस्तुत गर्न लगाउनुहोस् । • प्रस्तुतिकरणमा केही थपघट गर्नु पर्ने भए गर्न लगाउनुहोस् । • यो योजना लेख्न मात्र नभै कार्यान्वयन गर्नुपर्छ भनी वताउनुहोस् ।	१५मिनेट	लघु प्रवचन	
क्रियाकला ६ सत्र संक्षेपीकरण • सहभागीहरुको केही जिज्ञासाहरु भए समेट्दै यस सत्रमा गरिएका कार्यहरुलाई समेट्दै संक्षेपीकरण गर्नुहोस् ।	५मिनेट	लघु प्रवचन	

प्रशिक्षण – सिकाई क्रियाकलाप	अवधि	प्रशिक्षण – सिकाई सामाग्री	कैफियत

क्रियाकलाप ७ सत्र मूल्यांकन
▪ यस सत्रमा राखिएका निर्दिष्ट उद्देश्यहरु हासिल भए कि भएनन् भनेर थाहा पाउनको लागि सहभागीहरुलाई
▪ निम्न प्रश्नहरु गर्नुहोस् ।
  ▪ कार्ययोजना भनेको के हो
  ▪ कार्ययोजनामा के के विषयहरु हुन्छन्
  ▪ अहिले तयार गरिएको कार्ययोजनामा के के क्रियाकलापहरु राखियो
	५मिनेट	लघु प्रवचन	

क्रियाकलाप ८ प्रक्षिणको पश्चात जानकारी र मूल्याङ्कन ▪ सहभागीहरुलाई प्रशिक्षण पश्चात्को फाराम वितरण गरी भर्न अनुरोध गर्नुहोस् । ▪ सहभागीहरुलाई प्रशिक्षणको मूल्याङ्कनको लागि तयार गरिएको प्रशिक्षण मुल्याङ्कन फाराम वितरण गरी भर्न लगाउनुहोस् । ▪ सहभागीहरुलाई आवश्यकता परेमा फारामहरु भर्न सहजीकरण गर्नुहोस् । **प्रक्षिणको संक्षेपीकरण र अग्रसम्वन्ध** ▪ प्रशिक्षकले प्रशिक्षण अवधिभर छलफल भएका विषयवस्तुहरुलाई संक्षिप्त रुपमा स्मरण गराउनुहोस् । ▪ सहभागीहरुबाट आएको अपेक्षाहरुको पुनरावलोकन गर्दै प्रशिक्षणमा समेटिएका र नसमेटिएका विषयवस्तुहरुको जानकारी गराउनुहोस् । ▪ सहभागीहरुलाई सक्रिय सहभागिताको लागि धन्यवाद दिदै प्राविधिक सत्रहरु समाप्त भएको भन्दै अव यस पछि समापन कार्यक्रम हुनेछ भनी सत्र अन्त्य गर्नुहोस्।	१५मिनेट		फारामहरु

प्रशिक्षण – सिकाई क्रियाकलाप	अवधि	प्रशिक्षण – सिकाई सामाग्री	कैफियत
क्रियाकलाप ९ समापन कार्यक्रम ▪ अतिथिहरुलाई आसन ग्रहण गराई प्रशिक्षणको प्रभावकारीताको बारेमा बढीमा दुई जना (एक जना महिला, एक जना पुरुष) सहभागीहरुलाई आफ्नो विचार राख्न लगाउनुहोस् । ▪ अतिथिहरुबाट प्रशिक्षणको समापन मन्तव्य व्यक्त गर्दै प्रशिक्षण कार्यक्रम समापन भएको घोषणा गर्न लगाउनुहोस् ।	१५मिनेट		

प्रस्तुति सामग्री (पावरप्वाइन्ट स्लाइड)

स्थानीय विकास प्रशिक्षण प्रतिष्ठान
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फोहोरमैला व्यवस्थापन तथा वातावरण व्यवस्थापन प्रशिक्षण

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प्रशिक्षण औपचारिकता

- परिचय
- नाम:
- ठेगाना:
- पद:
- कार्य अनुभव:

साधारण उद्देश्य

- स्थानीय तहमा सहभागीहरुको फोहोरमैला र वातावरण व्यवस्थापनका विभिन्न पक्षहरुको बारेमा ज्ञान र सीपमा अभिवृद्धि गरी सक्षम बनाउनु हो ।

निर्दिष्ट उद्देश्यहरु

यस प्रशिक्षणको अन्तमा सहभागीहरुले निम्न कार्यहरु गर्न सक्नेछन् ।

- फोहोरमैलाको वर्गीकरण र यसको विशेषता पहिचान गर्न सक्नेछन् ।
- फोहोरमैलाको पुनः प्रयोगको अवधारणा बुझ्न सक्नेछन् ।
- स्थानीय स्तरमा फोहोरमैला ब्यवस्थापनको लागी नीति र नियमहरु बुझ्न र फोहोरमैला व्यवस्थापन शुल्क निर्धारण गर्न सक्नेछन् ।
- ल्याण्डफिल, खतरनाक फोहोरमैला र लीचेट सम्वन्धी अवधारणा बुझ्न सक्नेछन् ।
- सुधारिएको विधिद्धारा फोहोरमैला विसर्जनको उचित व्यवस्थापन गर्न सक्नेछन् ।

अपेक्षा संकलन

प्रशिक्षणका विषयवस्तु

- फोहोरमैला व्यवस्थापनको सङ्कलन, ढुवानी र स्थानान्तरणका आधारभूत अवधारणा
- नगरपालिकाको फोहोरमैला पुन: चक्रण/फोहोरमैला विसर्जन
- फोहोरमैला व्यवस्थापनको लागि नीति तथा नियमावली (फोहोरमैला ऐन, २०६८) र कार्यान्वयन रणनीति
- जैविक फोहोरमैला प्रशोधन
- एकीकृत दिगो फोहोरमैला व्यवस्थापन
- फोहोरमैला व्यवस्थापनमा पात्र र सरोकारवालाहरू
- विषाक्त फोहोरमैला व्यवस्थापन

प्रशिक्षणका विषयवस्तु

- सेनेटरी ल्याण्डफिल व्यवस्थापन
- सेनेटरी ल्याण्डफिल स्थलमा सतहको पानी बग्ने नाली र Leachate व्यवस्थापन
- काठमाडौं उपत्यकाको नगरपालिकाको फोहोरमैला व्यवस्थापन र विसर्जन – एक मामिला अध्ययन
- फिल्ड अध्ययन भ्रमण
- फोहोरमैला थुपार्नाले वातावरण प्रदूषण
- फोहोरमैलाबाट ऊर्जा
- विभिन्न नगरपालिकाको मामिला अध्ययन र सिकाइको बारेमा अनुभव आदानप्रदान

प्रशिक्षण विधि

- मष्तिस्क मन्थन, समुह अभ्यास, लघुप्रवचन, प्रश्नोत्तर आदि। हरेक दिनको अन्तमा दिनभर छलफल भएका विषयवस्तुको संक्षेपीकरण गर्ने।
- दोस्रो दिन पहिलो दिन संचालन भएका गतिविधिको पुनरावलोकनबाट सत्र शुरुवात गर्ने।
- व्यवहारिक अभ्यासको लागि आवश्यक फाराम अभ्यास सिटहरु तयार गर्ने।

समय तालिका

०७३० – ०८३०	१ घण्टा	चिया र नास्ता
०८३० – ०९००	३० मि	अधिल्लो दिनको पुनरावलोकन
०९०० – १०३०	१ घ ३० मि	पहिलो सत्र
१०३० – १०४५	१५ मि	चिया विश्राम
१०४५ – १२१५	१ घ ३० मि	दोश्रो सत्र
१२१५ – १३१५	१ घण्टा	दिवा भोजन विश्राम
१३१५ – १४४५	१ घ ३० मि	तेश्रो सत्र
१४४५ –१५००	१५ मि	चिया विश्राम
१५०० – १६३०	१ घ ३० मि	चौथो सत्र

समूह मान्यता

- समय तालिकाको पालना ....
- मोबाईल साईलेन्ट मोडमा ....
- ....
-

पूर्व जानकारी

धन्यवाद

13

स्थानीय विकास प्रशिक्षण प्रतिष्ठान
(स्थानीय विकास प्रशिक्षण प्रतिष्ठान ऐन, २०४९ द्वारा स्थापित)
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ठोस फोहोरमैला व्यवस्थापन र यसको महत्त्व

फोहोरमैला

- फोहोरमैलालाई कसरी बुझ्ने?

- घर, उद्योग, निर्माण स्थल, अस्पताल तथा अन्य मानवीय गतिविधिबाट निष्कासन हुने विभिन्न प्रकारका अनावश्यक र काम नलाग्ने फोहोरलाई भनिन्छ।

परिचय

- मानव जातिको सुरुवात देखि नै फोहोरमैला उत्पादन हुने गरेको,

- जस्तै: जनावरहरू काट्दा उपयोग नहुने अङ्गहरू

- काठ, हड्डी आदि

- विकास सँगसँगै उत्पादन हुने फोहोरमैलामा बढी विविधता आउन थालेको

परिचय

- १९ औं शताब्दीको अन्त्य पछि सुरु भएको औद्योगिक क्रान्ति पछि विश्वमा विभिन्न वस्तुको खपतमा वृद्धि भएको
- आधुनिकीकरण तथा जनसङ्ख्या वृद्धिको कारणबाट फोहोरमैला उत्पादनमा उल्लेख्य वृद्धि भएको

फोहोरमैलाको किसिमहरू

- ठोस फोहोरमैला: ढुङ्गा, बालुवा, सिसा, काठ इत्यादि।
- तरल फोहोरमैला: ढल, रासायनिक पदार्थ।
- ग्याँसीय फोहोरमैला: विभिन्न उद्योगबाट निष्कासन हुने ग्याँसहरू।

तीन प्रकारका फोहोरमैलाहरू:

- कुहिने फोहोरमैला: भान्साबाट निस्कने तरकारी आदि।
- विषादीयुक्त फोहोरमैला: अस्पतालबाट निस्कने फोहोर जस्तै: सिरिञ्ज, प्याड आदि।
- नकुहिने फोहोरमैला: काठ, ढुङ्गा, बालुवा आदि।

फोहोरमैला उत्पादन हुने स्रोतको आधारमा फोहोरमैलाको किसिम

क) घरायसी फोहोरमैला: बस्तीबाट निस्कने फोहोरमैला

ख) औद्योगिक फोहोरमैला: विभिन्न उद्योगबाट उत्पादन हुने फोहोरमैला

ग) जैविक-चिकित्सा फोहोरमैला: अस्पतालबाट निष्कासन हुने फोहोरमैला

नगर बस्तीबाट उत्पादन हुने फोहोरमैला

- घरभित्र हुने विभिन्न क्रियाकलापबाट निष्कासन हुने फोहोरमैला
- विभिन्न निर्माण सम्बन्धी गतिविधिबाट निस्कने फोहोरमैला जस्तै: सिमेन्ट, डन्डी, ढुङ्गा, काठ आदि ।
- सडकमा जम्मा हुने विभिन्न प्रकारका फोहोरमैला जस्तै: कागज, प्लास्टिक, बोटल आदि ।

The type of litter we generate and the approximate time it takes to degenerate

Type of litter	Approximate time it takes to degenerate the litter
Organic waste such as vegetable and fruit peels, leftover foodstuff, etc	A week or two.
Paper	10–30 days
Cotton cloth	2–5 months
Wood	10–15 years
Woolen items	1 year
Tin, aluminum, and other metal items such as cans	100–500 years
Plastic bags	one million years
Glass bottles	undetermined

विषादीयुक्त फोहोरमैला

- विभिन्न रासायनिक पदार्थ उत्पादन हुने उद्योगबाट निष्कासन हुने (तरल, ग्याँसीय) विषादीयुक्त फोहोरमैला ।
- अस्पतालबाट निष्कासन हुने विषादीयुक्त फोहोरमैला जस्तै: सिरिञ्ज, रासायनिक तत्त्वहरू, आदि जुन मानव स्वास्थ्यको लागि अत्यन्त हानिकारक हुन्छन् ।

Source	Typical Waste Generators	Types of solid wastes
1:Residential	Single and multifamily dwellings	❖ Food wastes ❖ Paper ❖ Cardboard ❖ Plastics ❖ Textiles ❖ Leather ❖ Yard wastes ❖ Wood ❖ Glass ❖ Metals ❖ Ashes ❖ Special wastes (e.g bulky items, consumer electronics, white goods, batteries, oil, tires), and household hazardous wastes.)

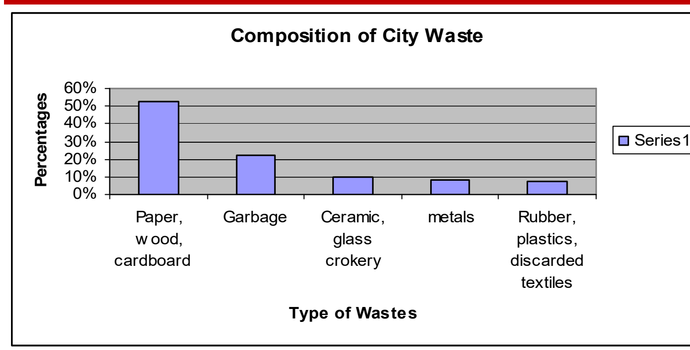
Source	Typical Waste Generators	Types of solid wastes
2: Industrial	Light and heavy manufacturing, fabrication, construction sites, power and chemical plants.	❖ Housekeeping wastes ❖ Packaging ❖ Food wastes ❖ Construction and demolition materials ❖ Hazardous wastes ❖ Ashes ❖ Special wastes.
3:Commercial	Stores, hotels, restaurants, markets, office buildings, etc.	❖ Paper ❖ cardboard ❖ plastics ❖ wood ❖ food wastes ❖ glass ❖ metals ❖ special wastes ❖ hazardous wastes
4: Institutional	Schools, hospitals, prisons, government centers.	Same as commercial.

5:Construction and demolition	New construction sites, road repair, renovation sites, demolition of buildings	❖ Wood ❖ steel ❖ concrete ❖ dirt etc.
6:Municipal services	Street cleaning, landscaping, parks, beaches, other recreational areas, water and wastewater treatment plants.	❖ Street sweepings ❖ landscape and tree trimmings ❖ General wastes from parks ❖ Beaches ❖ Recreational areas; sludge.
7:Process (manufacturing etc.)	Heavy and light manufacturing, refineries, chemical plants, power plants, mineral extraction and processing.	❖ Industrial process wastes ❖ Scrap materials ❖ Off-specification products.
8:Agriculture	Crops, orchards, vineyards, dairies, feedlots, farms.	❖ Spoiled food wastes ❖ Agricultural wastes ❖ Hazardous wastes (e.g., pesticides).

फोहोरमैलाको उत्सर्जन

- मुख्य गरेर घरायसी, व्यावसायिक, औद्योगिक नगर बस्ती निस्कने फोहोरमैला र कृषिबाट निस्कने फोहोरमैलाहरू हुन ।
- सहरी क्षेत्रमा निस्कने फोहोरमैलाको बनौट:
  - कागज, काठ, कार्ड बोर्ड: ५३%
  - कुहिने फोहोर: २२%
  - सेरामिक्स, सिसा, कुकरी: १०%
  - धातु: ८%
  - रबर, प्लास्टिक, लत्ता कपडा: ७%

फोहोरमैलाको उत्सर्जन



फोहोरमैलाको उत्सर्जन

क) स्वास्थ्यमा असर

- सङ्कलन नगरी थुप्रिन गएमा वातावरण दुर्गन्धित हुने ।
- जसको कारणले महामारी फैलिन सक्ने ।
- रोगहरू जस्तै: हैजा, झाडापखाला, आउँ, प्लेग, कमलपित्त, र पेट सम्बन्धी रोगहरूले मानिसको मृत्यु हुने ।

फोहोरमैलाको उत्सर्जन

ख) वातावरणीय असर:

- फोहोरमैलालाई समयमा नै उचित किसिमले प्रशोधन नगरेमा विघटन (Decomposed) हुने ।
- जसका कारणले वातावरण दुर्गन्धित हुने ।

फोहोरमैला व्यवस्थापनका

4 R अवधारणा

- चार 4 Rs भन्नाले इन्कार, पुन प्रयोग, पुन: चक्रण र न्यूनीकरण हुन ।

धन्यवाद

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स्थानीय विकास प्रशिक्षण प्रतिष्ठान
(स्थानीय विकास प्रशिक्षण प्रतिष्ठान ऐन, २०४९ द्वारा स्थापित)
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नेपाल सरकार
सङ्घीय मामिला तथा सामान्य प्रशासन मन्त्रालय

फोहोरमैला व्यवस्थापनको सङ्कलन, ढुवानी र स्थानान्तरणका आधारभूत अवधारणा

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W>>> www.ldta.org.np

फोहोरमैलाको उचित व्यवस्थापन गर्नुपर्ने कारणहरू

निम्न कारणले गर्दा फोहोरमैलाको उचित व्यवस्थापन गर्न आवश्यक छः

- वातावरणीय प्रदूषण नियन्त्रण गर्न;
- प्रदूषणका कारणले सीर्जित रोगहरू नियन्त्रण गर्न;
- शहरको प्राकृतिक सुन्दरतालाई सुधार गर्न, पर्यटन विकास र वातावरणीय सुन्दरतालाई राम्रो गर्न;
- सङ्कलन लागत, ढुवानी, स्थानान्तरण र प्रशोधन कम गर्न;
- आय आर्जन बढाउनमा मद्दत गर्न: फोहोरमैलाबाट पैसा कमाउन,
- फोहोरमैलाबाट ऊर्जा प्रवर्द्धन गर्न;
- रोजगारी सिर्जना गर्न;
- स्थानीय स्तरमा व्यवसायिकरणको विकास गर्न;
- मानिसमा लाग्ने रोगहरूको उपचार खर्च कम गर्न;
- त्यसैले, नेपालमा सहरी जनसङ्ख्या वृद्धि र जीवनशैलीमा आएको परिवर्तनसँगै फोहोरमैलाको व्यवस्थापनमा चासो बढी रहेको छ ।

फोहोरमैला व्यवस्थापन: मुद्दा र अभ्यासहरू

- फोहोरमैलाले स्वास्थ्य र वातावरणमा पार्ने प्रभावको बारेमा जनचेतनाको कमी,
- कुहिने र नकुहिने र हानिकारक फोहोरमैलालाई स्रोतमै छुट्टाउने अभ्यास नहुने,
- आफ्नो क्षेत्रमा फोहोर नगर्ने अरूको भएमा केही फरक नपर्ने सोच,
- फोहोरमैलाको सङ्कलन र स्थानान्तरण नगरपालिकाको कार्य हो भन्ने अवधारणा,
- फोहोरमैलालाई नदी किनारमा थुपार्नु नै समस्याको समाधान हो भन्ने सोचाइ । नदीको पानी प्रदूषित हुन्छ भन्ने सोचाइमा कमी,
- नगरपालिका वा निजी क्षेत्र वा समुदायले फोहोरमैला व्यवस्थापन गरे बापत महसुल तिर्न आनाकानी गर्नु,
- एउटै घरमा धेरै मानिस भाडामा बस्ने र फोहोरमैला कम उत्सर्जन गर्न चासो नदिने,
- नगरपालिकाको नियम कानुन नमान्ने । फोहोरमैला सडकमा फ्याँक्ने र गैर नागरिकको व्यवहार दर्साउने,
- सेनेटरी ल्याण्डफिल स्थलमा फोहोरमैला विसर्जन गर्न प्राय समस्या आइरहनुले नगरपालिकालाई सङ्कलन र ढुवानीको विवशता छ । नगरपालिकाले पनि समुदायलाई उचित किसिमले सहयोग गर्न सञ्चार गरेको पनि देखिँदैन ।
- सडक नजिक फोहोरमैला थुपारेको कारणले पर्ने असर बारे समुदाय पनि सचेत भएको देखिँदैन ।

एकीकृत फोहोरमैला व्यवस्थापन

एकीकृत फोहोरमैला व्यवस्थापनमा निम्न लिखित क्रियाकलापहरू समावेश गर्नुपर्छ:

- घरायसी स्तरमा 4R अवधारणा कार्यान्वयन गर्ने,
- घरायसी स्तरमा सून्य फोहोरमैलाको सिद्धान्त प्रभावकारी हुने,
- घरधुरीमै फोहोरमैला छुट्टाउने अभ्यास गर्ने,
- नियमित र समयमा नै घरबाट फोहोरमैला सङ्कलन र तोकिएको स्थानमा थुपार्न लगाउने,
- ढुवानीको समयमा फोहोरलाई सडकमा खस्न नदीन ध्यान दिने,
- सम्भव भए सम्म सङ्कलन र ढुवानी बिहानमा गरी यातायात र मानव क्रियाकलापहरूलाई बाधा नपुऱ्याउने ।

एकीकृत फोहोरमैला व्यवस्थापन

एकीकृत फोहोरमैला व्यवस्थापनमा निम्नलिखित क्रियाकलापहरू समावेश गर्नुपर्छ:

- सङ्कलित फोहोरमैला स्थानान्तरण केन्द्रमा ढुवानी गर्नुपर्छ (काठमाडौंको हकमा) र सेनेटरी ल्याण्डफिल स्थलमा ढुवानी गर्नु पर्छ र बाटोमा दुर्गन्ध र वातावरणीय समस्या आउनु हुँदैन ।
- नियामक निकायले सङ्कलनदेखि विसर्जनसम्म नियमित रूपमा अनुगमन गर्नुपर्छ । समुदायको कुनै पनि गुनासोलाई समय मै सम्बोधन गर्नु पर्छ ।
- समुदायमा आधारित संस्था, निजी व्यापारी, वडा सदस्यहरू र सरोकारवालाहरूलाई आवश्यकता अनुसार परिचालन गर्नुपर्छ ।
- सरोकारवालाहरूलाई तालिम र जनचेतना अभिवृद्धिका कार्यक्रमहरू सञ्चालन गर्नुपर्छ ।
- फोहोरमैलाको प्रदूषणबाट स्वास्थ्यमा पर्ने प्रभावको लेखाजोखा अनुगमन संयन्त्रभित्र समावेश गर्नुपर्छ ।
- सबै नगरपालिकाहरूले फोहोरमैलाको प्रकार, विशेषता, मुद्दा र अवस्था अनुसार एकीकृत फोहोरमैला व्यवस्थापन प्रणालीको विकास गर्नुपर्छ ।
- काठमाडौं जस्तो ठूलो शहरलाई प्राविधिक रूपमा सेनेटरी ल्याण्डफिल फिल्ड राम्रो विकल्प हो तर सम्भाव्य समाधान होइन । यसको डिजाइन, निर्माण र सञ्चालन व्यवस्थापन धेरै जटिल र महङ्गो छ । एकीकृत फोहोरमैला व्यवस्थापन 4R मा केन्द्रित हुनुपर्छ ।

एकीकृत फोहोरमैला व्यवस्थापन

- फोहोरमैलालाई सही किसिमले छुट्टाउने,
- कुशल रूपले फोहोरमैला सङ्कलन
- फोहोरको न्यूनीकरण
- फोहोरमैलालाई प्रारम्भिक सङ्कलन वाहनबाट व्यावसायिक वाहनसम्म
- फोहोरमैलाको ढुवानी
- फोहोरमैलालाई प्राङ्गारिक र पुन: चक्रण
- ल्याण्डफिलिङ
- खतरनाक फोहोरमैलाको व्यवस्थापन
- सार्वजनिक शिक्षा र सहभागिता
- नीति, ऐन, कानुनको तर्जुमा र कार्यान्वयन

एकीकृत फोहोरमैला व्यवस्थापन रणनीति

फोहोरमैला सङ्कलन व्यवस्था

- सही तरिकाले तर्जुमा गरी कार्यान्वयन गरिएको फोहोरमैला सङ्कलन व्यवस्थाले आम जनताको स्वास्थ्यमा पर्ने नकारात्मक असर कम गर्छ ।
- ध्यान दिनुपर्ने कुराहरू:
  - समुदायमा फोहोरमैला जम्मा गर्ने Container को व्यवस्थापन
  - स्रोतमा फोहोरमैला छुट्टाउने
  - सङ्कलन संयन्त्र
  - सडक र सार्वजनिक स्थलको सफाइ
  - सङ्कलन गर्ने समय तालिका

फोहोरमैला सङ्कलन व्यवस्था

- गाडि जाने बाटो निर्धारण
- सङ्कलनको लागि कामदारको सङ्ख्या
- ठूलो फोहोरमैला सङ्कलनको लागि विशेष व्यवस्था
- चिकित्सा र घरायसी खतरनाक फोहोरमैलालाई छुट्टा छुट्टै सङ्कलन गर्ने व्यवस्था
- फोहोरमैलालाई प्रारम्भिक सङ्कलन वाहनबाट व्यावसायिक वाहनसम्म स्थानान्तरण

फोहोरमैला सङ्कलन संयन्त्र

- सडकको छेउमा सङ्कलन
- घर दैलोमा सङ्कलन
- सामुदायिक Containers
- तोकिएको समयमा सङ्कलन गर्ने

ढुवानी र अन्तिम विसर्जन

- स्रोतबाट सङ्कलन गरी विसर्जन केन्द्रसम्म स्थानान्तरण गर्ने कार्यमा ढुवानी गर्ने सुविधा तथा उपकरणले असर गर्छ ।

स्थानान्तरण केन्द्र

- प्रारम्भिक सङ्कलन वाहनबाट द्वितीय सङ्कलन वाहनसम्म स्थानान्तरण
- छोटो समयको लागि स्थानान्तरण केन्द्रमा भण्डारण
- सङ्कलन केन्द्र बस्ती, उद्योग, विद्यालय, अस्पतालबाट टाढा हुनुपर्छ ।

स्थानान्तरण केन्द्रमा फोहोरमैला जम्मा गर्दाको फाइदाहरू

- यातायातको भीडभाडमा कमी
- टाढा भएको कारणले अवैध रूपमा थुपार्ने
- गाडीहरूको मर्मत सम्भार खर्च कम हुने
- फोहोरमैला छुट्टा इने

स्थानान्तरण केन्द्रका प्रकार

१. साधारण स्थानान्तरण केन्द्र:

२. जटिल स्थानान्तरण केन्द्र

धन्यवाद

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स्थानीय विकास प्रशिक्षण प्रतिष्ठान
(स्थानीय विकास प्रशिक्षण प्रतिष्ठान ऐन, २०४९ द्वारा स्थापित)
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W>>> www.ldta.org.np

पुन: चक्रण

- फोहोरमैला सङ्कलन, क्रमबद्ध, बजारिकरण र सामाग्रीको Processing
  - आवासीय
  - व्यावसायिक
  - औद्योगिक

आवासीय फोहोरमैला

- एकल/बहु परिवार आवास
- पुन: चक्रणयोग्य
  - कागज
  - प्लास्टिक
  - धातु
  - फ्याँकेको खाना
  - घर आँगन सफाइ
  - इलेक्ट्रोनिक
  - लत्ता कपडा

व्यावसायिक फोहोरमैला

- व्यापार, कार्यालय, दुकान, बजार, संघ संस्था, सरकार र अन्य
- पुन: चक्रणयोग्य
  - कागज
  - प्लास्टिक
  - धातु
  - फ्याँकेको खाना
  - घर आँगन सफाइ
  - इलेक्ट्रोनिक
  - लत्ता कपडा
  - काठको फल्याक

औद्योगिक फोहोरमैला

- Non process line, shipping, plant offices

अन्य फोहोरमैलाहरू

- जैविक-चिकित्सा फोहोरमैला
- निर्माण र घर भत्काउँदा निस्किने फोहोरमैला
- कार्पेट
- फर्निचर
- अन्य

पुन: चक्रणका अवसरहरू

१. कागज, खाना प्याकिङ गर्ने बाकस, कार्ड बोर्ड, पत्रिका, कार्यालयका कागज-पत्र

२. कन्टेनर – खाद्य बट्टा, आल्मुनियम, सिसा, प्लास्टिक आदि

३. फ्याँकेको खाना

४. तरकारीको फोहोरमैला

५. अखाद्य, पेय पदार्थको कन्टेनर सिसा फुटेको सिसा वा प्लेटहरू

६. घरायसी खतरनाक फोहोरमैला – कीटनाशक, रङ्ग रोगन

७. निर्माण र घर भत्काउँदा निस्किने फोहोरमैला

८. ब्याट्री

९. अन्य – टायर, घरायसी उपकरण, इलेक्ट्रोनिक फोहोर

फोहोरमैला विसर्जनका विधिहरू

ल्याण्डफिल

- पुन प्रयोग र पुन: चक्रण गर्न नसकिने
- दुर्गन्ध कम गर्न नियमित मर्मत सम्भार गर्न आवश्यक
- सजिलो र सस्तोमा हुने

भस्मीकरण

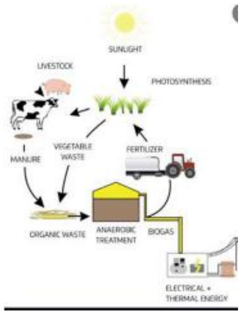
- फोहोरमैला बालेर नियन्त्रण हुने
- विषाक्त (कार्बन डाइअक्साइड र कार्बन मनोअक्साइड) – वातावरणमा छोड्नुभन्दा पहिले प्रशोधन गर्न आवश्यक
- ९०% ले आयतनमा कमी ल्याउने
- स्वच्छ

फोहोरमैला संघनन (Compaction)

- बट्टा, प्लास्टिक बोटल
- ब्लकहरू

जैविक ग्यासँ उत्पादन

- खाद्य वस्तु
- जनावरको फोहोरमैला
- जैविक उद्योग फोहोरमैला
- ब्याक्टेरिया, फङ्गीको सहायताबाट कुहिने वस्तुलाई जैविक ग्यासँमा रूपान्तरण



प्राङ्गारिक मल

- जैविक फोहोरमैलालाई खाल्डोमा पुरेर

गड्याउले प्राङ्गारिक मल (Vermicomposting)

- गड्याउलाको प्रयोग
- जैविक वस्तुलाई degradation गर्ने

धन्यवाद

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स्थानीय विकास प्रशिक्षण प्रतिष्ठान
(स्थानीय विकास प्रशिक्षण प्रतिष्ठान ऐन, २०४९ द्वारा स्थापित)
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फोहोरमैला व्यवस्थापनको लागि नीति तथा नियमावली (फोहोरमैला ऐन, २०६८) र कार्यान्वयन रणनीति

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फोहोरमैला व्यवस्थापन ऐन, २०६८ (२०११)

- फोहोरमैला उत्सर्जन, सङ्कलन, र विसर्जन
- स्थानान्तरण केन्द्र, ल्याण्डफिल स्थलको प्रावधान
- फोहोरमैला व्यवस्थापनमा निजी तथा सामुदायिक क्षेत्रको सम्लग्नता
- फोहोरमैला व्यवस्थापनमा सेवा शुल्कको प्रावधान
- प्रदूषण नियन्त्रण र फोहोरमैला व्यवस्थापन कार्यको रेखदेख गर्ने प्रावधान
- फोहोरमैला व्यवस्थापन परिषदको प्रावधान
- फोहोरमैला व्यवस्थापन प्राविधिक सहयोग केन्द्र प्रावधान
- दण्ड तथा जरिबानाको व्यवस्था
- विविध

फोहोरमैला उत्सर्जन, सङ्कलन र विसर्जनको प्रावधान

१. फोहोरमैला व्यवस्थापनमा स्थानीय सरकारको जिम्मेवारी:

- संरचनाको निर्माण र सञ्चालन – स्थानान्तरण, ल्याण्डफिल स्थल
- सफाइ, फोहोर फ्याँक्के वा फोहोर थुपार्ने प्रबन्ध

२. फोहोरमैला व्यवस्थापनको लागि जिम्मेवारी

- फोहोरमैला उत्सर्जनमा न्यूनीकरण गर्ने

- फोहोरमैलालाई छुट्ट्याउने

- फोहोरमैला सङ्कलन केन्द्र तोक्ने

- फोहोरमैला ढुवानी गर्ने

- फोहोरमैलाको न्यूनीकरण, पुन प्रयोग, इन्कार र पुन: चक्रण गर्ने

फोहोरमैला व्यवस्थापनमा निजी तथा सामुदायिक क्षेत्रको सहभागिता

- सञ्चालनको लगि प्रमाण-पत्रको प्रावधान
- फोहोरमैला व्यवस्थापन निजी क्षेत्रले गर्न सक्ने
- प्रतिस्पर्धाको आधारमा व्यवस्थापन गर्न स्वीकृत दिने
- ल्याण्डफिल स्थल निर्माण र सञ्चालन गर्न अनुमति दिने
- सार्वजनिक-निजी-साझेदारीमा फोहोरमैला व्यवस्थापन गर्न दिने

फोहोरमैला व्यवस्थापन सेवा शुल्कको प्रावधान

- सामाजिक, सांस्कृतिक तथा आर्थिक स्थिति तथा जनताको भुक्तानी गर्ने चाहना, सञ्चालन तथा व्यवस्थापन लागत इत्यादि लाई मध्यनजर राखि स्थानीय सरकारले सेवा शुल्क निर्धारण गरेर निजी क्षेत्रसँग सम्झौता गर्नुपर्छ ।

प्रदूषण नियन्त्रण र फोहोरमैला व्यवस्थापन कार्यको रेखदेख गर्ने प्रावधान

- प्रदूषण नियन्त्रण
- फोहोरमैला व्यवस्थापनको रेखदेख
- वित्तीय, सामाजिक विकास र वातावरण संरक्षणको प्रावधान

फोहोरमैला व्यवस्थापन परिषदको प्रावधान

- परिषदको विधान
- परिषदको काम, कर्तव्य र जिम्मेवारी
- परिषदको बैठक र निर्णयहरू

दण्ड सजाय

- दण्ड
- सजाय
- सेवा तथा सुविधाहरू रोक्ने
- सुनुवाइको व्यवस्था

विविध

- स्वास्थ्यसँग सम्बन्धित फोहोरमैलाको व्यवस्थापन
- रासायनिक विषको प्रावधान
- फोहोरमैला व्यवस्थापनमा सम्लग्न स्थानीय संस्था तथा निकायहरूको अभिलेख राख्ने
- सूचना उपलब्ध गराउने
- अधिकारको निक्षेप गर्ने
- नेपाल सरकारसँग सञ्चार गर्ने
- पुरस्कारको व्यवस्था गर्ने
- नियम विनियमहरू तयार गर्ने
- निर्देशिका तयार गर्ने
- ऐनलाई समय सापेक्ष गराउने
- रद्द र बचावट

फोहोरमैला व्यवस्थापन शुल्क/नगरपालिका क्षेत्रमा महसुल निर्धारण

- बजारको वर्तमान प्रवृत्तिमा छलफल
- समूह कार्य
- समुदायको महसुल तिर्ने चाहना
- भुक्तानी सङ्कलन प्रक्रिया
- नगरपालिकामा शुल्क वा महसुल निर्धारण

धन्यवाद

स्थानीय विकास प्रशिक्षण प्रतिष्ठान
(स्थानीय विकास प्रशिक्षण प्रतिष्ठान ऐन, २०४९ द्वारा स्थापित)
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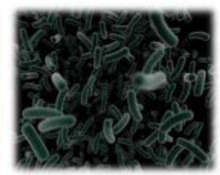
सत्रको रूपरेखा:
१. परिचय
२. जैविक फोहोरमैलाको प्रकार
३. प्रशोधन विधिहरू
४. प्राङ्गारिकमुक्त प्रविधि

जैविक भनेको के हो?

- जैविक पदार्थ एक पदार्थ हो जुन एक पटक जीवित जीवबाट आएको हुन्छ ।
- जीव: जनावर, बिरुवा र सूक्ष्मजीवहरू
- एक पटक जीवित: या त जीवित वा मरेका शरीर





प्राङ्गारिक भनेको के हो?

प्राङ्गारिक एउटा प्रक्रिया हो जहाँ जैविक पदार्थ विघटित भइ पुन प्रयोग गर्न मिल्ने पदार्थ (मल)को रूपमा रूपान्तरण भइ माटोलाई सुधार गर्छ ।

प्राङ्गारिक तयार गर्न फोहोरमैलालाई घर बाहिर जम्मा गर्ने र केही महिनासम्म रहन दिनुपर्छ।

जैविक फोहोरमैलाको प्रकार

औद्योगिक

कृषि

दैनिक

औद्योगिक जैविक फोहोरमैला

Pharmaceutical plants, paper plants, leather plants...etc.

कृषि, वन र पशुधन

Organic wastes from gardens, vegetables, mushrooms, forestry, livestock, fish farms and sheep farms.

दैनिक जैविक फोहोरमैलाहरू

जैविक फोहोरमैलाको प्रशोधन विधि

परिचय र बेफाइदाहरू

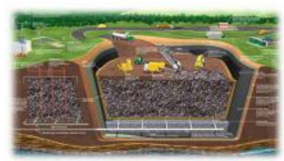
भस्मीकरण

प्रशोधन विधि: उच्च तापक्रममा जलाउने
प्रशोधन समय: धेरै घण्टा
अन्तिम उत्पादन: खरानी (उच्च विषाक्त)
आवश्यकता: प्रदूषण अनुगमन

बेफाइदाहरू:
- उच्च निर्माण
- उच्च मर्मत खर्च
- हावा प्रदूषण
- CO_2 उत्सर्जन
- Dioxin
- २० % खरानी
- जैविक पदार्थ खेर जाने

ल्याण्डफिल

प्रशोधन विधि: छैन
प्रशोधन हुन लाग्ने समय: वर्षौं वा दशकौं
अन्तिम उत्पादन: छैन
आवश्यकताहरू: स्थल, पानी छिर्न नहुने, र Air Exhaust
बेफाइदाहरू: हावा प्रदूषण, धेरै क्षेत्र, जमिन तलको पानी प्रदूषण र आगो लाग्न सक्ने




- Prohibited to landfill without treatment in EU (Council Directive on Landfill 1999/31/EC)

प्राङ्गारिक

- प्रशोधन विधि: किण्वीकरण
- प्रशोधन हुन लाग्ने समय: ३-६ महिना
- अन्तिम उत्पादन: माटोको पुन: नवीकीकरण
- आवश्यकता: धेरै क्षेत्र, निरन्तर पत्र/पत्र गरेर थुपार्ने
- बेफाइदाहरू: दुर्गन्ध आउने, ठूलो क्षत्रफल र समय, Carbon lose

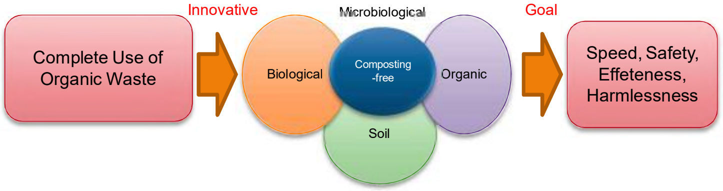

छिटो किण्वीकरण

- प्रशोधन विधि: जैविक विघटिकरण
- प्रशोधन हुन लाग्ने समय: २४-७२ घण्टा
- अन्तिम उत्पादन: प्रयोग गर्नु भन्दा पहिले महिनौं भण्डारण गर्नुपर्ने
- आवश्यकताहरू: भण्डारण क्षेत्र, सानो आकार, कम तेल भएको
- बेफाइदाहरू: दुर्गन्ध आउने, ठूलो क्षेत्रफल, ऊर्जा खपत


जैविक ग्याँस

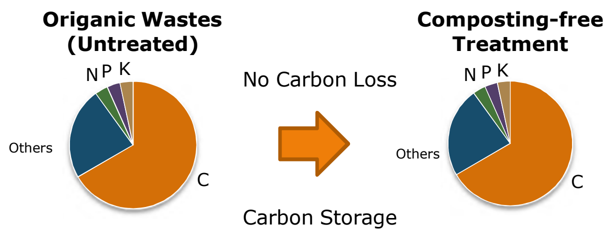
- प्रशोधन विधि: Anaerobic bacteria decompose
- प्रशोधन हुन लाग्ने समय: ७-१४ दिन
- अन्तिम उत्पादन: CH4 and Sludge (पुन: प्रशोधन गर्नुपर्ने)
- आवश्यकता: उच्च Sealed गरिएको ट्याङ्की, धेरै क्षेत्रफल
- बेफाइदाहरू: ठूलो क्षेत्रफल र समय, उच्च लागत र उच्च मर्मत खर्च

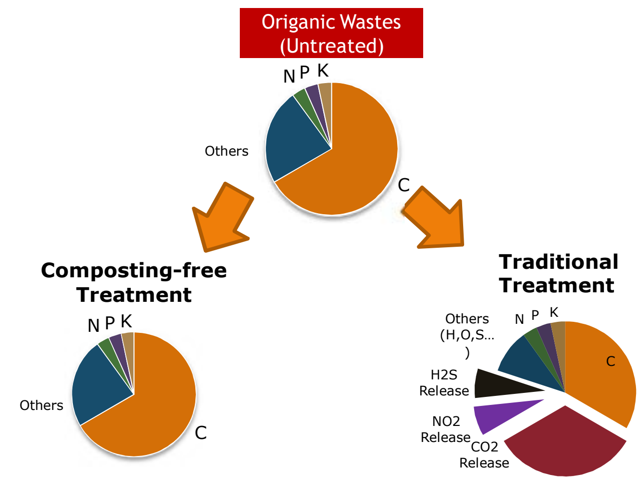

प्राङ्गारिकमुक्त प्रविधि अवधारणा र Theory



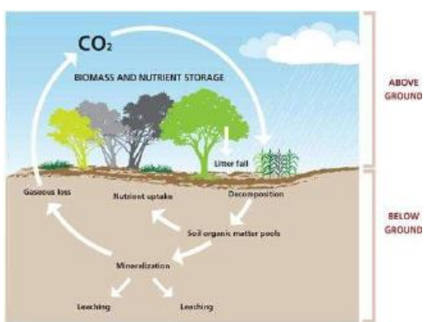
कार्बन भण्डारण

- Composting-free applies **organic enzymes** as catalyst to "**react**" with organic wastes
- प्रशोधन समय केवल ३-८ घण्टा
- कार्बन कन्टेन्टमा हानी नहुने





- कार्बन भण्डारण प्रक्रियाले वायुमण्डलबाट कार्बन हटाउँछ ।
- माटोले कार्बन भण्डारण गर्छ ।



अन्तिम उत्पादन तुलना टेबुल

Technique Type	Process Period	End Product After Treatment			
		Weight of Solid Material (kg)	Content of Water (kg)	Total Weight (kg)	Water Content (%)
Original Waste Before Treatment	Untreated	20	80	100	80%
Traditional Compost	60 Days	10	5	15	33%
Fast Fermentation	3 Days + 30 Days	10	5	15	33%
Composting-free (No drying process wet fertilizer)	1 Hour	22	80	102	78%
Composting-free (Complete drying process dry fertilizer)	3~24 Hours	22	11	33	33%

प्राङ्गारिकमुक्त vs. प्राङ्गारिक

Treatment Method	Composting-free	Composting
Treatment Time	**3~8 Hours**	3~12 months
Space Requirement	**Small**	Large
Air Pollution	**No Smell**	Bad Smell
Water Pollution	**Clean Water**	High COD Waste Water
CO_2 Emission	**1~2%**	40~60%
End Product	**High Quality Organic Fertilizer**	Organic Soil Conditioner

प्राङ्गारिकमुक्त उपकरण

प्रकार र क्षमता

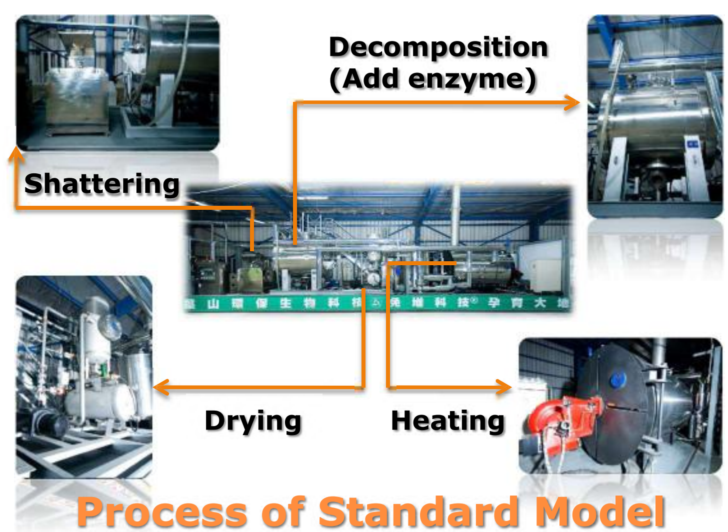


प्राङ्गारिकमुक्त उपकरण

- **स्ट्यान्डर्ड ढाँचा:**

Batch Volume：5000L or Customized
Batch Time：3 (Reaction) to 8 (Drying) hours

स्ट्यान्डर्ड ढाँचा सरकार वा उद्योगबाट सञ्चालन हुने ठूलो स्तरको जैविक फोहोरमैला प्रशोधन केन्द्रलाई उपयुक्त हुन्छ ।



व्यावसायिक ढाँचा

- **Batch Volume** : 250L, 500L, 1000L or Customized
- **Batch Time** : 3 (Reaction) to 24 (Drying) hours

Shattering Transportation

व्यावसायिक ढाँचाको प्रक्रिया

छिटो प्रशोधन

- ३-८ घण्टामा वस्तु तयार हुने
- प्रशोधनको आवश्यकता नपर्ने
- बस्तुलाई सिधैँ उपयोग गर्न सकिने

द्वितीय प्रदूषण नहुने

- प्राङ्गारिकमुक्त उपकरणहरूको डिजाइन र उत्पादन प्रदूषणमुक्त हुन्छ ।
- दुर्गन्ध र द्वितीय प्रदूषण हुँदैन । (हावा र पानी)

कार्बन भण्डारण

- प्राङ्गारिकमुक्त Enzyme को प्रयोग जैविक पदार्थलाई प्रतिक्रिया जनाउन गराइन्छ ।
- CO_2 उत्सर्जन नहुने ।
- CO_2 को उत्सर्जन न्यूनीकरणलाई कार्बन बजारमा पुन बिक्री गर्न सकिने ।


धन्यवाद

102

स्थानीय विकास प्रशिक्षण प्रतिष्ठान
(स्थानीय विकास प्रशिक्षण प्रतिष्ठान ऐन, २०४९ द्वारा स्थापित)
"An Autonomous, Professional, Client Centered, Gender Responsive National Institute of Excellence in the area of Local-Self Governance."
Local Development Training Academy
(Established by Local Development Training Academy Act, 2049)
LDTA >>>
नेपाल सरकार
सङ्घीय मामिला तथा सामान्य प्रशासन मन्त्रालय

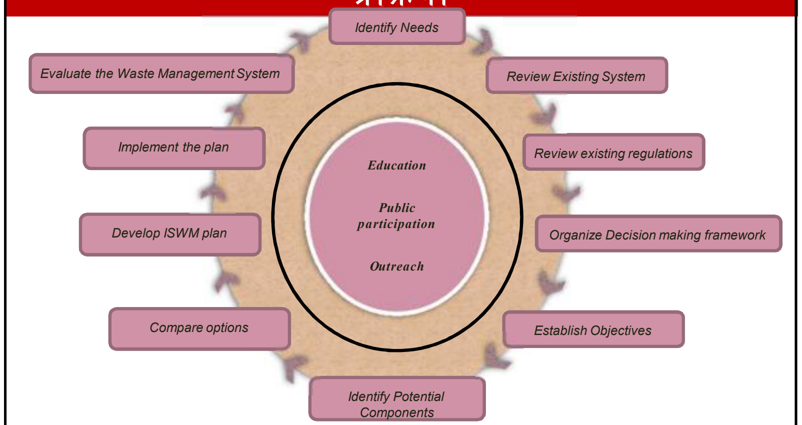
एकीकृत दिगो फोहोरमैला व्यवस्थापन

P >>> +977 (1) -5522004, -5521051
F >>> +977(1) - 5521521
E >>> ldta.org.np@gmail.com
W>>> www.ldta.org.np

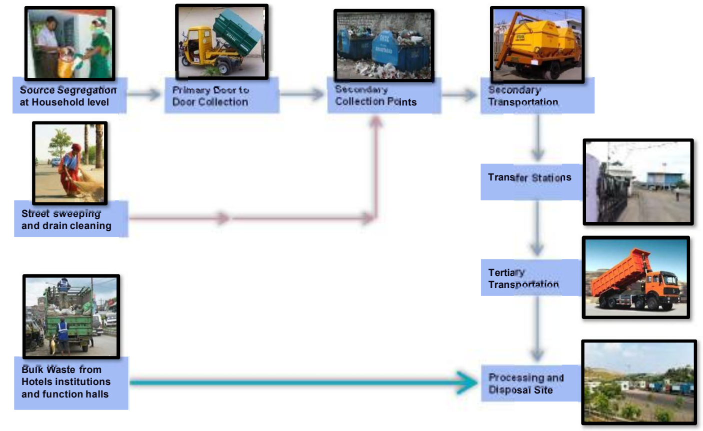
परिभाषा

- एकीकृत फोहोरमैला व्यवस्थापन एक वृहत् फोहोरमैला सङ्कलन, प्रशोधन, रिकभरी र विसर्जन विधि हो जसको उद्देश्य वातावरणीय दिगोपना, आर्थिक सामर्थ्य, र सामाजिक स्वीकार्यता प्रदान गर्नु रहेको छ ।

एकीकृत फोहोरमैला व्यवस्थापन – योजना तर्जुमा प्रक्रिया



सङ्कलन तथा ढुवानी व्यवस्था



स्रोतमा नै विभाजन/छुट्टाउने र यसको महत्त्व

- फोहोरमैलाको गुणस्तरीयता र प्रशोधन सुविधामा सुधारको लागि स्रोतमा नै विभाजन/छुट्टाउनु महत्त्वपूर्ण हुन्छ ।
- सूखा र भिजेको फोहोरमैलालाई छुट्टा छुट्टै भण्डारण गर्न घरायसी स्तरमा नै स्रोत विभाजन गर्न प्रोत्साहित गर्नु पर्छ ।
- भिजेको फोहोरमैलामा पकाएको वा नपकाएको खाना, तरकारी, फलफूल, माछा, पात पतिङ्गर र घाँस जस्ता हरियो फोहोरमैला सामेल गरिएको हुन्छ ।
- सूखा फोहोरमैलामा पुन: चक्रण गैर-जैविक जस्तै – कागज, प्लास्टिक, सिसा, धातु, सेरामिक्स, रबर, छाला, लत्ता कपडा, काठ, ढुङ्गा, बालुवा, खरानी, पराल र प्याकिङ गर्ने सामाग्री समावेश गरिएको हुन्छ ।
- जड (निर्माण कचेडा) र विषाक्त (ब्याट्रि, सङ्क्रमित कटन, औषधी, रङ्ग रोगन, जुत्ता पालिस) फोहोरमैलालाई अलग/अलग गर्नु पर्छ ।
- जनचेतना अभियानबाट स्रोत विभाजन हासिल गर्न सकिन्छ ।
- स्रोत विभाजनले नगर ल्याण्डफिलको आयु बढाउन र लागत प्राप्ति योजनालाई बढवा दिन्छ ।

प्राथमिक सङ्कलन र ढुवानी

- घर/घरबाट सङ्कलन गर्ने कार्य सङ्कलन कार्यकर्ताले ठेला र अटो-रिक्साबाट गर्न सक्नेछन् ।
- अटो-रिक्सा उन्नत प्रणाली भएको साधन हो । यसमा सूखा र भिजेको फोहोरमैलालाई छुट्टा छुट्टै भण्डारण गर्ने प्रावधान रहेको हुन्छ ।
- सहरी स्थानीय निकायहरूले सेवा उपयोग गर्ने घरहरू र अन्य फोहोर उत्सर्जन गर्ने संघ संस्थासँग सेवा शुल्क

प्राथमिक सङ्कलन र ढुवानी

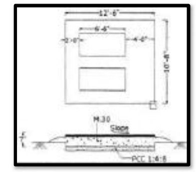



- ❖ सडकको सफाइ कुचीकारद्वारा गरिने छ। प्रत्येक सफाइकर्ताको औसत लम्बाई ०.२ - २.८ कि. मी. हुनेछ।
- ❖ नाली सफाइ प्राथमिक सङ्कलनको मुख्य क्रियाकलापभित्र समावेश गर्नु पर्नेछ। नाली सफा गरी माटो र बालुवा सडकको किनारामा राख्नु पर्नेछ।
- ❖ सडकको माटो, बालुवालाई सिधैँ द्वितीय ढुवानी व्यवस्थामा पठाइने छ।
- ❖ होटेल, संघ संस्था व्यावसायिक प्रतिष्ठानबाट निस्कने थोक फोहोरलाई छुट्टा छुट्टै ट्र्याक्टर वा अटो-रिक्सामा सङ्कलन गरी सिधैँ प्रशोधन केन्द्रमा पठाइने छ।

द्वितीय सङ्लन तथा ढुवानी

- ❖ घर/घरबाट सङ्कलन गरेको फोहोरमैलालाई स्थानान्तरण केन्द्रमा पठाउनु भन्दा पहिले अस्थायी रूपमा द्वितीय सङ्कलन एकाइमा भण्डारण गरिने छ।
- ❖ द्वितीय सङ्कलन एकाइका टोकरीहरूलाई रङ्ले छुट्याइने छ। हरियोमा जैविक फोहोर, नीलो वा पहेंलोमा अजैविक फोहोर राखिने छ।
- ❖ यी टोकरीहरूलाई रणनीतिक स्थानमा राखिने छ र फोहोर ढुवानी गर्ने वाहनले सजिलै पिक-अप गर्नेछन्।






स्थानान्तरण केन्द्र

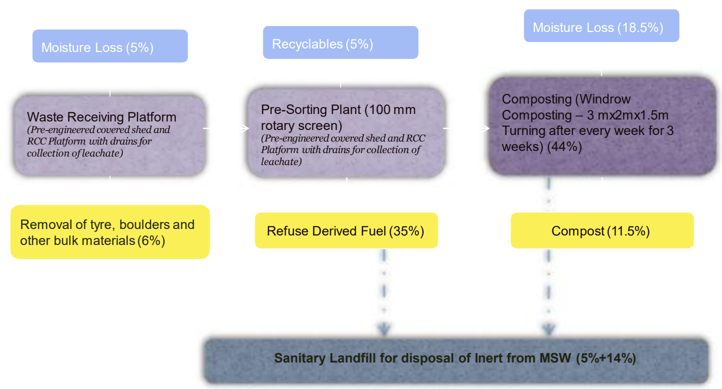
- ❖ फोहोरमैला स्थानान्तरण केन्द्रका सुविधाहरूको डिजाइन दोस्रो ढुवानी थाम्न सक्ने गरी गरिएको हुन्छ। र फोहोरमैलालाई खादने र ठूलो वाहनमा लोड गर्ने गरिन्छ।
- ❖ स्थानान्तरण केन्द्रको प्रयोग ढुवानीको लागत घटाउनको लागि गरिन्छ। यसले ऊर्जा खपतमा कम गर्ने, मर्मत सम्भारमा कमी, ट्राफिक कम र हावा प्रदूषण कम गर्न सहयोग गर्दछ।
- ❖ पुन: चक्रण हुने फोहोरमैला छानेर आय आर्जन गर्न सकिन्छ।

तेस्रो ढुवानी

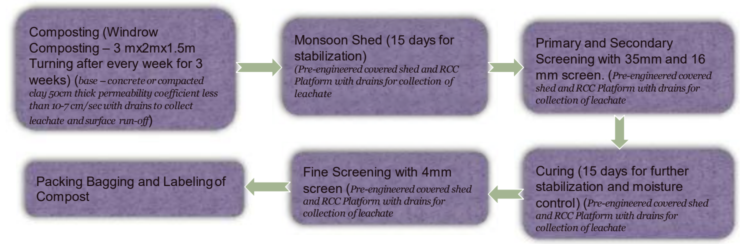
- ❖ तेस्रो ढुवानी स्थानान्तरण केन्द्रबाट विसर्जन स्थलसम्म फोहोरमैला पुऱ्याउन गर्ने गरिन्छ।



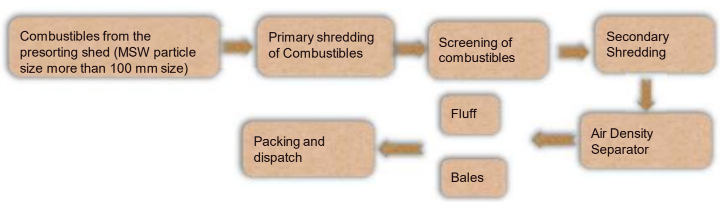
एकीकृत फोहोरमैला व्यवस्थापन बहाव प्रक्रिया



प्राङ्गारिक



Refuse Derived Fuel



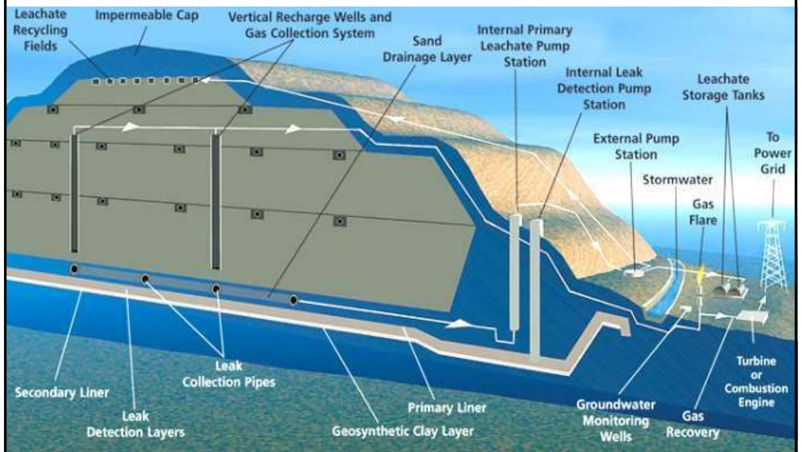
साधारण विशेषताहरू - RDF

S. No.	Parameters	Value
1	Moisture Content %	17.195
2	Ash Content %	16.795
3	Volatile Matter %	66.01
4	Chloride %	0.615
5	Carbon C %	46.7
6	Hydrogen H %	3.5
7	Nitrogen as N %	1.345
8	Sulfur as S%	0.5025
9	Fixed Carbon %	0.725
10	Net Calorific value Cal/g	3244
11	Gross Calorific Value Cal/g	3848.5

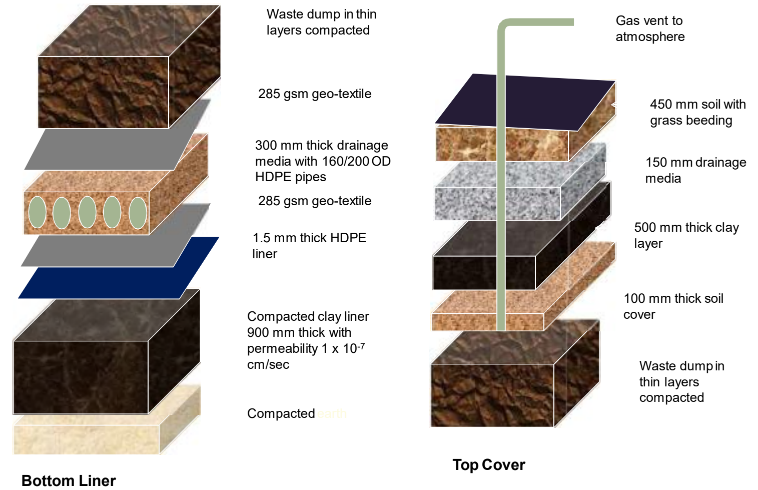
- Combustible components of MSW are paper, cardboard, plastics, textiles, rubber, leather and wood.
- RDF is mostly used in cement kilns, in cement kilns combustion takes place under a very high temperature of about 1450^{0}C and relatively longer residence time. These conditions are favorable for burning RDF.
- RDF quality for cement industry are:
  - Particle size - < 30 mm
  - Sulfur content < 1%
  - Chlorine content < 1%
  - Moisture Content < 30%
  - Hg content < 3 mg/Kg

RDF Components	%C	%H	%O	%N	%S	%Cl	%H_2O	%Ash
Paper	34.4	4.72	32.4	0.16	0.21	0.24	21	4.62
Plastic	56.4	7.79	8.05	0.85	0.29	3	15	8.59
Wood	41.2	5.03	34.5	0.02	0.07	0.09	16	2.82
Textile	37.2	5.02	27.1	3.1	0.28	0.27	25	1.98
Leather, rubber	43.1	5.37	11.6	1.34	1.17	4.97	10	22.5

सेनेटरी ल्याण्डफिल



सेनेटरी ल्याण्डफिल



धन्यवाद

120

स्थानीय विकास प्रशिक्षण प्रतिष्ठान
(स्थानीय विकास प्रशिक्षण प्रतिष्ठान ऐन, २०४९ द्वारा स्थापित)

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नेपाल सरकार
सङ्घीय मामिला तथा सामान्य प्रशासन मन्त्रालय

फोहोरमैला व्यवस्थापनमा पात्र र सरोकारवालाहरू

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F >>> +977(1) - 5521521
E >>> ldta.org.np@gmail.com
W>>> www.ldta.org.np

फोहोरमैला व्यवस्थापनमा विभिन्न सरोकारवालाहरू

फोहोरमैला उत्सर्जनकर्ताहरू: घरधुरी, संस्था, व्यावसायिक प्रतिष्ठान, सार्वजनिक स्थलहरू

सङ्कलनकर्ताहरू: प्राथमिक र द्वितीय सङ्कलकहरू/संरक्षण कार्यकर्ताहरू

सरकार: नगरपालिकाका कर्मचारी, प्रदेश सरकारका कर्मचारी, सङ्गठनका कार्यकर्ताहरू र प्रहरी विभाग

सामुदायिक अगुवाहरू/नेताहरू: सांसद, नगर प्रमुख, राजनीतिक पार्टीका स्थानीय नेताहरू, विशिष्ट व्यक्ति र सेलिब्रेटीहरू

सामाजिक संघ संस्थाहरू: गैर सरकारी संस्था, RWAs and SHGs

व्यापारी र फोहोरमैला प्रोसेसर: फोहोरमैला व्यापारी, स्क्राप डिलर, पुन: चक्रण गर्ने र फोहोरमैला सेवा प्रदायक

सञ्चार/मिडिया: छापाखाना र विद्युतीय

फोहोरमैला उत्सर्जनकर्ताहरू: जनचेतना अभियान

क) व्यक्तिगत – नागरिक: सार्वजनिक सन्देश मार्फत शिक्षा र जनचेतना

१. पम्प्लेट
२. पोस्टर
३. पत्रिका
४. एफ एम, रेडियो, टेलिभिजन
५. इमेल र सामाजिक मिडिया
६. सार्वजनिक बैठक
७. घर दैलो कार्यक्रम

फोहोरमैला उत्सर्जनकर्ताहरू: जनचेतना अभियान

ख) घरधुरी: आवासीय क्षेत्र, अपार्टमेन्ट, सुकुमबासी बस्तीहरूमा तल दिएको माध्यमद्वारा पुग्ने

१. बैठक
२. महिला समूह र संस्थासँग कार्यशाला
४. टोल सुधार संस्थाहरूको सहकार्यमा घर दैलो अभियान र बैठक

घर दैलो अभियानका अवयवहरू

सूचनामूलक, शिक्षात्मक र सञ्चार सामाग्री: पम्प्लेट, पोस्टर/ब्यानर र श्रव्य/दृश्य सामाग्री (ऐच्छिक)

सहभागी:

१. टोल बासी र महिला स्वयंसेवकहरू
२. टोल सुधार समितिका पदाधिकारीहरू
३. गैर सरकारी संस्था, समुदायमा आधारित संस्था (आवासीय क्षेत्र र व्यावसायिक क्षेत्र समेट्ने गरी अभियान सञ्चालनको समय तालिका)
४. स्थानीय क्षेत्र स्वच्छ राख्ने जिम्मेवारी नगरपालिकाका कर्मचारी, कार्यकर्ताहरूको
५. स्थानीय बासिन्दाको सहभागिताको लागि स्वीकृति

फोहोरमैला उत्सर्जनकर्ताहरू : जनचेतना अभियान

ग) संस्थागत: विद्यालय, महाविद्यालय, अस्पताल, सरकारी विभागहरू, अनुसन्धान प्रतिष्ठान, आदि । संस्थागत सरोकारवालाहरू सँगको बैठक (कर्मचारी, विद्यार्थी)

फोहोरमैला उत्सर्जनकर्ताहरू : जनचेतना अभियान

घ) व्यावसायिक: पसल, कार्यालय र अन्य व्यावसायिक प्रतिष्ठान र व्यावसायिक संस्थाको समन्वयमा बैठक सञ्चालन (बेकरी, रेस्टुरेण्ट, पान पसल, कपडा पसल, हार्डवेयर पसल, बैक आदि) । फोहोरमैला व्यवस्थापनको लागि उत्सर्जनकर्तासंग घर दैलो अभियानलाई औपचारिक रूप दिने ।

फोहोरमैला उत्सर्जनकर्ताहरू : जनचेतना अभियान

ङ) थोक फोहोरमैला उत्सर्जनकर्ताहरू : ठूला संघ संस्थाहरू, निर्माण एकाइ, होटेल, सुपरमार्केट आदि, फोहोरमैला विसर्जनको लागि औपचारिकता, राम्रा अभ्यासहरूको प्रवर्द्धनमा प्रशासनसँग साझेदारी

फोहोरमैला उत्सर्जनकर्ताहरू : जनचेतना अभियान

च) सार्वजनिक स्थल/धार्मिक स्थल: पार्क, सडक, खेल मैदान, खुला क्षेत्र, बजार क्षेत्रको को सफाइ । बटुवाहरूलाई सन्देश सहितको बोर्ड । सार्वजनिक स्थलहरू सफा राख्ने जिम्मेवारी संरक्षण कार्यकर्ताहरूको हो ।

सङ्कलनकर्ताहरू: निष्कासन/सङ्कलन/ढुवानी :

- स्रोतमा
- स्थानीय बासिन्दा, गृहिणी, संरक्षणकर्ता (फोहोरमैला छुट्टाउन प्रवर्द्धन गर्नेको लागि र छुट्टाइएको फोहोरमैलालाई छुट्टै भण्डारण गर्ने) को सहभागितामा घर दैलो अभियान गर्ने
- सङ्कलन र ढुवानी
- छुट्टाइएको फोहोरमैलालाई स्रोतदेखि द्वितीय एकाइ र द्वितीय एकाइदेखि स्थानान्तरण केन्द्रसम्म जम्मा गर्ने । प्रत्येक चरणमा स्थानान्तरण गर्दा स्रोतलाई न्यूनीकरण गर्ने ।
- प्राथमिक र द्वितीय समूहका सङ्कलक, कुचीकार, र संरक्षणकर्ताहरूलाई तालिमको व्यवस्था गर्ने

व्यापारी र फोहोरमैला Processors:

फोहोरमैला व्यापारी, कुड कर्कट डिलर, पुन: चक्रणकर्ता, र फोहोरमैला सेवा प्रदायकहरू

- अनौपचारिक व्यापारीहरूको पहिचान,
- व्यापार मेलाको प्रवर्द्धन
- फोहोर व्यापारी, कुड कर्कट डिलर, पुन: चक्रणकर्ता, र फोहोरमैला सेवा प्रदायहरूलाई Sensitization सम्बन्धी बैठक सञ्चालन ।

सरकार

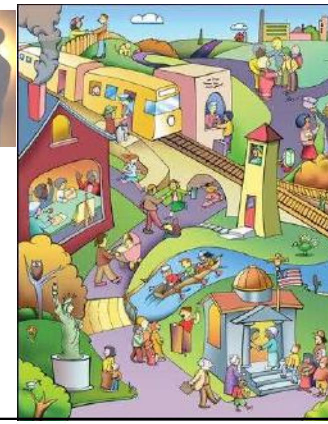
नगरपालिकाका कर्मचारी र कार्यकर्ता:

- आयोजना कार्यान्वयन क्षेत्रका बासिन्दाहरूलाई जानकारी गराउने र सहयोगको लागि अपिल गर्ने,
- नगरपालिका प्रशासन, प्रहरी र अन्य सरकारी विभागका कर्मचारी जानकारी गराउने,

निर्वाचित जनप्रतिनिधि र समुदायका अगुवाहरू

तलका व्यक्तिहरूलाई कार्यक्रमको बारेमा जानकारी गराउने:

१. मन्त्री
२. नगर प्रमुख
३. नगर उप-प्रमुख
४. स्थानीय नेताहरू
५. गन्य मान्य व्यक्ति



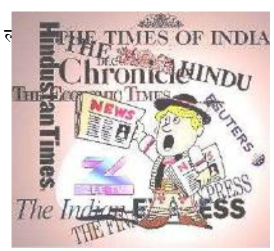
मिडिया

तलका क्रियाकलापहरू सञ्चालन गर्न सञ्चार साझेदारीको पहिचान गर्ने:

१. पत्र-पत्रिका
२. टिभी च्यानल
३. रेडियो
४. इन्टरनेट पोर्टल

जनचेतना कार्यक्रम, प्रतिवेदन आदिको घोषणा गर्नको ल

- Hold Press Meets
- Press Releases/Announcements
- विज्ञापन



अनुकूल वातावरण

स्रोतमा नै छुट्टाउन सहजिकरण गर्ने र सङ्कलकहरूलाई ठेला, अटो-रिक्सा आदिले Equipped गर्ने,

फोहोरमैला फ्याँक्ने टोकरी नजिक क्रमबद्ध गर्नको लागि संरचना निर्माण गर्ने

सफाइ गर्ने क्षेत्रका निरीक्षक र अन्य कर्मचारीहरूलाई प्रशिक्षित गर्ने,

फोहोरमैलालाई जलाउनुको सट्टा वैकल्पिक वातावरण-मैत्री उपायहरू सिर्जना गरी प्रवर्द्धन गर्ने ।

धन्यवाद

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स्थानीय विकास प्रशिक्षण प्रतिष्ठान
(स्थानीय विकास प्रशिक्षण प्रतिष्ठान ऐन, २०४९ द्वारा स्थापित)

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LDTA >>>

नेपाल सरकार
सङ्घीय मामिला तथा सामान्य प्रशासन मन्त्रालय

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परिचय

फोहोरमैला:

- फोहोरमैला कुनै पनि फ्याँकिएको वा परित्यक्त सामाग्रीहरू वा मानवीय क्रियाकलापहरूबाट उत्पादित बस्तु हो ।
- यी बस्तुहरू ठोस, तरल, अर्ध ठोस वा ग्याँसीय रूपमा रहेका हुन्छन् ।
- द्रुत सहरीकरण, सुधारिएको जीवनयापन र उपभोगमा आएको परिवर्तनले यसको वृद्धि हुने क्रममा छ ।
- केन्द्रीय तथ्याङ्क विभागको सर्वेक्षण अनुसार फोहोरमैला व्यवस्थापन नेपालको सहरी क्षेत्रको प्रमुख वातावरणीय समस्या रहेको जनाएको छ ।

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फोहोरमैला व्यवस्थापन

- एकीकृत फोहोरमैला व्यवस्थापन एउटा वृहत् फोहोरमैला सङ्कलन, प्रशोधन, पुन प्राप्ति, र विसर्जन गर्ने विधि हो । यसको उद्देश्य वातावरणीय दिगोपना, आर्थिक सामर्थ्य र सामाजिक स्वीकार्यता प्रदान गर्नु रहेको छ ।
- एकीकृत फोहोरमैला व्यवस्थापनका मुख्य पात्रहरूमा:
- निजी क्षेत्र, संघ संस्था र समुदायमा आधारित संस्थाहरू
- सार्वजनिक/समुदाय
- स्थानीय सरकार (पालिका)

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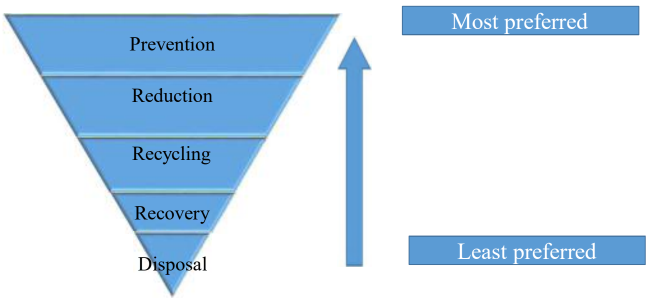
फोहोरमैला व्यवस्थापनमा तहगत् प्रणाली



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फोहोरमैला व्यवस्थापनमा फोहोर न्यूनीकरण

- फोहोरमैला विभाजन/छुट्टाउने
- फोहोरमैला सङ्कलन
- फोहोरमैला ढुवानी
- फोहोरमैला प्रशोधन

5

सार्वजनिक-निजी क्षेत्र साझेदारी

- सार्वजनिक-निजी क्षेत्र साझेदारी भन्नाले हाल सार्वजनिक क्षेत्रले प्रदान गर्दै आएको समान वा सेवा पूर्ण रूपमा वा आंशिक रूपमा निजी क्षेत्रमा स्थानान्तरण गर्नु हो ।
- यसमा सार्वजनिक सेवा प्रवाह गर्ने जिम्मेवारी निजी क्षेत्रको सहभागितामा हुन्छ ।

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नेपालमा फोहोरमैला व्यवस्थापन

- नेपालको नगर सेवामा फोहोरमैला व्यवस्थापन गर्नु पर्ने ठूलो दबाब छ ।
- नगर क्षेत्रबाट उत्सर्जन हुने फोहोरको उपयुक्त व्यवस्थापन हुन सकेको छैन ।
- गरिबहरूको बसोबास भएको बस्तीहरूमा स्वास्थ्य तथा वातावरणीय खतरा सिर्जना गरेको छ ।
- सहरी क्षेत्रका सुकुमबासी बस्तीहरू यो समस्याबाट बढी प्रभावित रहेका छन् ।

7

नेपालमा फोहोरमैला व्यवस्थापन

- सहरी क्षेत्रको फोहोरमैला व्यवस्थापन मुख्य चुनौतीको रूपमा रहेको छ।
- धेरै जसो सहरी क्षेत्रमा फोहोरमैला व्यवस्थापनका आधारभूत सेवाहरूको अभाव रहेका छ।
- वित्तीय व्यवस्थापन र व्यवस्थापन क्षमताको अभाव रहेको छ।
- फोहोरमैला सम्बन्धी तथ्याङ्कको अभाव छ।

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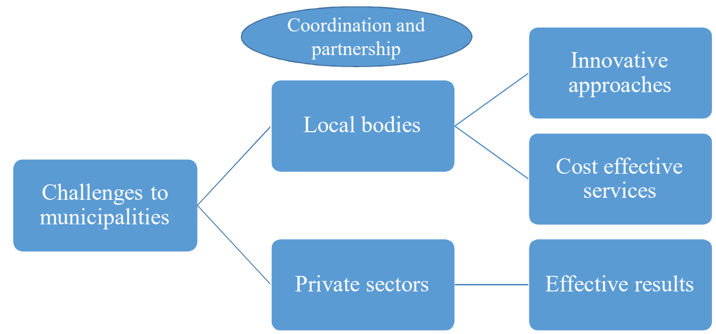
नेपालमा सार्वजनिक-निजी क्षेत्र साझेदारी (PPP)



11

चुनौतीहरू

- नगरपालिकाको मात्र जिम्मेवारी सम्झनु
- फोहोरमैला व्यवस्थापन प्रभावकारी रूपमा सञ्चालन हुन नसक्नु
- स्थानीय सरकारको क्षमतामा कमी
- तथ्याङ्कको अभाव

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चुनौतीहरू

निरन्तर.......

- फोहोरमैला छुट्टाउने प्रावधान नभएको
- उपकरणको अपर्याप्तता, प्राविधिक ज्ञानको कमी र क्षमता अभिवृद्धि सम्बन्धी कार्यक्रम नहुनु
- बजेटको अपर्याप्तता
- राजनीतिक हस्तक्षेप
- नीति, मार्गदर्शन, कार्यविधिको अपर्याप्तता
- निजी क्षेत्रको क्षमतामा कमी
- नगरपालिका र निजी क्षेत्र बीचमा समन्वयको कमी
- नगरपालिकाका कर्मचारीको अवरोध (जागिर जाने डर)

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निकास

- सफल व्यवस्थापनको अवलोकन गरी कार्यान्वयन गर्ने
- फोहोरमैला सङ्कलनमा प्रभावकारिता बढाउने
- समयमा नै र घर/घर सङ्कलन गर्ने परिपाटीको विकास गर्ने

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अवसर

- निजी क्षेत्रको सहभागिता बढाउने
- पुन: चक्रण नहुने फोहोरमैलालाई ल्याण्डफिलमा व्यवस्थापन गर्ने
- विषाक्त फोहोरमैलालाई साधारण फोहोरमा नमिसाउने

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मामिला अध्ययन

सार्वजनिक-निजी क्षेत्र साझेदारी फोहोरमैला व्यवस्थापन
सेप्टेम्बर ३०, २०११
विराटनगर उप-महानगरपालिका

- घर/घरबाट फोहोरमैला सङ्कलन सेवा दिन असमर्थ।
- सन् २००२ मा सहरी वातावरण आयोजनाको लागि UNDP को आर्थिक सहयोगमा सार्वजनिक-निजी क्षेत्र साझेदारी कार्यक्रम स्थानीय मन्त्रालयले संस्थागत रूपमा सञ्चालन गरेको।
- विराटनगर उप-महानगरपालिकाले पहिलो पटक फोहोरमैला व्यवस्थापनमा निजी क्षेत्रलाई सम्लग्न गराएको।
- हाल विराटनगरमा फोहोरमैला व्यवस्थापन "वातावरणका लागि स्वास्थ्य र शान्ति" नामक संस्थाले सञ्चालन गरेको छ।
- मणि दाहाल, उपाध्यक्षका अनुसार घरबाट फोहोरमैला सङ्कलन, सडक सफाइ, नाली सफाइ, मरेका जनावर हटाउने र फोहोरमैला व्यवस्थापन गर्ने कर्मचारीको भर्ना, तालिम र स्थानीय बासिन्दालाई समेत तालिम दिने गरेका छन्।निजी क्षेत्रले फोहोरमैला सेवा प्रदान गरे बापत शुल्क उठाउने गर्दछ।
- आय बढाउनको लागि पुन: चक्रणबाट सामाग्रीको उत्पादन, प्राङ्गारिक मल उत्पादन, चर्पीबाट बायो ग्याँस उत्पादन गरेको छ।

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निरन्तर.......

- PPPUE ले समुदायमा आधारित दिगोपनाको प्रयास गरेको छ।
- स्रोतमा नै फोहोरमैला छुट्टाउन शिक्षकलाई तालिम दिने गरेको।
- PPPUE ले तलका पाँच क्षेत्रलाई प्राथमिकता दिएको छ:
  - फोहोरमैला व्यवस्थापन
  - सहरी सरसफाइ
  - खानेपानी वितरण
  - नवीकरणीय ऊर्जा र
  - सडक र ढुवानी सेवाहरू

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धन्यवाद

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स्थानीय विकास प्रशिक्षण प्रतिष्ठान
(स्थानीय विकास प्रशिक्षण प्रतिष्ठान ऐन, २०४९ द्वारा स्थापित)

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W>>> www.ldta.org.np

तपाइलाई थाह छ, भारतको हैदरबाद सहरमा प्रत्येक दिन ४०० मे. टन फोहोरमैला उत्सर्जन, सङ्कलन, ढुवानी र विसर्जन हुने गर्दछ ?

हामीले फोहोरमैला न्यूनीकरण र पुन: चक्रण नगरेसम्म हाम्रो वातावरण ह्रास हुने छ र सार्वजनिक स्वास्थ्य जोखिममा पर्ने छ।
तपाइले व्यक्तिगत रूपमा स्रोतमा फोहोरमैला छुट्टायर घर, संस्था, पसल आदिको सङ्कलन, ढुवानी गर्न सहयोग गरी वातावरण संरक्षण गर्न सक्नुहुन्छ ।

वातावरण संरक्षण गरौं, विश्वलाई बचाऔं

फोहोरमैला न्यूनीकरण र पुन: चक्रण गर्न सहयोग गरौं ।

स्रोतमा नै फोहोरमैला छुट्टाऔं ।

भिजेको र सूखा फोहोरमैला छुट्टाउने कार्यले व्यवस्थापन गर्न सहयोग पुग्दछ

भिजेको र सूखा फोहोरमैला:

कुहिने फोहोरमैला जस्तै तरकारी, फलफूलका बोक्रा, सुकेका फूल र पात पतिङ्गर, खाना र भान्साबाट निस्कने फोहोर भिजेको फोहोरमैला हुन ।

प्लास्टिक, कागज, सिसा, धातु, आल्मुनियम आदि सूखा फोहोरमैला हुन ।

फोहोरमैला छुट्टाउन किन आवश्यक छ?

❖धेरै जसो फोहोरमैलाहरू पुन: चक्रण गर्न सकिने खालका हुन्छन् । जब, फोहोरमैला छुट्टाइदैन यो फोहोरमैलालाई पुन: चक्रण गर्न कठिन हुन्छ ।






घरमा नै फोहोरमैलालाई छुट्टायर भिन्न/भिन्न भाँडोमा भण्डारण गरौं

पुन: चक्रणका केही तथ्यहरू

१ टन कागज पुन: चक्रण गर्दा १७ रूख, ७००० ग्यालन पानी बच्दछ।

१ सिसाको बोतल पुन: चक्रण गर्दा १०० वाटको बल्ब ४ घण्टा बचाउँछ।

१ टन प्लास्टिक पुन: चक्रण गर्दा १०००-२००० ग्यालन बराबरको ग्याँसीय पदार्थ बचाउँछ।

प्रयोग गरेको क्यानबाट आल्मुनियम तयार गर्दा ९५% ऊर्जा बचत हुन्छ।





एकीकृत नगर फोहोरमैला व्यवस्थापनको लागि नगरपालिकाले गर्नुपर्ने




- स्रोतमा नै फोहोरमैला छुट्टाउने, पुन प्रयोग, र पुन: चक्रण प्रवर्द्धन गर्ने
- प्राथमिक र द्वितीय सङ्कलन केन्द्र र ढुवानी गर्ने व्यवस्था गर्ने
- विसर्जन गर्ने सुविधाहरूको निर्माण गर्ने



घरबाट फोहोरमैला सङ्कलन गर्ने सेवाको लागि नगरपालिकाले गर्नु पर्ने

- फोहोरमैला सङ्कलनकर्ताहरूलाई सुरक्षित र विश्वसनीय सेवा सम्बन्धी तालिम सञ्चालन गर्ने
- समयमा नै फोहोरमैला सङ्कलन गरी थुप्रो हुन नदिने
- भिजेको र सूखा फोहोरमैलालाई छुट्टा छुट्टै सङ्कलन, भण्डारण र ढुवानीको व्यवस्था गर्ने।

फोहोरमैला न्यूनीकरणको लागि

भिजेको फोहोरमैलालाई प्राङ्गारिक मल बनाउने

सूखा फोहोरमैलालाई पुन: चक्रण गर्ने

सूखा र भिजेको फोहोरमैलाको अवशेषलाई ल्याण्डफिलमा विसर्जन गर्ने

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(स्थानीय विकास प्रशिक्षण प्रतिष्ठान ऐन, २०४९ द्वारा स्थापित)

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विषाक्त फोहोरमैला व्यवस्थापन

परिभाषा:
कुनै पनि अवशेष वा अवशेष को संयोजन अन्य रेडियोधर्मी फोहोरको तुलनामा यसको रासायनिक प्रतिक्रिया वा विषाक्त, विस्फोटक, संक्षारक वा अन्य विशेषताहरूको कारणले मानव वा वातावरण को लागि सम्भावित खतरा पैदा गर्दछ । या त एक्लै वा अन्य फोहोरमैलासँग सम्पर्कमा हुँदा भण्डारण , ढुवानी, प्रशोधन वा विशेष सावधानी बिना विसर्जन सकिँदैन ।

स्रोतहरू:

- अजैविक तथा जैविक रासायनिकहरू
- पेट्रोलियम रिफाइनरिज्
- फलाम तथा स्टील
- गैर फलाम धातुहरू
- छाला चप्काउने (Tanning)
- धातु परिष्करण

विषाक्त फोहोरमैला वर्गीकरण

१. प्रज्वलनशीलता	-प्रज्वलन फोहोरमैला
२. क्षयशील	-क्षयशील फोहोरमैला
३. प्रतिक्रियाशीलता	-प्रतिक्रियाशील फोहोरमैला
४. विषाक्तता	-विषाक्त फोहोरमैला

विषाक्त फोहोरमैला सम्बन्धी को नीति नियमहरू:

❖ नियन्त्रण गर्ने उद्देश्य
❖ निर्दिष्ट जिम्मेवारीहरू
❖ विषाक्त फोहोरमैला परिचालन नियमहरू
  १. ढुवानीका लागि तयारी
  २. आवश्यकताहरू
  ३. अभिलेखीकरण र रिपोर्टिङ
❖ विषाक्त फोहोरमैला ढुवानीकर्ता परिचालन
  १. ढुवानी गर्नु भन्दा पहिला सूचना
  २. आवश्यकताहरू

विषाक्त फोहोरमैलाको ढुवानी र भण्डारण:

✓ कोक्रोदेखि चिहानसम्मको अवधारण
✓ स्रोतमा उत्पादित फोहोरमैलालाई ढुवानी गर्न ट्रकको आवश्यकता पर्ने
✓ ढुवानी गर्दा विशेष ध्यान दिनु पर्ने
✓ प्रशोधन र विसर्जन गर्नु भन्दा पहिले अस्थायी रूपमा भण्डारण गर्नु पर्ने

विषाक्त फोहोरमैला व्यवस्थापन रणनीति:

उद्देश्यहरू:
१. फोहोरमैला न्यूनीकरण
२. प्रशोधन विधिद्वारा विषाक्तता हटाउने र बेअसर गर्ने
३. भस्मीकरण विधिद्वारा दहनशील फोहोरमैलालाई नास गर्ने
३. अवशेषलाई ल्याण्डफिलमा विसर्जन गर्ने

१. फोहोरमैला न्यूनीकरण:

❖ स्रोत संरक्षण, आर्थिक दक्षता र वातावरणीय सुरक्षामा सहयोग
❖ समावेश गरिएका रणनीतिहरू:
- स्रोतमा न्यूनीकरण
- पुन: चक्रण, र
- फोहोरमैला विनिमय

२. प्रशोधन विधि:

- भौतिक
- रासायनिक र
- जैविक

भौतिक प्रशोधन:

- विभिन्न छुट्टाउने विधिहरू
- जहाँ तरल र ठोस मिसिएको फोहोरमैला छ त्यहाँ प्रशोधन गर्नै पर्ने
- भौतिक प्रक्रियाहरू:
- स्क्रिनिङ, थिग्राउने, Centrifugation, flotation, adsorption, stripping and RO आदि.

रासायनिक प्रशोधन:

- ✓ विषाक्त फोहोरमैलालाई पूर्ण रूपमा विषाक्त रहित बनाउने
- ✓ रासायनिक विधिहरूमा:
- ✓ Neutralization, Precipitation, Oxidation and Reduction.

जैविक प्रशोधन:

- ➢ विषाक्त फोहोरमैलाको मिश्रणलाई कुहाउन विभिन्न किसिमका सूक्ष्म जीवाणुको प्रयोग
- ➢ Tests have been conducted to degrade PCBs using pseudomonas & flavo bacterium.
- ➢ Psuedomonas Bacteria – Benzene, Phenol, cresol.

३. भस्मीकरण:

- ✓ फोहोरमैलाको रहेको विषादीलाई ९९.९९% हटाउने
- ✓ प्राथमिक उत्पादनहरूमा $CO2$, Vapor र खरानी
- ✓ Sulphur भएको फोहोरमैलालाई भस्मीकरण गर्दा $SO2$, $CO2$, $H2O$ हुने
- ✓ दुई प्रकारका भस्मीकरण: Liquid Injection System र Rotary Kilns.

४. ठोस वा स्थिरीकरण

- ✓ फोहोरमैलालाई अघुलनशील, कडा पदार्थमा रूपान्तरण गर्ने
- ✓ यो विधिबाट निकललाई नाश गर्न नसकिने

५. विसर्जन विधि:

- यो विधिमा जमिनमा विसर्जन, जमिनभित्र विसर्जन, र इनारमा विसर्जन समावेश गरिएको
- विसर्जन विधिको छनौट आर्थिक, प्रदूषण जोखिमको संभाव्यता लेखाजोखाका आधारमा गर्ने
- ल्याण्डफिलबाट हुने वातावरणीय प्रदूषणको बचावट गर्न C/S आवश्यक हुन्छ।

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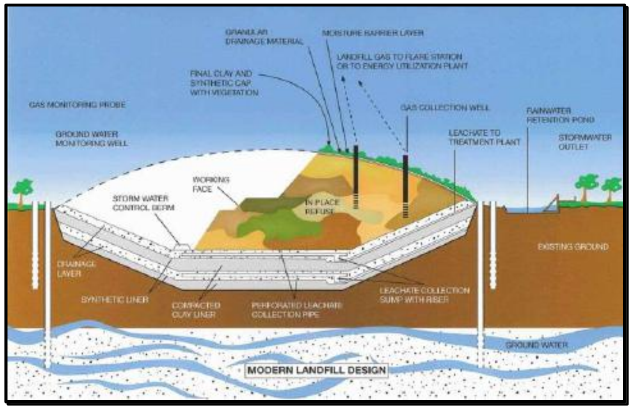
सेनेटरी ल्याण्डफिल भनेको के हो?

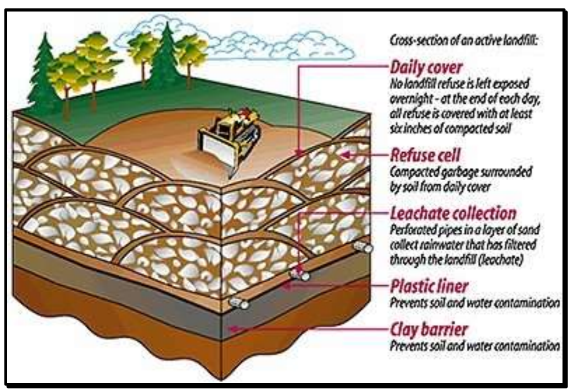
- सेनेटरी ल्याण्डफिल एउटा ठोस तथा विषाक्त फोहोरमैला जमिनमा विसर्जन गर्नको लागि तयार गरिने इन्जिनियरिङ विधि हो।
- फोहोरमैलालाई ल्याण्डफिलमा राखिन्छ।
- ल्याण्डफिल जहाँ विषाक्त फोहोरमैला विसर्जन गरिन्छ त्यसलाई सुरक्षित ल्याण्डफिल भनिन्छ।



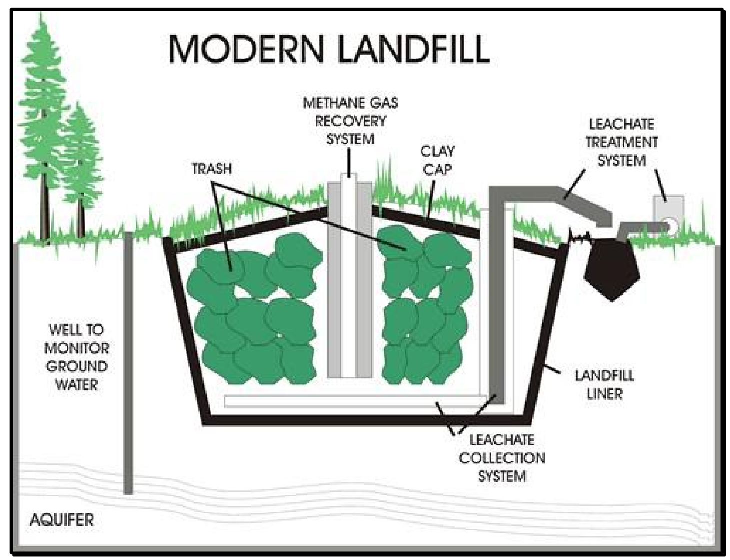
➢ Landfill need not be an engineered site when the waste is mostly inert at final disposal. **In rural area** waste contain large proportion of soil and dirt. The practice of disposal of such waste is called as **non–engineered disposal method**.

सिद्धान्त

➢ ल्याण्डफिलिङ्को उद्देश्य फोहोरमैलालाई पुर्ने वा रासायनिक संरचनालाई बदल्ने ता कि त्यसले वातावरण र सार्वजनिक स्वास्थ्यलाई खतरा नहोस्।



Landfill Design



ल्याण्डफिलका विशेषताहरू

१. फोहोरमैलालाई छनौट गरेर राखिन्छ र निर्देशित मार्गदर्शन अनुसार ल्याण्डफिल तयार गरिन्छ ।
२. फोहोरमैलालाई छरिन्छ र गह्रौं मेशिनले खाँदिन्छ ।
३. फोहोरमैलालाई प्रत्येक दिन माटोको पत्रले खाँदिन्छ ।
४. Most important feature of modern sanitary landfill design is the technology used to prevent GW pollution.

ल्याण्डफिलको लागि आवश्यकता हरू

१. पूर्ण वा आंशिक रूपमा Hydrological Isolation
२. औपचारिक Engineering तयारी
३. स्थायी नियन्त्रण
४. योजनाबद्ध फोहोरमैला Placement and Covering

ल्याण्डफिल प्रक्रियाका महत्त्वपूर्ण पक्षहरू

फोहोरमैला विसर्जनमा भर पर्ने सम्भाव्य कारकहरू

- फोहोरमैलाको प्रकार
- फोहोरमैलाको मात्रा
- फोहोरमैलाको विशेषताहरू
- ऐन तथा नियमहरू
- माटो र स्थलको विशेषताहरू

ल्याण्डफिलको क्षमता र डिजाइन अवधि

✓आकार
✓निर्माण स्थलको भौगोलिक अवस्था
✓फोहोरमैला उत्सर्जनको दर

निर्माण स्थल छनौट प्रक्रिया

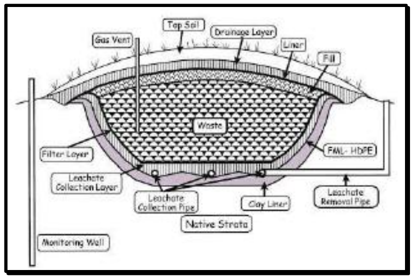
निर्माण स्थलको निर्धारण गर्ने तत्त्वहरू

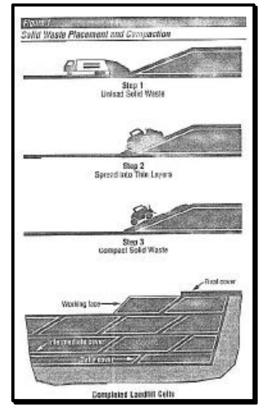
✓आकार, क्षेत्रफल, र आयतन
✓प्राविधिक र वातावरणीय कारकहरूs
✓जलवायु र Hydrological अवस्था
✓कार्य योजना, निर्माण स्थलको विवरण, सञ्चालन, इन्जिनियरिङ कार्य र निर्माण स्थलको पुनर्स्थापना
✓ल्याण्डफिल निर्माण स्थलको स्वीकृति

ल्याण्डफिलको अवयवहरू

An environmental sound landfill comprises

- An appropriate liners for protection of GW
- Runoff controls
- Leachate collection and treatment system
- Monitoring wells
- Appropriate final cover design



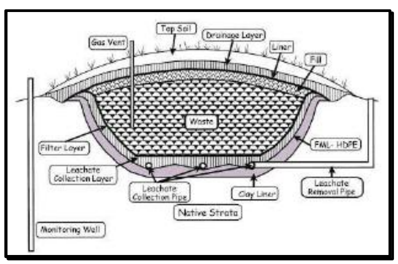


Landfill Cells

ल्याण्डफिल – डिजाइन र सञ्चालन

१. योजना तर्जुमा चरण:

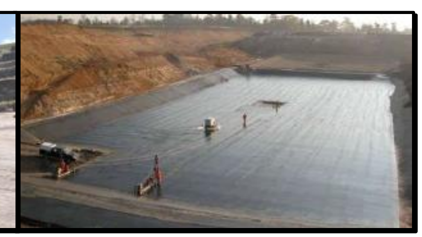
- वास्तविक डिजाइनको लागि प्रारम्भिक Hydro-geological र Geo-technical site investigations ।



ल्याण्डफिल – डिजाइन र सञ्चालन

२. निर्माण चरण :

- निर्माण स्थलमा अर्थ वर्क, सडक, सुविधा निर्माण (नाली आदि)



ल्याण्डफिल – डिजाइन र सञ्चालन

३. सञ्चालन चरण (५-२० वर्ष)

➢ Involves work at the front of the fill area

➢ Operation of env installations

➢ Completion of finished sections

➢ Has a high traffic intensity

ल्याण्डफिल – डिजाइन र सञ्चालन

४. सम्पन्न चरण (२०-१०० वर्ष)

➢ It involves termination of actual filling to the time when envt. Installations need no longer to be operated.

➢ The emissions may have decreased to a level where they do not need any further treatment and can be discharged freely into the surroundings.

5) Final storage phase

➢ In this phase the landfill is integrated into the surroundings for the further purpose, no longer needs special attention.

ल्याण्डफिलका फाइदाहरू

✓ माटोको गुणस्तरमा सुधार हुने ।

✓ जमिनको भाग माथि उकासिने । ल्याण्डफिललाई नगरपालिकाको पार्क, खेल मैदान, गल्फ मैदान आदिको रूपमा विकास गर्न सकिने ।

✓ प्राविधिक रूपले ठूला सहर र धेरै जनसङ्ख्या भएको स्थानमा उपयुक्त हुने ।

✓ भस्मीकरण विधि खर्चिलो र अवशेषलाई पुन ल्याण्डफिलमा विसर्जन गर्नु पर्ने ।

✓ सबै फोहोरमैलालाई पुन: चक्रण गर्न नसकिने ।

बेफाइदाहरू

✓ स्थानीय समुदायले सधैँ विरोध गर्ने,

✓ आर्थिक सम्भाव्यता दूरीको आधारमा उपयुक्त स्थल पत्ता लगाउन गाह्रो हुने ।

✓ पूर्णरूपमा सुरक्षित ल्याण्डफिल निर्माण गर्न नसकिने । Leachate को रूपमा प्रदूषण बाहिर निस्कने ।

✓ जसलाई नियमित रूपमा अनुगमन, मर्मत सम्भार गरी प्रशोधन गर्नु पर्छ ।

✓ हावा, माटो, पानी र ध्वनि प्रदूषणले मानव स्वास्थ्यमा खतराको सम्भावना रहि रहने ।

✓ यदि उचित किसिमले डिजाइन, सञ्चालन र सम्भार मर्मत नगरेमा स्थानीय Ecosystem लाई क्षति पुऱ्याउने ।

✓ कामदार र Scavengers को स्वास्थ्य र सुरक्षामा उच्च जोखिम हुने ।

✓ उच्च लगानी हुने ।

सार्वजनिक, वातावरण र स्वास्थ्य सम्बन्धी चासो

- ल्याण्डफिल वरिपरिको वातावरण प्रदूषण हुन हुँदैन।
- Hydrology (GW flow) and geology (Rock type, soil permeability) को कारणले जमिन मुनिको पानीलाई सिधैँ असर गर्दछ।
- ल्याण्डफिलको अवस्थिति होचो स्थान र सिमसार क्षेत्रमा हुनु हुँदैन। फोहोरमैलाले सतहको पानी र भूमिगत पानीलाई प्रदूषण गर्नु हुँदैन।
- बाढी आउने समथर जमिन, नदी किनारमा पनि अवस्थित हुनु हुँदैन। ताल वा पोखरी देखि कम्तीमा पनि ६० मिटर टाढा हुनु पर्छ।
- ल्याण्डफिलको आधार र जमुनिको पानीको सतह बीचको ठाडो दूरी १.५ मिटर हुनु पर्छ।

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सेनेटरी ल्याण्डफिल स्थलमा सतहको पानी बग्ने नाली र Leachate व्यवस्थापन

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ल्याण्डफिल

- ल्याण्डफिल भन्नाले फोहोरमैला लगेर थुपार्ने स्थानलाई भन्ने गरिन्छ।
- परापूर्वकाल देखि नै ल्याण्डफिलमा फोहोरमैला विसर्जन गर्ने चलन रहेको छ।

ल्याण्डफिलको वर्गीकरण

१. खुला रूपमा थुपार्ने
२. नियन्त्रित रूपमा थुपार्ने
३. सेनेटरी ल्याण्डफिल

ल्याण्डफिल Leachate

- ल्याण्डफिल सञ्चालन गर्दा एक प्रकारको तरल पदार्थ निस्कन्छ जसलाई Leachate भनिन्छ।
- यो एउटा जैविक विघटनबाट उत्पन्न, तरल फोहोरमैला र वर्षातको पानीको मिश्रण हो।
- यसमा उच्च जैविक कार्बन, उच्च नाइट्रोजन र अम्ल हुन्छ।

ल्याण्डफिलमा Leachate को बनौट

Constituent	Typical Ranges[1]
alkalinity, as $CaCO_3$	21–5400 mg/L
ammonia	0.01–1000 mg/L
arsenic	0.011–10,000 mg/L
barium	0.1–2000 mg/L
benzene	<1.1–7370 μg/L
BOD_5	42–10,900 mg/L
cadmium	5–8200 μg/L
chloride	4–9920 mg/L
chromium	0.001–208 mg/L
DDT	4.28–14.26 μg/L
dieldrin	<2–4.5 μg/L
iron	0.090–678 mg/L
lead	1–19,000 μg/L
manganese	0.010–550 mg/L

ल्याण्डफिलमा Leachate को बनौट

Constituent	Typical Ranges[1]
pH	3-7.9
phenols	<3-17,000 μg/L
phosphate	<0.01-2.7 mg/L
selenium	3-590 μg/L
specific conductance	1200-16,000 μmhos/cm
toluene	<5-100,000 μg/L
total organic carbon	11-8700 mg/L
vinyl chloride	0.140-32.5 mg/L

ल्याण्डफिलमा ग्याँस

- Component Methane Carbon Dioxide Nitrogen Ammonia

Component	Percent (dry volume basis)
Methane Carbon Dioxide Nitrogen Ammonia	40-60% 40-60% 2-5% 0.1-1.0%

- Methane : यो प्रज्वलनशील र विस्फोटक हुन्छ।
- Carbon Dioxide: वातावरणलाई हानिकारक नहुने।
- Nitrogen: वातावरणलाई हानिकारक नहुने।
- Ammonia: हावामा एमोनिया भएमा आँखा, नाक, घाँटी र फोक्सो पोल्ने हुन्छ।

जैविक-रियाक्टरको परिभाषा

"..... एउटा सेनेटरी ल्याण्डफिल जैविक फोहोरमैलालाई रूपान्तरण र स्थिरीकरण गर्ने उद्देश्यले सञ्चालित सूक्ष्म जैविक जीवाणु वृद्धि गर्ने प्रक्रिया हो।

ल्याण्डफिललाई Bioreactor को रूपमा किन सञ्चालन गरिन्छ?

- फोहोरमैलालाई ऊर्जामा बदल्न,
- Leachate लाई भण्डारण र प्रशोधन गर्न,
- हावा प्राप्त गर्न,
- दिगोपनाको सुनिश्चित गर्न।

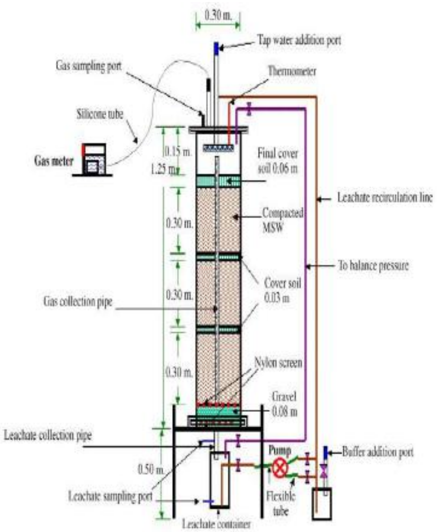

Fig. 1. Simulated landfill reactor.

- These reactors had diameter and height of 0.30 and 1.25m,respectively
- PVC leachate collection pipe with a diameter of 1.8 cm was installed at the center of the bottom of the reactor.
- Leachate was collected in a transparent container

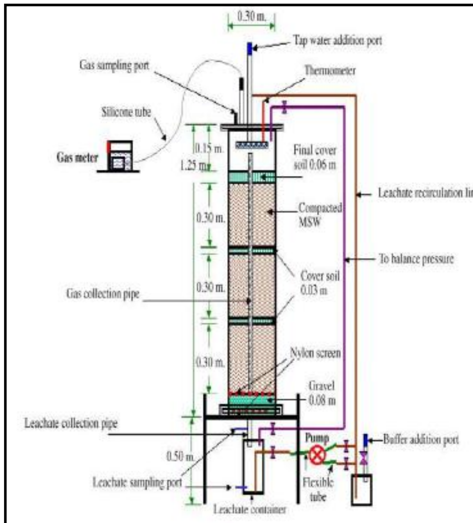

Fig. 1. Simulated landfill reactor.

- A leachate sampling port was installed in the collection pipe.
- A tap-water addition port was installed at the top of the reactor.
- A distribution pipe was installed at the top of the reactor to add liquid to the waste mass.
- A 1.8cm diameter PVC pipe was used to construct a gas-sampling port

Experimental design and operation

- One reactor was operated as a control without leachate recirculation (RC).
- while the other two served as experimental reactors, one with leachate recirculation (R1)
- and the other with leachate recirculation and supplemental water addition (R2).

The simulated landfill reactors operation processes

	Operational processes		
	RC	R1	R2
1st step			
Day 0–199	Water addition as simulated rainfall (61)	Water addition as simulated rainfall (61)	Water addition as simulated rainfall with supplemental water addition in an early acid phase (day 73–105) (37.51)
Day 200	Buffer addition	Buffer addition	No buffer addition
2nd step			
Day 203–329	Water added as same amount of R1's recirculated leachate	Leachate recirculation	Leachate recirculation
3rd step			
Day 330–360	Leachate from fresh waste was fed and increased OLR afte the waste in the rectors stabilized		

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काठमाडौं उपत्यकाको नगरपालिकाको फोहोरमैला व्यवस्थापन र विसर्जन – एक मामिला अध्ययन

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का.म.पा. को फोहोरमैला उत्सर्जन र सङ्कलन

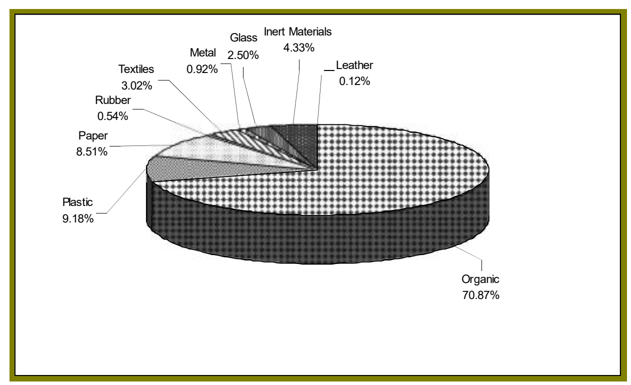
- Waste Generation 0.3 kg/p/day
- Total domestic waste gen. App. 246 ton/day

Others

- Commercial waste (12%)app. 30 ton/day
- Street Waste (12%) app. 30 ton/day
- Waste from VDC (12%) 30 ton/day
- **Total Generation** ***335 ton/day***
- **Collection** ***306 ton/day***

About 70% waste are organic

फोहोरमैला संरचना



काठमाडौंमा फोहोरमैला व्यवस्थापनको वर्तमान अवस्था

- सङ्कलन र ढुवानी
  - कुचीकार: १०१८ जनाले दैनिक बढार्ने
  - सडक किनाराको फोहोरमैला पालिकाले वा निजी सेवा प्रदायकले ढुवानी गर्ने

टेकु स्थानान्तरण केन्द्र:
(८१ एकाइ) टिपर, ट्याक्टर) प्राथमिक सङ्कलनको लागि र २५ एकाइ (१७ Roll qipr)


Road sweeping


New vehicles

हामी कहाँ छौं?

- नगरपालिकाहरू पूर्ण रूपमा जिम्मेवार
- का.म.पा.को नयाँ विधिहरू
  - घर/घरबाट सङ्कलन
  - सेवा शुल्क व्यवस्था
  - स्रोतमा नै छुट्टाउने
  - प्राङ्गारिक मल तयार गर्ने
  - निजी क्षेत्रको सहभागिता
- वाग्मती नदी किनारमा फोहोरमैला थुपार्न छोडेको
- कार्य योजना तयार गरेको

फोहोरमैला सङ्कलन वाहनहरू


Tractors


Mini-Compactor

Tipper

Need to replace

Newly Constructed by Japanese government – direct loading system 2005

Teku Transfer Station

फोहोरमैला न्यूनीकरण

- प्राङ्गारिक मल:
- गड्याउले प्राङ्गारिक मल:
- पुन: चक्रण गर्ने फोहोरमैला सङ्कलन गरी “कवाडी” लाई बेच्ने:
-फोहोरमैला सङ्लन गर्ने ३०-३५ समूह:
- वडा नं. २१ मा सामुदायिक पुन: चक्रण केन्द्रको स्थापना:

प्राङ्गारिक मल


Compost bin


Vermi-composting

अन्तिम विसर्जन

- ५ जुन, २००५ मा सिसडोल ल्याण्डफिल सञ्चालन
- दैनिक ३००-३५० टन फोहोरमैला स्थानान्तरण
- दीर्घकालीन योजना तयार

ल्याण्डफिल स्थलमा सञ्चालन बहाव

ल्याण्डफिल स्थलमा वाहनहरूको व्यवस्थापन

Compactor (7 tons) – 7 nos

Roll Of Truck (7 tons) – 17 nos.

Komatsu Dozer

Sheep Footed Compactor

ल्याण्डफिल स्थलमा वाहनहरूको व्यवस्थापन

सामाजिक पक्ष:

- फोहोरमैला सङ्कलन सेवा: ८९% घरधुरी
- ४१% उत्तरदाताको प्राङ्गारिक मल प्रति सकारात्मक धारणा व्यक्त गरेको
- गैर सरकारी संस्थाको सहभागिता

वित्तीय पक्ष:

- का.म.पा. ले १७ मिलियन फोहोरमैला व्यवस्थापनको लागि खर्च गर्ने गरेको जुन पालिकाको जम्मा खर्चको ३०-३५% रहेको

आम शिक्षा

Public awareness program

आम शिक्षा

व्यवस्थापकीय पक्ष:

- फोहोरमैला व्यवस्थापन शाखा
- यान्त्रिक शाखा, र
- वातावरण महाशाखा अन्तर्गत ल्याण्डफिल स्थल व्यवस्थापन शाखा
- जम्मा फोहोरमैला व्यवस्थापन कर्मचारी सङ्ख्या: १२९९ (जम्मा कर्मचारीको ६०%)

संस्थागत सबलीकरण र संस्थागत प्रबन्ध:

- कर्मचारीको क्षमता अभिवृद्धि (तालिम, अध्ययन, र राष्ट्रिय तथा अन्तर्राष्ट्रिय कार्यक्रममा सहभागिता)
- तत्कालीन र दीर्घकालीन कार्य योजना तयार

प्रभावहरू

- PPP कार्यक्रमबाट फोहोरमैला व्यवस्थापन ३५% मा पुगेको
- ४०% भन्दा बढीले सेवा शुल्क निजी क्षेत्रलाई भुक्तानी गर्ने गरेको
- सार्वजनिक चर्पीहरूको पुनर्स्थापना गरेको
- सहरी सरसफाइ सुधारको लागि घुम्ती चर्पी निर्माण भइ रहेको
- नयाँ निर्माण गरिने घरमा सेप्टिक ट्याङ्कीको व्यवस्था गरेको (४०% घरमा)
- नयाँ निर्माण गरिने घरहरूमा वर्षात्को पानी सङ्कलन गर्ने र पुनर्भरण गर्न विनियमावली तयार गरी कार्यान्वयनमा ल्याएको।

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जाँच सूची

- नजिकको ल्याण्डफिल स्थल वा स्थानान्तरण केन्द्रको भ्रमण
- अध्ययन क्षेत्रको विभाजन
- ल्याण्डफिल वा स्थानान्तरण केन्द्रको व्यवस्थापन
- छलफल ??????।

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फोहोरमैला थुपार्नाले वातावरण प्रदूषण

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अनुचित Dumpsite

- नकारात्मक वातावरण असर
- सङ्क्रमित रोगहरू फैलिने
- चेतनाको अभाव
- नगरपालिकाको अप्रभावकारी फोहोरमैला व्यवस्थापन
- जमिन र पानी प्रदूषण
- नालीमा अवरोध
- जैविक विविधतामा नोक्सान

नेपालमा फोहोरमैला व्यवस्थापनको दृश्य

- सामुदायिक फोहोरमैलाको सङ्कलन, ढुवानी र विसर्जन गर्न समस्या
- चेतनाको कमी र गरिब मानिसहरू अस्वस्थकर क्षेत्रमा बस्न बाध्य
- सामुदायिक फोहोरमैला अवैध रूपमा थुपार्ने
- फोहोर फ्याँक्ने भाँडोको अभाव
- फोहोरमैलालाई खुला ट्रकमा ढुवानी

अव्यवस्थित फोहोरमैला विसर्जन गर्नाले वातावरणमा पर्ने नकारात्मक असरहरू

- फोहोरमैला थुप्रिनाले नाली बन्द हुने
  - झिंगा, किराको वृद्धि
  - लाम्खुट्टेको वृद्धिको कारण मलेरिया डेङ्गु रोग
  - मुसाको वासस्थान – रोग फैलिने, केवल काटिने

अव्यवस्थित फोहोरमैला विसर्जन गर्नाले वातावरणमा पर्ने नकारात्मक असरहरू

- पेशागत खतरा
  - तनाव बढ्ने
  - धारिलो औजारबाट घाइते हुने
  - दुर्घटना हुने

अव्यवस्थित फोहोरमैला विसर्जन गर्नाले वातावरणमा पर्ने नकारात्मक असरहरू

- खुला रूपमा फोहोरमैला
  - हावा प्रदूषण
  - बिरामी हुने
  - दृश्यात्मक कमी

अव्यवस्थित फोहोरमैला विसर्जन गर्नाले वातावरणमा पर्ने नकारात्मक असरहरू

- खुला रूपमा ट्रकमा फोहोरमैला सङ्कलन

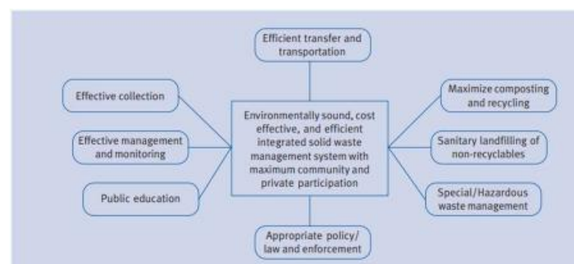
अव्यवस्थित फोहोरमैला विसर्जन गर्नाले वातावरणमा पर्ने नकारात्मक असरहरू

- फोहोरमैला सङ्कलन गर्नाले
  - सडक तथा खुला स्थान फोहोर देखिने
  - प्लास्टिक झोलाको कारणले जनावरहरू मर्ने
  - खुला रूपमा फोहोरमैला थुपार्नाले यातायातमा रोकावट
  - वर्षात् समयमा पानी प्रदूषण
  - दुर्गन्ध फैलिने

फोहोरमैला व्यवस्थापन रणनीति

- वातावरणीय जिम्मेवारीहरू – पुन प्रयोग, पुन: चक्रण, र न्यूनीकरण
- प्रभावकारी फोहोरमैला विसर्जन र व्यवस्थापन
- नियन्त्रण र ल्याण्डफिलको अनुगमन
- फोहोरमैलाको रूपान्तरण योजना
- अव्यवस्थित फोहोरमैला विसर्जनको लागि दण्ड
- जनचेतना
- उपयुक्त नीति तथा कानुन

फोहोरमैला व्यवस्थापनको लागि रणनीति



धन्यवाद

249

स्थानीय विकास प्रशिक्षण प्रतिष्ठान
(स्थानीय विकास प्रशिक्षण प्रतिष्ठान ऐन, २०४९ द्वारा स्थापित)
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यसको अर्थ

फोहोरमैलाबाट ऊर्जा निकाल्ने प्रविधिले फोहोर पदार्थलाई इन्धनको विभिन्न रूपमा रूपान्तरण गर्छ जसलाई ऊर्जाको रूपमा उपयोग गर्न सकिन्छ।

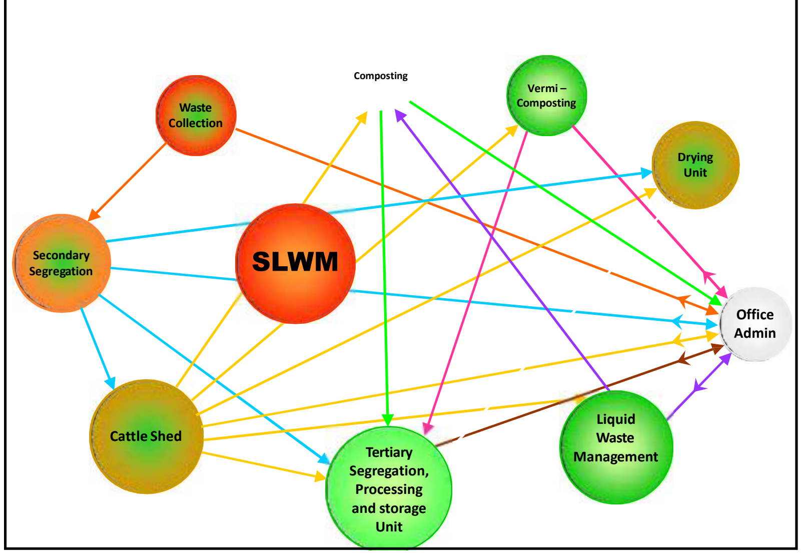
फोहोरमैलाको उपयोग

Scrap metals are now almost systematically extracted from the bottom ash. Metal quality is very high and rising market prices mean good income stream for operators

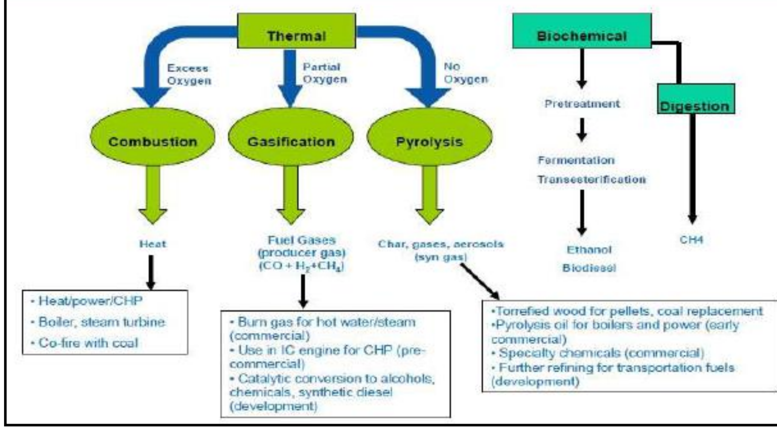
Worthwhile residues: part of a resource-efficient society...
...and a revenue stream!

Reusable **bottom ash** is a useful construction material. Using it offsets the need to extract raw materials, which has considerable environmental impacts. It is disposed of when no demand exists or if waste contaminated it.

एकीकृत र दिगो ठोस तथा तरल फोहोरमैला व्यवस्थापन (अन्तरसम्बन्ध)



प्रविधिको पुनरावलोकन



प्रविधिको छनौट

Environment
- CO_2 Control
- DXNs Control
- Emission Control
- Landfill Control

Economy
- Cost Control
- Profit
- Growth

Energy
- Energy Recovery
- High Efficiency
- Utilization / Sale

Waste Characteristics
- Waste type
- Waste quality
- Waste content

वातावरण

International Standards for Atmospheric Emissions from MSW Incinerators

Country	Switzerland	Germany			France	Sweden	Norway	Denmark	Netherlands	India *	USA (EPA) **	EC Directive 76/2000 EEC ***
Date of Issue	1986	TA Luft 1986	BIMSch Germany V90 (1990), Daily mean	VH90 (1990), Half-hour max	1986	1986				2000	1999	2000
Gas Correction	11% O_2 dry	11% O_2 dry	11% O_2 dry	11% O_2 dry	7% CO_2 wet	10% O_2 dry	10% CO STP dry	10% CO_2 STP dry	11% O_2 STP dry	12% CO_2 dry	7% O_2 dry	11% O_2 dry
Particulate (mg/Nm^3)	50	30	10	60	50	20	30	40	5	150	70	30
HCl	30	50	10	60	100	100	100	100	10	50	62	10
HF	5	2	1	4					1			1
SO_2	500	100	50	200			300	300	40		20	50
NO_x (Calc as NO)	500	500	100	400					70	450	388	200
CO		100	50	80	1250	100			50		157	50
Total C		20	10	40					10			20
Dioxin (ng/Nm^3)			0.1 NATCO equivalent			0.1toxic equivalent			0.1 toxic equivalent		0.41 toxic equivalent	0.1 toxic equivalent

Source: Sewage and Industrial Effluent Treatment, J. Arundel (Blackwell Science, 1995)

Mass र ऊर्जा सन्तुलन

Technology	Plant Capacities (TPD MSW)	Power Generation Potential (MW /100 TPD)
Biomethanation	150, 350, 500 and 1000	1
Landfill with Gas recover	100	0.4
Gasification	500	2
Compositing	NA	NA
Incineration	500	1.24

प्रविधिहरूको लेखाजोखा

WTE technology options have been analysed using a set of five main evaluation criteria:

- **System Configuration (0-30)**
  - Simplicity and operability (0-12), process flexibility (0-12) and scale-up potential (0-6).
- **System auxiliaries (0-30)**
  - Pre-treatment (0-20), post-treatment (0-10).
- **Environmental Aspects (0-30)**
- **Resource Recovery (0-30)**
- **Commercial Aspects (0-30)**
  - Capital Cost (0-12), Operational Cost (0-12), Track Record (0-6).

मूल्याङ्कन जाँच सूची

Technology	Evaluation Scores				
	Technical	Commercial	Environmental	Total	Ranking
	60 (40%)	60 (40%)	30 (20%)	150 (100%)	
A. Biological Options					
1. Biomethanation	40 (27)	42 (28)	25 (17)	107 (71)	1
2. Landfill	40 (27)	28 (19)	15 (10)	83 (55)	2
3. Composting	40 (27)	15 (10)	15 (10)	70 (47)	4
B. Thermal Options					
4. Incineration	28 (19)	34 (22)	5 (3)	67 (44)	5
5. Gasification	28 (19)	37 (24)	15 (10)	80 (53)	3

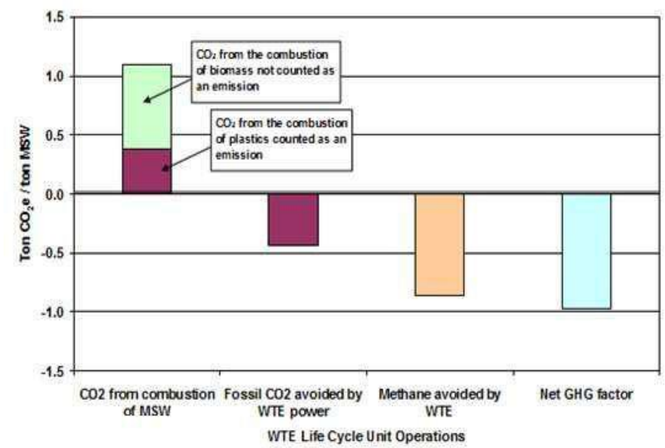
WTE प्रविधिहरूको छनौटको लागि मापदण्ड

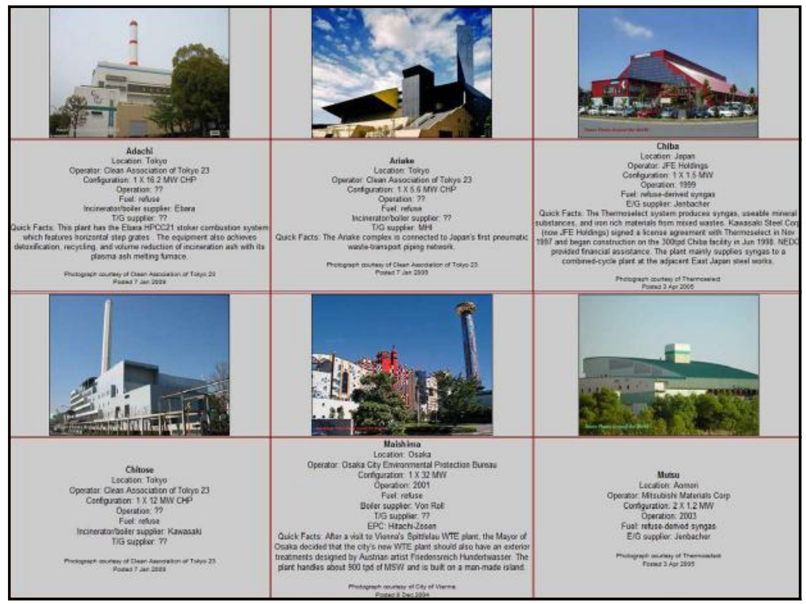
CRITERIA	INCINERATION	ANAEROBIC DIGESTION	GASIFICATION/ PYROLYSIS
Power generation	Steam turbine	Gas turbine	Gas/Steam turbine
Efficiency 50 – 60% (based on volatiles)	85-90% (based on calorific value)	50 – 60% (based on volatiles)	90-95% (based on calorific value)
Residue	Ash	Digested slurry	Ash, Char
Residue Disposal	Landfill	Farm land	Reuse possible, or as roading material
Relative Capital Cost	Very High	Medium	Very High
O&M	High	Low	Limited (few moving parts)
Commercial viability	Less viable owing to costly downstream air pollution control	Readily viable	Varies considerably

WTE प्रविधिहरूको छनौटको लागि मापदण्ड

CRITERIA	INCINERATION	ANAEROBIC DIGESTION	GASIFICATION/ PYROLYSIS
Air Pollution Overall	Dust Collection, Gas Scrubbing (Elaborate)	H2S – Scrubbing (Compact)	Dust collection, Gas scrubbing (Compact)
Water Pollution	Minor	Down-stream aerobic	Low
Solid/Hazardous wastes	Ash to Landfill	Stabilised sludge	Ash/Slag (Reuse)
Environmental impacts	Can be minimized (costly)	Minimum	Can be controlled (additional costs)
Waste disposal	Complete, except for ash to landfill	Complete except for sludge stabilization	Complete, except for ash
Waste Collection	Municipal/Agency	Municipal/Agency	Municipal/Agency

WTE को वातावरणीय प्रदर्शन

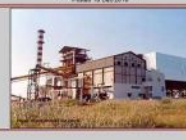




Burnaby
Location: Canada
Operator: Montenay Inc
Configuration: 1 X 25 MW
Operation: 1988-2003
Fuel: refuse
Boiler/incinerator supplier: Martin/B&W
T/G supplier: Alstom
Quick facts: Burnaby is an 800 tpd WTE plant owned by the Greater Vancouver Regional District (GVRD). The incinerator was completed in 1988 and has been selling steam to a nearby paper recycling facility to replace the use of natural gas. A steam set was added in 2003 along with an air-cooled condenser. The plant has three processing lines.
Photograph courtesy of Montenay Inc
Posted 12 Nov 2003

CACEM UTVD
Location: French West Indies
Operator: Martiniquaise de Valorisation
Configuration: 1 X 7.2 MW
Operation: 2002
Fuel: refuse
Boiler/incinerator system supplier: Vinci, CTC
T/G supplier: ??
EPC: Vinci, SDEM
Quick Facts: This facility is near Fort-de-France, Martinique, and was commissioned in Jul 2002. It is owned by CACEM (Communaute d'Agglomeration du Centre de la Martinique), but operated by a private company. Design throughput is 112,000tpy of MSW on two treatment lines. A third line is being considered.
Photograph courtesy of SDEM Entreprises
Posted 5 Oct 2009

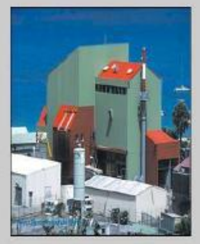
Kajang
Location: Malaysia
Operator: Recycle Energy Sdn Bhd
Configuration: 1 X 8.9 MW
Operation: 2009
Fuel: RDF
Boiler/incinerator system supplier: Maxitherm
Turbine supplier: Shin, AVK
EPC: Worley
Quick Facts: Kajang is in Semenyih 13km from Kuala Lumpur. It is the only operational WTE plant in Malaysia. Throughput is approx 1,100 tpd of MSW processed into fluff at the facility. About 5 MW is available for export to the grid. Main equipment for the plant was sourced from China (baghouse), France (CEMs), Germany (generator), India (controls, condenser, and panels), Indonesia (boiler, to DanBoiler (DK) design), Japan (turbine), Malaysia (blowers and fans, BOP), and the US (governor).
Photograph courtesy of Power
Posted 10 Dec 2010



La Colette
Location: Jersey
Operator: Jersey Transport and Technical Services
Configuration: 1 X 10.2 MW
Operation: 2011
Fuel: refuse
Boiler/incinerator system supplier: CNIM
Turbine supplier: ??
EPC: CNIM, Camerons Ltd, Spie Batignolles TPCI, Fichtner
Quick Facts: The £120mn La Colette EFW project was approved on 9 Jul 2008 and construction got underway in Feb 2009. First waste was burned in Feb 2011. This was the largest capital project ever for the States of Jersey. An existing WTE plant will be closed after the new unit is fully operational.
Photograph courtesy of Camerons Ltd
Posted 12 Mar 2012

MSZ-3
Location: Russia
Operator: OOO EVN-Ekotechprom MSZ 3
Configuration: 1 X 10.9 MW CHP
Operation: 2007
Fuel: refuse
Boiler/incinerator system supplier: Standardkessel, Podolski
T/G supplier: TGM Kanis
EPC: Abfallverwertung Niederosterreich
Quick Facts: Construction of the MSZ-3 project started in Mar 2005 and EVN has contracted to operate the plant until 2019, after which ownership will pass to the City of Moscow. The plant has two lines and a design throughput of 360,000 tpy of municipal waste. The new plant was constructed on the site of a former waste disposal plant which, after operating for more than 20 years, had to be dismantled almost in its entirety. Final acceptance was on 27 Sep 2007 and it was officially opened on 15 Dec 2007 by Moscow Mayor Yuri Luzkov. The total investment was about €175mn.
Photograph courtesy of EVN
Posted 1 Nov 2009

Shadnagar
Location: India
Operator: Selco International Ltd
Configuration: 1 X 6.6 MW
Operation: 2003
Fuel: RDF
Boiler/incinerator system supplier: Walchandnagar
Turbine supplier: Triveni, BHEL
EPC: Keppel Seghers
Quick Facts: This facility in Andhra Pradesh is the only operational WTE plant in India. Selco has a 20yr PPA with APTRANSCO at Rs3.48/kWh and connects to the grid through a 33/11kV substation. The plant went commercial in Nov 2003.
Photograph courtesy of Selco International Ltd
Posted 14 Nov 2010



St.Barthelemy
Location: French West Indies
Operator: Ouanalao Environnement SA
Configuration: 1 X 4.5 MW
Operation: 2001
Fuel: refuse
Boiler/incinerator system supplier: Bouillet
Quick Facts: St-Barthelemy is a 25 km² island north of Guadeloupe with about 7,000 inhabitants. The plant has a single line with an oscillating kiln handling 36 tpd of MSW, the island's entire output. It is coupled to a thermal seawater desalination plant run by UCDEM that is capable of supplying up to 1,350m³ per day of potable water, meeting local requirements even at the height of the tourist season.
Photograph courtesy of Groupe Tiru
Posted 7 Apr 2007

Tuas
Location: Singapore
Operator: Keppel Seghers
Configuration: 1 X 22 MW
Operation: 2009
Fuel: refuse
Boiler/incinerator system supplier: Keppel Seghers
Turbine supplier: ??
EPC: Keppel Seghers
Quick Facts: In Oct 2006, a groundbreaking ceremony was held for Singapore's fifth WTE plant, a design-build-operate 22-MW project undertaken by Keppel Seghers. Design through-put is 800 tpd of solid waste, about 40% of Singapore's waste output. The plant went commercial in Nov 2009.
Photograph courtesy of Keppel Seghers
Posted 27 Jan 2010

Tuas South
Location: Singapore
Operator: National Environment Agency
Configuration: 2 X 23 MW
Operation: 1986
Fuel: refuse
Boiler/incinerator system supplier: MHI
Turbine supplier: MHI, Meidensha
EPC: Mitsubishi, Commonwealth Engineers Co Ltd, JDC Corp
Image courtesy of JDC Corp
Posted 27 Jan 2010

फाइदा

- Carbon Credits को माध्यमबाट उत्प्रेरणा र नगद प्रवाह
- फोहोरमैला न्यूनीकरण (As MSW increase at approx 1-1.33%) Reduction in release of GHG and toxins into water.
- प्रशोधन केन्द्र सञ्चालन गर्न थप इन्धनको आवश्यक नपर्ने
- Supply linkage issues don't exist after tie-up's with ULB's. व्यावसायिक रूपमा कारगर परिपक्क प्रविधि
- सहरी सरसफाइमा वृद्धि
- विषाक्त ग्याँस उत्सर्जनमा नियन्त्रण
- सरकारको वित्तीय सहयोग
- फोहोरमैला नियन्त्रण
- भस्मीकरण पश्चात् धातु प्रत्युपलब्धि

बेफाइदा

- स्रोतमा फोहोरमैला छुट्टाउने अभाव
- प्राविधिक विज्ञता र उपयुक्त संस्थागत प्रबन्धको अभाव
- सहरी स्थानीय निकायहरूको सही सङ्कलन, छुट्टाउने विधि, ढुवानी र प्रशोधन/विसर्जन गर्न चाहना नहुनु
- चेतनाको अभावमा नागरिकको फोहोरमैला व्यवस्थापनमा भावशून्य सोच
- फोहोरमैला व्यवस्थापनमा सामुदायिक सहभागिताको अभाव। महसुलमा ध्यान दिन आवश्यक
- सहरी सेवा वितरणमा जटिलता

स्थानीय विकास प्रशिक्षण प्रतिष्ठान (स्थानीय विकास प्रशिक्षण प्रतिष्ठान ऐन, २०४९ द्वारा स्थापित) "An Autonomous, Professional, Client Centered, Gender Responsive National Institute of Excellence in the area of Local-Self Governance."
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क्रियाकलापहरू

- समूह विभाजन
- मामिला अध्ययन उपलब्ध गराउने
- मामिला अध्ययनलाई अध्ययन गरी प्रश्न उत्तर
- प्रत्येक समूहको प्रस्तुतीकरण
- छलफल

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नमुना कार्य योजना

क्र स	क्रियाकलापहरु	कहिले गर्ने	जिम्मेवारी कसको	सहयोगी निकाय	कसरी गर्ने
४					
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SOLID WASTE MANAGEMENT IN URBAN NEPAL

A Review

NATIONAL CONSERVATION STRATEGY IMPLEMENTATION PROGRAMME
NATIONAL PLANNING COMMISSION, HMG NEPAL, IN COLLABORATION WITH
IUCN - THE WORLD CONSERVATION UNION

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List of Acronyms

BS	Bikram Sambat
CEDA	Centre for Economic Development and Administration
GNP	Gross National Product
GTZ	Deutsche Gessellschaft fur Technische Zusammenarbeit (German Technical Cooperation)
HABITAT	United Nations Centre for Human Settlements (UNCHS)
HMG	His Majesty's Government
ICIMOD	International Centre for Integrated Mountain Development
MAB	Man and Biosphere Committee
MHPP	Ministry of Housing and Physical Planning
MLD	Ministry of Local Development
NGO	Non-Governmental Organisation
SWMB	Solid Waste Mangement Board
SWMP	Solid Waste Management Project
SWMRMC	Solid Waste Management and Resource Mobilisation Centre
UNCHS	United Nations Centre for Human Settlements
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNICEF	United Nations Children's Fund

This Review was undertaken by Ms. Angeline Ackermans, an urban planner who worked as a professional volunteer in the NPC/IUCN NCS Implementation Project from June 1990 to December 1991.

Introduction

CHAPTER I

At all levels of socioeconomic development, human beings produce solid waste. The production of waste is closely linked to behaviour and attitudes. In the past, little was wasted; almost everything was reused, recycled, or assimilated into the soil. Even today, in small rural communities, nature usually takes care of the waste. With a few localised exceptions, the dumping of organic waste around houses in rural communities causes few problems; natural systems are able to absorb it and recycle its nutrients.

Concentration of people in urban areas with very high population densities, use of non-biodegradable materials, new sources of waste (shops, institutions, and factories) and the maintainance of traditional habits and attitudes, appropriate to rural but not to urban living, have disturbed this balance. In towns, the dumping of waste around houses results in an accumulation of health and environmental problems.

The concept of waste management planning is fairly new to Nepal. Rapid urbanisation since 1950 has forced many towns to try and tackle the problem. The quality of the urban environment is a matter of growing concern, and the importance of efficient solid waste management is being increasingly recognised (Thapa, 1987). Nevertheless many factors act against effective solid waste management, including traditional values, religious beliefs, and the caste system. Work requiring direct contact with wastes is strictly for the lower classes. Technical and organisational problems and the absence of environmental quality standards also inhibit the development of an acceptable level of solid waste management (Joshi, 1987).

This paper sets out to review available information on solid waste and its management in the urban areas of Nepal with specific focus on the nature and extent of the problem, the information gaps, and the adverse environmental and health impacts resulting from uncollected wastes. Strategies for more effective treatment of solid wastes in Nepal are discussed, particularly those which stress the role of women and children.

Definitions of solid waste and its constituents vary greatly from country to country. For the purposes of this study, material is waste when it is not considered useful by its owner and for that reason is not of his or her concern. "Solid Waste" describes non-liquid waste materials. It is a relative term because sludges of certain kinds fall within the scope of solid waste management.

As the solid waste problem is mainly related to urban areas, the next chapter will deal with the process of urbanisation in Nepal.

Solid Waste: An Urban Problem

CHAPTER II

The process of urbanisation has been slow in Nepal, primarily because of its geographical remoteness, inaccessibility, and rugged topography. These factors have ensured the perpetuation of rural subsistence pocket economies (ICIMOD, 1986).

Changes after 1950, however, had a significant impact on the pace of urbanisation. An anti-malaria campaign and the resulting availability of new land in the fertile valleys; expansion of infrastructure and improved medical care; and poverty and population pressure in the hills all encouraged migration and the concentration of people around trading centres. Expanding trade with India, the introduction of development plans, as well as increasing foreign assistance spurred urban growth.

Regional differences in urban growth rates are notable. The concentration of Nepal's urban population in the terai and inner terai has steadily increased (60 per cent in 1987 as compared to around 17 per cent in 1952/54) due to the productive resource base, along with in-migration and linkages with India since the 1950s. The proportion of urban population in the Kathmandu valley, the capital and first urban centre, has declined from 83 per cent in 1952/54 to 29 per cent in 1987 (Banskota et al., 1990).

Although regional in character, urbanisation will be the most distinctive feature of socioeconomic development in Nepal in future decades. The urban population increased from 2.9 per cent of the total in 1952/54 to 9 per cent in 1988 and is likely to be 14 per cent in 2000, with a growth rate of 6.5 per cent during the period from 1988 to the year 2000 (UNDP, 1990a; Sharma, 1989) (Figure 1).

In terms of absolute population Kathmandu is still the largest town, and a recent study conducted by UNDP (1990) predicts that this factor will remain constant for the next decade. Kathmandu's growth rate is currently estimated at 4.60 per cent (Thapa, 1989).

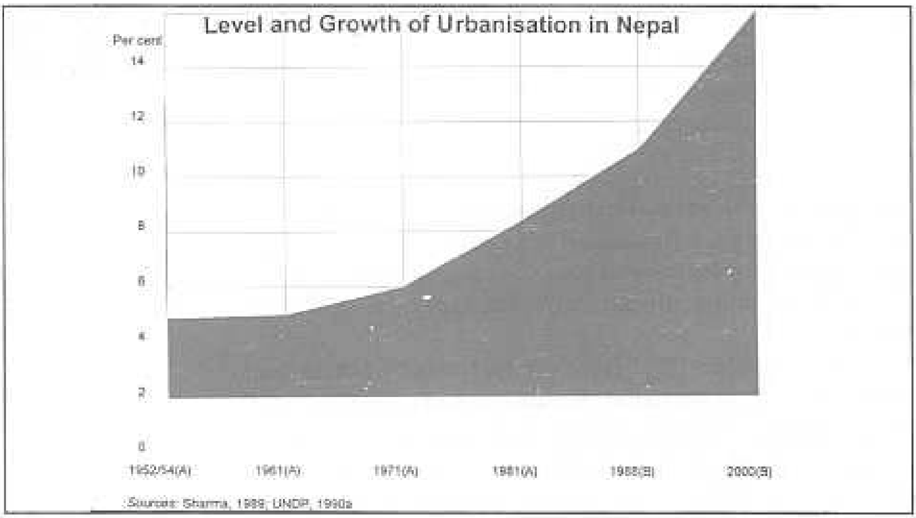

Figure 1: Level and Growth of Urbanisation in Nepal

Urban development in Nepal has been chaotic and unplanned (Sharma, 1987) and, along with increasing industrial and commercial activities, has led to a deterioration in the urban living environment (Joshi, 1987). The pressure on the existing infrastructure: roads, sewerage, drainage, solid waste management, and electricity; is growing, with an increasing incidence of overload and breakdown. The demands on solid waste management are particularly serious (Banskota et al., 1990).

In urban Nepal, the persistence of traditional attitudes and traditional waste disposal habits in both residential and industrial areas is hampering efforts by local authorities to collect and dispose of wastes safely and effectively. Minimal community awareness and concern mean, for example, that the following problems have arisen.

- People do not perceive waste heaps as problem areas.
- Empty land, streets, footpaths, and streams, are used as dumping sites.
- Sewerage systems become blocked and malfunction.
- Industries dispose of solid waste and untreated waste water into rivers and open drains.
- River water and groundwater, important sources of drinking water, are contaminated directly or indirectly by solid waste.

- Decomposition and inefficient burning of solid waste contributes to air pollution. The Kathmandu valley is especially vulnerable to air pollution because of its bowl-like topography, dense population, industrial development, and the growing number of motor vehicles.
- Land polluted with solid waste cannot be used for other purposes.
- The proportion of non-biodegradables and hazardous waste is increasing.

In the long term, progress in solid waste management will depend on greater community participation and on better urban management and planning (Sharma, 1987; UNDP, 1990). Important initiatives have been taken to raise community awareness and to improve the efficiency of solid waste management in Nepal (Sharma, 1987; Devkota, 1988; Bhattarai, 1988; GTZ & SWMRMC, 1988; Nirola, 1990). Observation of various urban areas in Nepal shows however, that a lot still remains to be done.

CHAPTER II

Solid Waste Management in Nepal

Traditional Waste Management

Waste management in Nepal has always been considered the responsibility of untouchable castes (Habitat, 1990). Traditionally people from these castes were hired by town administrations to collect solid wastes; most often equipped with primitive tools such as a buffalo rib to lift waste and a *kharpan* (basket slung on the shoulder) to carry and dump the collected waste in nearby open fields or on river banks (Aryal, 1986; Thapa, 1989).

With growing urbanisation and higher population densities and changing waste composition and growth in the amounts of solid waste, traditional practices of waste management could not keep pace.

In the Kathmandu valley, numerous uncontrolled waste dumps developed in close proximity to dwellings. These heaps transformed entire urban areas into slums, marred the historical beauty of the towns, and most significant, constituted a massive threat to public health (Thapa, 1985; GTZ & SWMRMC, 1988).

The inhabitants of Kathmandu allowed this process to occur over time, without any concerned action to deal with the waste accumulating around them. A negative impact, however, was evident in the tourism sector; leading the government to focus on the problem. A tourism master plan prepared for the Kathmandu valley in 1972 recommended the need for improved sanitary conditions in the valley (Aryal, 1986).

Although the local municipal bodies were responsible for solid waste collection and disposal, they generally lacked adequate facilities and resources to provide such services in more than the core areas (UNICEF, 1987; Joshi, 1987).

Problems related to waste handling increased. Following two studies of the problem, one by Flintoff (1971) the other by Tabasaran (1976) from the University of Stuttgart, the governments of Nepal and Germany agreed jointly to develop a waste disposal system in the Kathmandu valley.

The pre-project phase (1978-1980) comprised of two steps:

STEP 1: 1978

Evaluation of all legal, organisational, and other requirements necessary for the establishment of an executing agency, with recommendations to establish the "Solid Waste Management Board" (SWMB) under the Ministry of Works, Supplies and Transport.

STEP 2: 1979-1980

Based on the results of Step 1, a bilateral agreement for Phase 1 of the Solid Waste Management Project (SWMP) was concluded between the government of Nepal and the government of Germany in December 1979. Subsequently, the executing agency was founded, the Board established, and a Nepalese project manager nominated to oversee the project (GTZ & SWMRMC, 1988).

The Project commenced in 1980 within the three main cities of the valley: Kathmandu, Patan, and Bhaktapur.

Solid Waste Management in the Kathmandu Valley

With the reorganisation of solid waste management for the Kathmandu valley, the staff and the advisers of the Solid Waste Management Project had to cope with a project area that was in urgent need of sanitation facilities (GTZ & SWMRMC, 1988). Waste collection and sewage disposal were totally inadequate and toilets were few. Solid waste lay on the roadsides and piled up in the courtyards of the three cities. Some 9,000 tonnes of solid waste had accumulated in 300 courtyards of Kathmandu and 4,000 tonnes in 150 courtyards of Patan. The waste collected from various city areas was, as before, being disposed of on river banks and in open places without appropriate consideration of environmental and sanitary effects (Thapa, 1986).

In general, according to a study conducted by Thapa (1986), solid waste disposal methods practised before 1980 were characterised by a lack of

- policy and programmes relating to solid waste disposal;
- trained manpower;
- capable institutions;
- appropriate equipment;
- coordination among agencies concerned;
- concepts relating to solid waste;
- public awareness and participation;
- a central sanitary landfill site;
- laws to deal with the problems sociated with solid waste; and
- poor mobilisation of available resources, manpower, and equipment

During the first phase (1980-1983), the project concentrated on developing an economic and locally suitable concept of waste management, then the necessary infrastructure (Thapa, 1989; Pant, 1985). Traditional unhygienic and impractical cleaning equipment, such as the short brooms, curved bones, and shoulder baskets, which obliged the street sweepers to work in a bent position, were changed for long brooms, hand carts, and shovels. Concrete bins were placed in different parts of the city as strategic waste collection points (Abhimanyu, 1985). Cleaning services were provided in a limited number of wards (Joshi, 1987) and a pilot compost plant was established for recycling organic waste. Phase 1 was characterised by trial and error and learning by doing (Aryal, 1983; Thapa, 1985, 1986).

The second phase (1984-1986) is referred to as the implementation phase (Pant, 1985). Cleaning activities were expanded and rehabilitation of old courtyards commenced (Joshi, 1987;Thapa, 1989). A full-scale composting plant was established, along with a central sanitary landfill site. A system was developed to impose service charges and to lay the basis for the project's future self-reliance (Pant, 1985).

During this phase, public utilities such as toilets, bathing places, and slaughterhouses were constructed. Emphasis was laid on encouraging public awareness and responsibility for cleanliness and for maintaining a healthy environment

(Thapa, 1985) and on developing community participation in sanitation activities (Thapa, 1984). Feasibility studies concerning different aspects of waste management were carried out in major towns outside the Kathmandu valley (Biratnagar, Birganj, Hetauda, Janakpur, Bharatpur, Nepalgunj and Siddharthanagar) (Thapa, 1985, 1989).

The third phase (1987-1990) involved mobilisation of the resources necessary to implement policies and programmes developed in the first two phases. The main objective was to make the project financially self-reliant through the sale of compost and the collection of service charges from various sources, including from the use of public toilets and container services. Self-reliance was also a goal in the areas of

- technical planning and operation,
- public relations and community participation,
- financial planning and accounting,
- management and organisation, and
- legal framework and fee collection.

This phase aimed to increase the waste collection volume per working day by an average of 15 per cent per annum, in order to make the sanitary landfill site fully operational and to increase compost production and marketing (GTZ & SWMRMC, 1988).

A major achievement of this phase was the introduction of a Solid Waste (Management and Resource Mobilisation) Act in 1988. The Act includes punitive clauses to control the unmanaged and haphazard dumping of solid waste. It also provides clear direction for more effective and efficient waste management. The Act covers the three cities of the Kathmandu valley, but it can be extended to any part of the Kingdom according to need and resources (Joshi, 1987; Thapa, 1989).

The assistance project ended on the 15th of July 1990. Although no official evaluation is available, it is evident that the operation is not yet self-reliant. The achievements of the project are nonetheless very encouraging and significant especially considering the complexity of waste handling in the old cities, the social constraints, and the fact that systematic waste management is new to Nepalese society (Furedy, 1986).

The fourth phase (1990-93) is aiming at a further extension of collection at reduced unit costs, a consolidation of activities, and a reorganisation of responsibilities in solid waste management policy (natural level) and implementation (local level) levels.

Solid Waste Responsibilities

The Solid Waste Act established the Solid Waste Management and Resource Mobilisation Centre (SWMRMC) with all the responsibilities and activities of the old project. The Centre is a statutory authority with a status similar to a government-owned corporation, although with more commercial flexibility and less government control (GTZ & SWMRMC, 1988). It is the only organisation in Nepal responsible for solid waste management. It has a working relationship with three municipalities (Kathmandu, Patan and Bhaktapur) of the valley. According to an agreement between the municipality and the Centre, the task of cleaning the city is the responsibility of the municipalities, with the maximum use of available resources, manpower, and equipment, and with the necessary technical assistance provided by the Centre (Joshi, 1987).

The municipality of Kathmandu, for example, employs 700 street sweepers to work two hours in the morning and two hours in the afternoon and for additional duty during festival times or when members of the royal family are passing or visiting a certain place. Their monthly wage is NRs 800-900 with no difference between sex or age groups; the level of experience is the only criterion. The municipality provides the sweepers with equipment (baskets, brooms, and shovels) to collect the waste and throw it into containers which are provided and emptied by the Centre. Containers are trucked to a transfer station and then to the site for final disposal or to a compost plant for treatment. The Centre also provides sweepers and equipment. The salary of these sweepers are on par with the salaries paid by the municipalities. These sweepers are paid on the basis of experience, and are required to work six hours a day over two shifts. In practice, municipal and Centre sweepers tend to turn up only for one shift.

For the purpose of waste management, Kathmandu's city road network is divided into three catagories: the metalled main roads, which are cleaned by the Centre, and the unmetalled dirt roads and roads in old and slum areas which

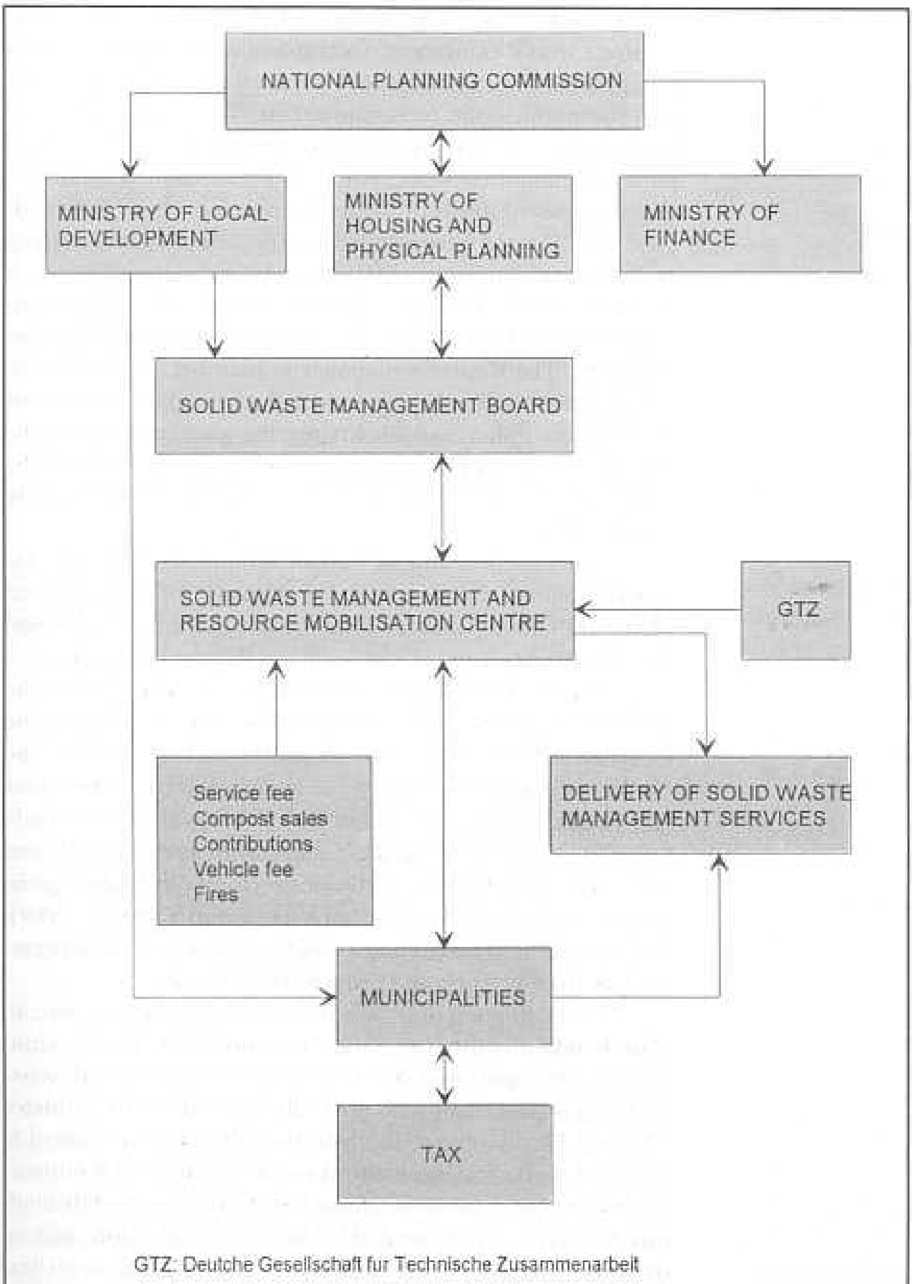

Figure 2: Solid Waste Management Organisational Structure 1990-91

are cleaned by the municipality -- being too narrow for the Centre's heavy equipment. Containers are available only on main roads. Coordination between the well-equipped Centre and the municipalities is a problem. The Centre tends to work independently, rather then strenghtening the municipality in sanitation work, which has undermined the traditional responsibilities of the local governments in this field.

The Centre is controlled by the Ministry of Housing and Physical Planning (MHPP) and administered by an 8 member Board. This Board functions under the chairmanship of the Secretary of the Ministry of Housing and Physical Planning. The Centre's manager is member of the Board. Other members are the three elected municipal chairmen of Kathmandu, Patan, and Bhaktapur, the joint secretary of the Ministry of Local Development (MLD), an officer from the Ministry of Finance, and an engineer from the Water Supply Corporation.

The Centre's annual budget is approved by the National Planning Commission, the Ministry of Housing and Physical Planning, and the Ministry of Finance and allocated through the Ministry of Housing and Physical Planning.

Financial and technical assistance are provided by the Federal Republic of Germany through the Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ). The Centre's financial resources are augmented by service fees (for hotels, restaurants, and offices), compost sales, vehicle fees (for trucks leaving the Centre with recyclables), and fines and household contributions (for households given private services like septic tank cleaning) (Thapa, 1989). Future income through taxes and the possibility of generating gas from waste could provide other inputs.

Every municipality has its own city cleaning unit; in Kathmandu it is the City Sanitation and Public Health Unit. The unit is supervised by an executive secretary and assistant executive officer who are both deputed by the Ministry of Local Development, the Ministry ultimately responsible for solid waste management in municipalities. The municipal budget for solid waste management is dispersed through this Ministry, supplemented by local tax collection, and, in the valley, by the Centre for the local government contribution to waste disposal (GTZ & SWMRMC, 1988). Despite these inputs the financial situation of the municipalities is very weak. They receive a nominal central budget and have

Table 1: Solid waste management in 33 municipalities for 1989

Municipality	Number of Unit			Volume of Waste Managed (m^3/day)	Disposal Site (ha)	No. of Staff
	Garbage Bins	Hand Carts	Tractor Trailer			
Banepa	22	2	1	2.50	0.25	22
Bhadrapur			1	4.00		26
Bhaktapur		17	3	30.60	0.50	51
Bharatpur		2		8.00	0.50	16
Bidur				1.20		4
Biratnagar		5	3	4.00	0.10	75
Birendranagar		4				5
Birganj	19	4	1	4.00		176
Butwal		5	1		1.00	57
Damak	30	4				7
Dhangadi	10	3	1	8.00		12
Dhankuta						4
Dharan	4	12	1	14.00		
Dhulikhel				12.80		8
Dipayal				0.00		0
Hetauda		16	1	4.00	0.30	46
Ilam	6	4				7
Inaruwa	15	2				6
Jaleshor	40	2		2.00	0.07	8
Janakpur	30	3	2	9.40	0.25	45
Kalaiya		1	1	3.00	2.00	12
Kathmandu	76	200	29	130.00	4.50	958
Lahan		2	1	5.50		14
Lalitpur	20	50	8	50.00	4.50	235
Mahendranagar		2	1	7.00		16
Malangawa	15	4	0	1.50	2.00	3
Nepalgunj			2	16.00	0.50	92
Pokhara			1	3.00	0.50	40
Rajbiraj	30	4	1	9.00		16
Siddharthanagar	9	16	1	6.00	0.25	
Tansen		2		1.00	0.50	17
Taulihawa		6		8.00	0.00	9
Tribhuvannagar		4		1.00	0.25	12

Source: Ministry of Housing and Physical Planning (1989) to run all their affairs on their own internal resources which are almost nil (Banskota et al., 1990). This point will be stressed in the next paragraph.

Despite the constraints, significant advances have been made since 1988 in managing solid waste in all 33 urban centres of Nepal (Table 1). Even municipalities with almost no equipment seem to manage considerable amounts of waste per day. A shortcoming, however, is the absence of figures on the amount of waste which is generated per day. The difference between the managed waste and the generated waste would give some idea about the amount of waste which remains uncollected.

Information on disposal site is not available for some municipalities. No official disposal site exists for Dhankuta. Collected waste is thrown directly into the surrounding forests without treatment such as burning or covering the waste with soil. There appears to be relation between the number of staff and the volume of waste managed. In Bhadrapur, Biratnagar, and Birganj, for example, the same quantity of waste is managed, but the number of staff members involved differs considerably. Similarly, there is no clear rational for the distribution of equipment. Bhadrapur has 1 tractor/trailor while Birganj has 19 bins, 4 handcarts, and 1 tractor/trailor.

Problems of Solid Waste Management in Nepal

Nepal is one of the poorest countries in the world. Some 19 million people earn an average of US$ 160 per capita each year (UNDP, 1990b). Only 30 per cent of the country's GNP is earmarked for social services (GTZ & SWMRMC, 1988) of which solid waste management and drainage systems receive the least attention (Banskota et al., 1990). When money is scarce, governments are reluctant to invest in what they consider to be non-productive sectors.

Underlying these economic constraints is a highly centralised and uncoordinated administration which is responsible for urban infrastructure. In practice, municipalities are unable to operate without the substantial involvement of and control from the central level, despite the wide-ranging functions and power. While institution building at the central level has received some attention over the years, the municipal level has been neglected. Municipalities, for example, have the power but not the capacity to collect taxes, thus making them dependent on central government funding (Banskota et al., 1990). The low priority given to waste management is most often a consequence of inadequate resources within municipalities. In Dhankuta, for example, only four containers are available for some 16,500 residents who generate 4 tonnes of solid waste per day. No funds are available to increase the number of waste collectors (four sweepers) nor to invest in more equipment.

Yet the problems and constraints do not all lie (local) government. Facilities provided by the municipality are not always used by the residents in the way they should be used (Manandhar et al., 1987).

In Nepal, traditional rural habits of throwing waste outside the house still exist in urban areas (UNICEF, 1990).

The perception of being and feeling responsible for the waste one produces is sometimes in conflict with traditional beliefs and practices. In traditional Hindu culture, only certain people, within a strict caste system, are responsible for cleaning tasks and waste disposal. For other castes responsibility ceases once waste is placed outside the home. Yet there is evident concern and pride in having a clean personal environment. The inner space, particularly the hearth, must be kept clean while the outside space, being in the public domain, is of less concern (UNICEF/UNEP, 1990). This "Ghar Bahira" (outside the house) syndrome inhibits efforts to create an effective public, solid waste management system.

People, mostly women, who are responsible for the household duties, dispose of household garbage close to

Table 2: Patterns of domestic waste disposal

Town	Deposited Outside	Pit Disposal	Used for Compost	Thrown in Containers	Dumped on Roads	Collected by Sweepers	Others
Pokhara	11.11	16.67	18.52	51.85	1.85	0.00	0.00
Biratnagar	17.70	39.82	24.78	1.77	15.04	0.88	0.00
Kathmandu	48.07	6.44	8.58	25.75	3.00	6.44	1.72

Source: Field Survey, UNDP, January 1990 their dwellings where it causes an unsanitary and smelly living environment (Table 2).

Deposits outside domestic dwellings sometimes are made at *chwaasa* (dumping place with religious significance). Pit disposal is either on the compound (*saaga*) or under the stairs inside the house on the ground floor (*nauga*). (*Chwaasa*, *saaga*, and *nauga* are terms used in Newari communities). Both *nauga* and *saaga* continue to be important in agrarian households, and are more common in Biratnagar, for example, which has a rural character, than in Pokhara and Kathmandu.

Not all the waste is disposed haphazardly outside the house. Biodegradable waste is often used as compost (stuck to walls) or thrown in a *saaga* on the compound. This *saaga* is emptied three or four times a year (or when it is full) and the contents used as fertiliser.

It is not this waste that causes waste management problems, but rather the waste dumped outside the house on communally recognised dumps (inside the courtyard or at open places, streetcorners, or riverbanks) and the waste thrown on the street, totalling 63.4 per cent of all waste generated (UNEP/UNICEF, 1990).

Research conducted by UNICEF and UNDP in 1990 determined that containers provided by the municipality are not popular among the people. These containers are either too far from the dwellings, unpublicised, or seen as smelly inconveniences that should be banned. Regardless of this fact, people feel that the municipality should take more initiative in cleaning up the environment (UNICEF, 1990; UNDP, 1990a).

Table 2 shows that some of the households hire private sweepers to clean the house and compounds, although this is not a common feature.

The effects of religion on behaviour patterns often overlooked in solving solid waste management problems. For example, at certain places, usually at crossroads, waste accumulates and is neglected by the city cleaners. These places known as *chwaasa* are generally viewed as 'inauspicious'. At these places *daan* is thrown; clothes, bedding, medicines, pottery, and other belongings of a deceased person given away in the name of the dead person's spirit. This is a Nepali custom based on the belief that someone of a Brahmin caste will be able to satisfy the spirit of the deceased by taking these items. As it is very difficult these days to find someone to receive the *daan* (even for a fee), people have begun depositing the *daan* at crossroads in the hope that the spirit of the deceased will be able to collect it. Since it is believed that these places are inhabited by evil spirits, people are reluctant to clean them: doing so will cause death. Such areas thus develop as dumping sites to satisfy the spirits. These heaps are growing in different places in Kathmandu and Patan, and, because of their ritual significance, require special management.

Another factor affecting waste disposal and cleaning activities is the important role of waste heaps in certain religious festivals. One of these festivals, "*Chakandeo Jatra*", takes place in March. During this festival

"the image of Chakandeo is quietly and mysteriously carried down a narrow dark lane to a garbage-dump area where the neighbouring people present him with offerings, flowers and red tika powder. The story has it that once, long ago, Chakandeo, against all caste rules, accepted offerings from a lowly woman garbage collector, an act which brought down upon his head the condemnation of wrathful priests. Now market gossip maintains it was more than offering which the garbage woman gave to Chakandeo, and this 'secret' visit to the garbage dump during his festival affirms that she was of such lowly caste that their mèetings were always conducted in the dark of night." (Anderson, 1988).

Not related to tradition or culture, but a day to day practice discouraging solid waste management, is the presence of scavenging people and animals who rummage through waste heaps and containers in search of food or recyclable materials. In doing so, they throw aside things which are of no interest to them, spreading waste and making collection more difficult.

Cleaning activities, in general, are looked upon as a very low status occupation. Renumeration is poor, with the result that waste workers (sweepers) feel justified in working one instead of two shifts.

The problem of lack of sanitation awareness is far reaching. Traditional habits and attitudes will only change if people feel that it is in their interests to change them (GTZ & SWMRMC, 1988). Awareness concerning the threat to living environments and health because of uncollected waste is lacking. UNDP (1990a) found that many people perceive that their living environment is dirty but do not relate lack of proper waste disposal to health problems. Polluted drinking water is perceived as the main cause of health problems (UNDP, 1990a) (Table 3).

As a result, people still throw waste at random and sweepers, appointed to clean up the cities, sometimes throw accumulated waste in places where no collection takes place. Collection is often haphazard or incomplete and transport in uncovered containers to transfer or landfill sites.

Table 3: Perceived causes of health problems

Town	Polluted Drinking Water	Unhygienic Surroundings	Unhygienic Food & Contaminated Utensils	Lack of Proper Disposal Methods	Unidentified	No Problems Perceived
Pokhara	22.22	3.70	0.00	5.56	66.67	1.85
Biratnagar	2.65	6.19	0.00	6.19	34.51	50.44
Kathmandu	48.07	2.15	1.72	4.29	30.04	13.73

Source: Field Survey, UNDP, January 1990

Solid Waste Quantity

CHAPTER IV

Quantity Data

Urbanisation in Nepal has given rise to a serious waste problem. According to a study conducted by Thapa (1989) some 350,000 residents of Kathmandu now produce an estimated 140 tonnes of waste per day, of which about two-thirds by volume is deposited outside the compound. One-third is directly used by the population for composting and fuel, or kept in the courtyards where it is impossible for the solid waste collection services to reach it (GTZ & SWMRMC, 1988).

Factors that influence the quantity of generated solid waste, in general, include geographic location, climate and season, economic factors, and social and religious customs.

The amount of waste generated will affect all stages of solid waste management, i.e., collection, transport, storage, and disposal. Estimates for waste generation in Nepal are based mainly on figures from other developing countries. Although there are some common trends, waste generation figures are not directly comparable from country to country.

There is a strong relationship between the standard of living (expressed in GNP) and the amount of solid waste produced per capita per day (Lohani and Thanh, 1978; Holmes, 1984; Deelstra et al., 1989; UNEP, 1990). Low income countries (per capita income below $360 in 1978) generate around 0.5 kg of waste per person per day; middle income countries (US $360-3,500 per capita income) generate about 1.5 kg per person per day; and high income countries (per capita income higher than US $3,500) generate around 2.75 to 4 kg per person daily (UNEP/UNICEF,1990).

Lohani and Thanh (1978) compared waste production rates in five Asian low income countries and found a range of 0.25 to 0.42 kg per person per day (Table 4). Waste production per capita in Nepal and Burma was about half that in Sri Lanka.

Table 4: Waste production per head for some Asian low income countries

Country*	Amount Per Head Per Day (kg)
Nepal (Kathmandu)	0.25
Burma (Rangoon)	0.25
Bangladesh (Dhaka)	0.35
India (Bangalore)	0.41
Shri Lanka (Colombo)	0.42

Source: Lohani and Thanh, 1978

* Note : Waste production is estimated for main cities and cannot be generalised for each country as a whole.

Looking at the available figures for Nepal, based on Kathmandu, a trend in the amount of waste produced is evident. Lohani and Thanh (1978) determined that the average amount of waste generated in 1978 was 0.25 kg per head per day. During the 1980s, this amount increased to about 0.40 kg per head per day (Sharma, 1985; GTZ & SWMRMC, 1988). Kathmandu currently produces an average of about 0.565 kg per head per day (Rai, 1990) suggesting that waste generation has more than doubled in just over ten years.

There is continuing controversy, however, about which of these figures should be used for solid waste planning and management purposes. In practice none of the figures are used. Waste is collected to the extent possible regardless of scientific measurements.

Per capita waste generation figures have been estimated for different Nepalese municipalities. Waste generation rates vary from 0.25 to 0.45 kg per head per day. These estimates are based on total waste generated in each community and on 1990 population projections. Little research has been carried out on the reasons for these differences or on variations in waste generation between different areas within a city (Thapa, 1989).

Waste generation rates differ not only between countries and within a country but also within a city.

Consumption patterns are a measure of the standard of living, and they are an important factor affecting the quantity of waste produced in a given community. Poor households buy few luxury goods packed in plastic, glass, tin, or paper. Their waste tends to be more biodegradable or recyclable. Bottles, for example, are used to make candlestands or oil lamps; tins are used as building material and watercans; sacks become cloths or wall-lining; paper is used to light fires or close vent-holes; and plastic is used for waterproofing.

Efforts have been made to project the growth in solid waste for 33 municipalities over a five year period. Thapa (1989) estimated that an increase in production of solid waste in Kathmandu of 40.4 per cent can be expected from 1990 to 1995, while the population is expected to increase by 25.2 per cent. Compared to other municipalities, the difference between the population growth and growth in the amount of waste for the five-year period for Kathmandu is rather high. With a few exeptions Thapa projects that the population growth rates and those of waste are more or less similar. (Table 5)

While Thapa is using 0.40 kg of waste generated per head daily from 1990 to 1995 in Kathmandu, estimates have been made using his method but using the previously mentioned 0.25 kg and 0.565 kg as a standard. The results of these estimations for Kathmandu are shown in Figure 3. This figure indicates that waste management and planning for equipment and services are strongly determined by the set of estimates that are used. Planning deals with projections, and, for that reason, the most accurate estimates should be used. Regular surveys and evaluation of municipal refuse on a systematic and continual basis will assist planners in determining proper collection and storage requirements.

Waste Figures and Their Limitation in Shaping Management Strategies

Average waste production figures are useful in setting broad management policies but have limited application because of the variables mentioned previously (geographic location, socialeconomic status, climate, season, and religious customs). Comparative analyses of total or average waste figures for different areas are also complicated by differences in

Table 5: Projection of daily production of solid waste in 33 municipalities for the period 1990-95

S. No.	Nagar Panchayat	Projected Growth Rate (%)	1990 Population	1990 Daily Production (tonne)	1991 Population	1991 Daily Production (tonne)	1992 Population	1992 Daily Production (tonne)
1.	Kathmandu	4.60	352491	141	368705	147	385667	154
2.	Biratnagar	5.50	174792	61	184405	65	194548	68
3.	Birgunj	8.00	124533	40	134495	44	145255	48
4.	Lalitpur	3.35	107450	35	111049	36	114769	37
5.	Pokhara	5.50	83352	27	87937	29	92773	30
6.	Dharan	5.00	78504	26	82430	27	86551	28
7.	Janakpur	10.10	82826	27	91191	30	100402	33
8.	Bhaktapur	2.65	61337	18	62962	19	64631	19
9.	Mahendranagar	3.50	59573	18	61658	18	63816	19
10.	Hetauda	5.00	59363	18	62331	19	65448	20
11.	Siddharthnagar	7.65	60415	18	65037	20	70013	21
12.	Nepalgunj	3.90	48140	14	50017	15	51968	16
13.	Bharatpur	5.70	47615	14	50329	10	53198	16
14.	Rajbiraj	6.00	47438	14	50285	15	53302	16
15.	Tribhuvannagar	6.05	44589	13	47287	14	50148	15
16.	Butwal	8.03	45940	14	49629	15	53614	16
17.	Damak	6.80	40597	12	43358	13	46306	14
18.	Lahan	4.50	29802	7	31143	9	32544	10
19.	Dhangadhi	6.00	31027	9	32889	10	34862	10
20.	Inaruwa	3.00	27274	7	38093	7	28935	7
21.	Jaleshwor	3.00	24717	6	25459	6	26223	7
22.	Tansen	5.17	26060	7	27406	7	28825	7
23.	Birendranagar	5.05	25567	6	2658	7	28214	7
24.	Kaliaya	3.00	20930	5	21558	5	22205	6
25.	Taulihawa	4.00	19218	5	19987	5	20787	5
26.	Bidur	1.50	17777	4	18043	5	18314	5
27.	Dhankuta	3.25	16454	4	18989	4	17541	5
28.	Bhadrapur	4.00	15938	4	16576	4	17239	4
29.	Banepa	5.15	15079	4	16006	4	16991	4
30.	Dhulihkel	1.50	10980	3	11114	3	11311	3
31.	Ilam	1.00	10525	3	10830	3	10736	3
32.	Kalangawa	5.00	11576	3	12155	3	12763	3
33.	Dipayal	5.00	10690	3	11224	3	11785	3
Total Population			1832570				2031681	
Product waste(in tonne)				590		635		658

Sources: Thapa, 1989

S. No.	Nagar Panchayat	1993 Population	1993 Daily Prod. (tonne)	1994 Population	1994 Daily Prod. (tonne)	1995 Population	1995 Daily Prod. (tonne)	1990-95 Population Growth (%)	1990-95 Prod. Growth (%)
1.	Kathmandu	403407	181	421961	189	441374	198	25.21	40.42
2.	Biratnagar	205248	72	216536	76	228445	80	30.69	31.14
3.	Birgunj	156875	55	169425	59	182979	64	46.93	60.00
4.	Lalitpur	118614	39	122588	40	126694	31	17.90	-
5.	Pokhara	97876	32	103259	34	108938	35	30.69	29.62
6.	Dharan	90879	30	95423	31	100194	33	27.62	26.92
7.	Janakpur	110542	36	121707	40	134000	44	61.78	62.96
8.	Bhaktapur	66343	20	88102	20	69906	21	13.97	16.66
9.	Mahendranagar	66049	20	68361	20	70753	21	18.76	16.66
10.	Hetauda	68720	21	72156	22	75764	25	27.62	38.88
11.	Siddharthnagar	75368	24	81134	26	87341	28	44.56	55.55
12.	Nepalgunj	53995	16	56101	17	58289	17	21.08	21.42
13.	Bharatpur	56230	17	59435	18	62823	19	31.93	35.71
14.	Rajbiraj	56500	17	59890	18	63483	19	33.82	35.71
15.	Tribhuvannagar	53182	18	56399	17	59811	18	34.13	38.46
16.	Butwal	57919	17	62570	19	67594	20	47.13	42.85
17.	Damak	49455	15	52818	16	56410	17	38.95	41.66
18.	Lahan	34009	10	35539	11	37128	11	24.61	57.14
19.	Dhangadhi	36954	11	39171	12	41521	12	33.82	33.33
20.	Inaruwa	29804	7	30698	9	31619	9	15.93	28.57
21.	Jaleshwor	27009	7	27820	7	28654	7	15.92	16.66
22.	Tansen	30315	9	31882	10	33531	10	28.66	42.85
23.	Birendranagar	29839	7	31136	5	32706	10	27.93	66.66
24.	Kaliaya	22871	6	23557	6	24264	6	15.92	20.00
25.	Taulihawa	21628	6	22483	6	23382	6	21.66	20.00
26.	Bidur	18589	5	18867	5	19150	5	7.72	25.00
27.	Dhankuta	18111	5	18700	5	19308	5	17.34	25.00
28.	Bhadrapur	17928	5	18645	5	19391	5	21.66	25.00
29.	Banepa	18036	5	19145	5	20382	5	34.77	25.00
30.	Dhulihkel	11481	3	11828	3	11828	3	7.72	0.00
31.	Ilam	10843	3	11061	3	11061	3	5.09	0.00
32.	Kalangawa	13401	4	14755	4	14755	4	27.46	33.33
33.	Dipayal	12374	3	13843	4	13843	4	29.49	33.33
Total Population		2140185		2255179		2377095			
Product waste (in tonne)			720		765		805		

the working definitions adopted for solid waste.

Another difficulty stems from variability in the method used to estimate the total quantity of waste produced per head per day. Most methods are based on measures of collected waste at disposal sites, which is seldom an accurate indication of waste generated because losses arise at various stages on the way to disposal (Flintoff, 1976). (Figure 4)

Some losses have been analysed in Kathmandu, Pokhara and Biratnagar. Approximately 15 per cent, 35 per cent, and 65 per cent respectively of household waste stays in places (in the house, at the compound) where it cannot be collected and for that reason will not reach a disposal site (UNDP, 1990a). About 5 per cent of the waste is taken from the waste stream by Kathmandu's street scavengers (GTZ & SWMRMC, 1988).

Solid waste quantities are expressed both in terms of volume and weight. The use of volume as a measurement of quantity can, however, be misleading. Because of different levels of compression, a cubic yard of loose waste represents a different quantity from a cubic yard of waste in a truck or at a disposal site. For this reason, weight seems to be a better quantity measure, although this too has limitations, e.g., weight increases during the rainy season due to water weight. In Nepal, both indicators are used and, for this reason, care must be taken when making comparisons between different studies (GTZ & SWMRMC, 1988; Banskota et al., 1990).

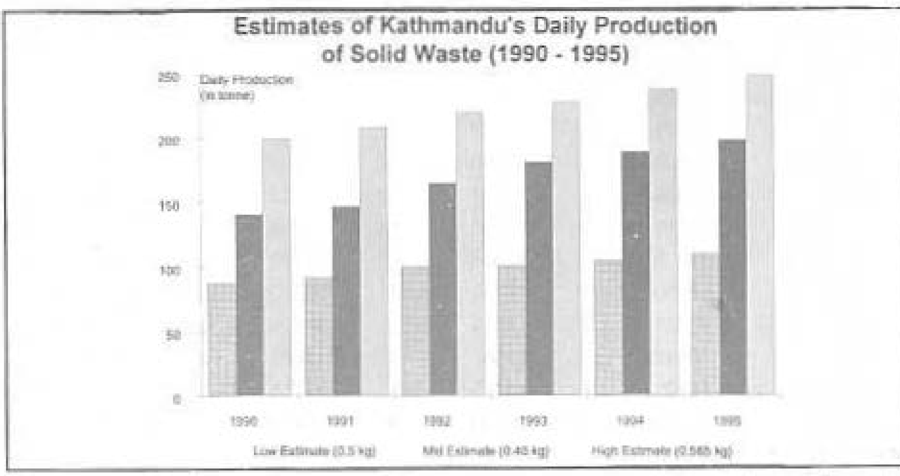

Figure 3: Estimates of Kathmandu's Daily Production of Solid Waste (1990-1995)

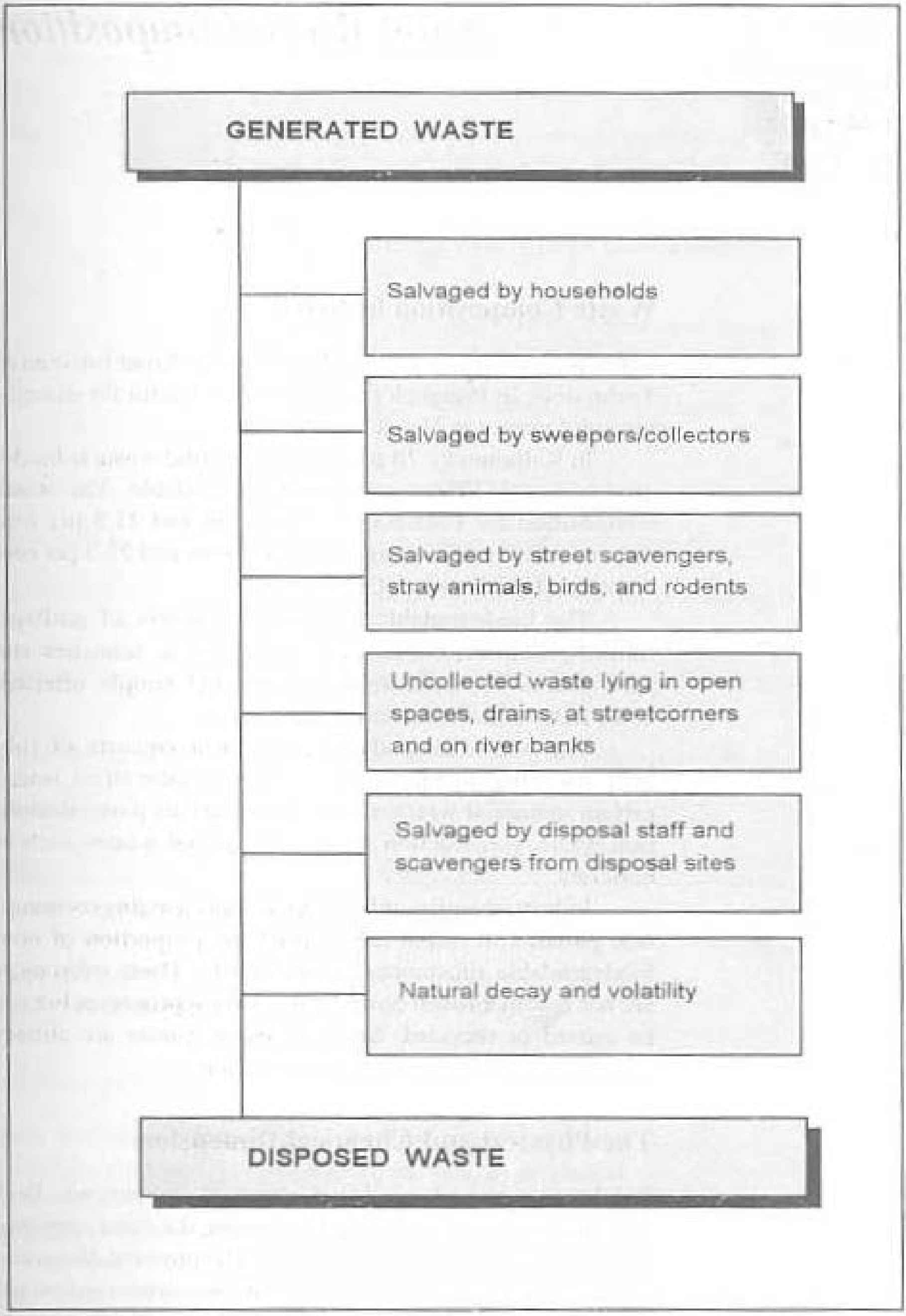

Figure 4: Loss of Waste in Management Process

CHAPTER V

Solid Waste Composition

Waste Composition in Nepal

Table 6 shows a scheme developed by the Asian Institute of Technology in Bangkok (1983) which is useful for describing solid wastes in Nepal.

In Kathmandu, 78 per cent of the solid waste is biodegradable, and 22 per cent non-biodegradable. The waste composition for Pokhara (78.5 per cent and 21.5 per cent respectively) and Biratnagar (70.7 per cent and 23.3 per cent respectively) is similar (CEDA, 1989).

The biodegradable component consists of garbage, rubbish, combustible material such as tree branches and yard trimmings, dead animals, rags and temple offering, some industrial waste, and sewage waste.

The non-biodegradable component consists of rubbish, including metals, feathers, ashes, some street waste, certain industrial waste, such as old machine parts, demolition waste, construction waste, and special wastes such as batteries.

Industrialisation, urbanisation, and changing consumption patterns in Nepal have raised the proportion of non-biodegradable substances in solid waste. These substances are not readily broken down by the natural processes but can be reused or recycled. Some of these wastes are already collected and taken to India for recycling.

The Physical and Chemical Dimension

Solid waste has physical and chemical dimensions. Both dimensions are important in determining the most appropriate disposal and treatment practices. The physical dimension has three main characteristics: density, moisture content and constituents.

Data on the composition of solid waste in Nepal are

Table 6: Waste material by kind and composition

Kind	Composition
Garbage	Wastes from preparation, cooking, and serving of food; market wastes; and wastes from handling, storage, and sale of produce
Rubbish	Combustibles: paper, cartons, boxes, barrels, wood, excelsior, tree branches, yard trimmings, wood furniture, bedding rags, temple offerings
	Non-combustibles: hair, metal, feathers, bones, cans, metal furniture, dirt, glass, crockery, minerals, plastic, rubber, pots
Ashes	Residue from fires used for cooking, heating, funerals, and on-site incineration
Street wastes	Sweepings, dirt, leaves, catch basin dirt, contents of litter receptacles
Dead animals	Cats, dogs, cows, goats, pigs, etc which die naturally or accidentally
Industrial wastes	Food-processing wastes, lumber and metal scrap, hides, old machine parts, waste from slaughterhouses, etc
Demolition wastes	Lumber, pipes, brick, masonry and construction materials from demolished buildings and other structures
Construction wastes	Lumber scrap, pipes, bricks, and other construction materials
Special wastes	Hazardous solids, pathological wastes, batteries
Sewage	Solids from septic tanks, excrement

limited and not always comparable over time; still, some general comments can be made.

Solid Waste Density

Density data are needed to assess the total volume of waste that must be managed. Lohani and Thanh (1978) estimated the density of the municipal waste in Kathmandu to be 600 kg/m^3. These figures were used in a 1988 study (of refuse collection vehicles for developing countries) conducted by United Nations Centre for Human Settlements (UNCHS). Compared to other countries, Nepal's solid waste density appears high (Table 7).

Table 7: Density of waste in different countries

Country	Waste Density (kg/m^3)
High-income countries:	
United States	100
United Kingdom	150
Middle-income countries:	
Singapore	175
Tunisia	175
Nigeria	250
Egypt	330
Low-income countries:	
Thailand	250
Shri Lanka	400
Indonesia	400
India	400-570
Burma	400
Pakistan	500
Bangladesh	600
Nepal	600

Source: UNCHS, 1988

A study carried out in 1988 by the Solid Waste Centre in Kathmandu reported a solid waste density of 390 kg/m^3 (SWMRMC, 1988). This amount is still comparatively high, although considerably less than the 1978 density, and suggests that changes in the composition of solid waste have taken place over the last ten years.

Waste in high income countries is low in density mainly because of the use of packaging materials. As with quantity, density changes with location and time of storage.

Solid Waste Moisture Content

The second important characteristic of the physical composition of waste is moisture content. The moisture content of solid waste is usually expressed as the weight of moisture per unit weight of wet or dry material. The moisture content differs with the type of waste. Food waste contains the highest percentage of moisture, followed by garden trimmings, wood, and textiles. Plastics, rubber, glass, and metals contain almost no moisture. For most solid waste in Asian countries, the moisture varies from 15 to 40 per cent depending on the composition of the waste, the season of the year (monsoon or dry season), and the humidity. The average moisture content for solid waste,in Kathmandu during May 1988 was 45.8 per cent (SWMRMC, 1988).

Solid Waste Constituents

The components of solid waste are similar throughout the world, but the proportions vary widely. Lohani and Thanh (1978) and Attarwala (1986) show the relationship between standard of living and waste composition very clearly. As income rises, the paper, metal, and glass content increases, while the organic content declines (Figure 5).

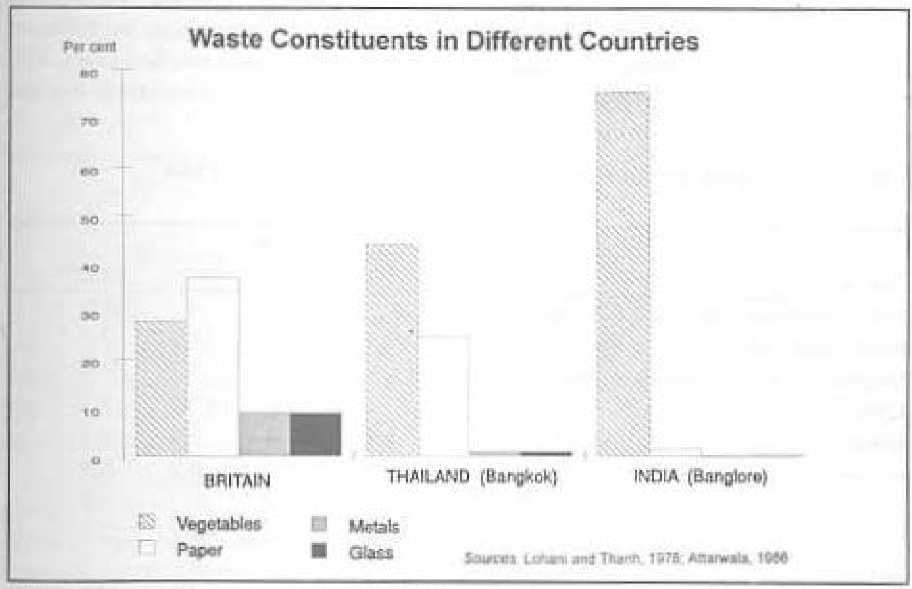

Figure 5: Waste Constituents in Different Countries

Typical components of Kathmandu's waste and their relative proportions are shown in Table 8. The data are derived from surveys completed between 1976 and 1988. By comparing the survey results over the years, patterns of change in waste composition can be seen, but there are certain reservations concerning the results that should be taken into consideration. These are given below.

- The first one is the arbitrary nature of the classification. Cartons, for example, are sometimes included as paper waste and sometimes excluded.
- As discussed in the previous chapter, the composition of disposed waste is not the same as that of generated waste. Recyclable wastes such as glass, paper, plastic, and metals, for example, may be collected before they enter the disposal/ compost site. The data from 1981 are taken before scavenging. Data for 1988 are taken after scavenging.
- The 1985 figures are the result of an analysis carried out when the Solid Waste Project in Kathmandu was fully operational. Because of the fact that the second phase of the project (1984-1986) concentrated on the establishment of a compost plant, the waste was carefully selected for its organic contents.
- The main problem with Table 8, however, stems from the fact that the surveys have been carried out by different people probably using different methods and locations. Yet, as no uniform data are given for the different items, it is not possible to interpret the figures.

Table 8: Composition of Kathmandu's waste from 1976 to 1988

	YEAR			
Component	1976	1981*	1985	1988**
Inert materials (sand, dust, ashes)	-	-	-	26.5
Inert materials (stones, ceramics)	77.6	3.4	15.0	2.4
Vegetable origin, leaves, garden'wastes	-	20.6	-	56.9
Other organic materials	-	37.6	67.5	0.7
Metal	4.9	3.4	2.2	0.4
Paper	-	-	6.0	5.4
Cartons	6.5	19.3	0.0	0.8
Textile	6.5	5.3	2.7	2.0
Glass	1.3	3.4	4.0	1.6
Plastic	0.3	3.6	2.6	2.0
Rubber, leather	0.0	0.0	0.0	0.4
Wood	2.7	1.6	0.0	0.5
Bones	0.2	1.8	0.0	0.3
Batteries	0.0	0.0	0.0	0.1
Density kg/l	0.43	0.29	0.0	0.39

* Data taken before scanvenging

** Data taken after scavenging

Source: Solid Waste Management and Resource Mobilisation Centre, 1988

According to a survey carried out by Rai (1990) in Kathmandu, recyclable materials (7 per cent metal scrap, 7 per cent plastic, 6 per cent paper, and 10 per cent glass) contain about 30 per cent of generated wastes. Since these percentages are higher than those in Table 8, it appears that metal, plastic and glass especially are being collected between the generation and disposal points. However, more information is needed to draw conclusions here because of the uncertainty about where and under what conditions these samples have been taken. It is obvious that, as far as ''component data'' are concerned, records are poor.

Over the years it is likely that changes occur in the composition of waste for reasons such as :

- a rising standard of living and changes in public taste which particularly influence the proportion of non-biodegradables;
- changes in technology (food processing and packaging) that tend to increase the use of materials such as plastic, tins, metals, and paper;
- changes in domestic fuel, e.g., a reduction in the use of solid fuel could cause falling ash content; and
- paving of roads which could cause a decline in inert material.

Besides the physical dimension of solid waste, the chemical dimension has also to be considered. Information on the chemical composition of solid waste is important in terms of treatment, composting, and possible hazards that could be created by solid waste. The chemical dimension has characteristics such as organic and inorganic content, toxic or non-toxic material.

Data concerning the chemical composition are not readily available. Some information exists, however, on the organic content of solid waste. The organic content is the most important factor in assessing the value of waste for compost production.

A comparatively recent survey conducted by Thapa (1989) deals with differences in waste composition between municipalities (Table 9). The differences in composition are related to the relative size of the urban area. The reason behind this is that smaller municipalities usually have a more rural character; they have lower living standards, use a large proportion of unpacked fresh food, use a smaller proportion of luxury goods, and have little, if any, industrial and com-

Table 9: General composition of solid waste ranked according to size of municipality (in percentage by weight)

S. No	Size of Municipality	Glass & Ceramics	Paper	Plastic	Metal	Textile	Wood/ Bones	Ash Dirt	Organic matter (Compostable)	Total in % by weight
1	20000	0.01	0.01	0.01	0.02	0.20	0.20	12.46	87.0	100
2	30000	0.01	0.01	0.20	0.03	0.20	0.30	12.25	87.0	100
3	50000	0.10	0.20	0.20	0.10	0.30	0.30	11.80	87.0	100
4	75000	0.40	0.60	0.50	0.10	0.30	0.30	11.80	86.0	100
5	100000	0.50	1.40	1.90	1.20	0.30	0.60	11.10	83.0	100
6	150000	0.90	1.90	2.20	1.50	0.60	0.70	10.20	82.0	100
7	200000	1.90	2.40	2.30	2.30	0.80	0.90	9.40	80.0	100
8	250000	2.10	2.70	3.10	2.60	0.90	1.20	8.40	79.0	100
9	300000	2.30	2.80	3.50	3.90	2.00	1.40	8.10	76.0	100
10	350000	2.40	3.00	3.60	4.20	2.10	1.80	7.90	75.0	100
11	400000	2.50	3.20	3.80	4.70	2.20	2.20	7.70	73.6	100
12	450000	2.60	4.20	3.80	4.70	2.20	2.20	6.70	73.6	100

Source: Thapa, 1989

mercial development. One outcome of this survey is notable: the organic content of waste declines with the growing size of the urban area. With growing urbanisation in Nepal, one can expect a growing amount of inorganic and non-decomposable waste matter.

The definition of urban areas in Nepal is restricted by the population size criterion and the political/administrative process involved in the designation of municipalities (Sharma, 1989). Consequently, no attention is given to the geographical location of the municipality, climate, commercial and industrial development, the occupational structure, nor the standard of living of the inhabitants, factors important in relation to the composition of solid waste generated.

CHAPTER VI

Solid Waste Sources

Source Classifications

Knowledge of the source of solid waste provides insights into trends in waste production, the composition of waste, and disposal practices. Yet specific information on the source of waste is seldom known. The most comprehensive waste records are those kept at landfills, transfer centres, or compost plants where it is difficult to identify the waste sources.

Nepal's main solid waste sources are: (1) domestic, (2) commercial, (3) industrial, (4) agricultural, (5) institutional, and (6) natural. Some solid waste components are not easy to categorise, especially inert materials such as sand and dust.

Domestic waste is produced by single family and multi-family dwellings, and it often accounts for about 75 per cent of the total waste collected (Flintoff, 1976). Domestic waste includes kitchen waste, paper and cartons, rags, some plastic, rubber, leather, bone, glass, crockery, pots, sweepings, and metals.

In poor neighbourhoods (on river banks, squatter areas, or older neighbourhoods), traditional cooking methods can also produce ash. Where sanitation facilities are limited, the waste includes faecal matter. In neighbourhoods populated by higher income groups, old furniture, tins, and yard trimmings are common waste products.

Commercial waste comes from a variety of sources which include stores, tea stalls, business premises, godowns, restaurants, markets, fruit vendors, office buildings, hotels, guesthouses, print shops, autorikshaws, and motor repair shops.

A high percentage of waste from these sources consist of paper; packing materials, such as glass, cartons and plastics, waste from food preparation; crockery; hair; glass; pots: ashes; spoiled and discarded goods; and sometimes hazardous solids.

In urban Nepal, markets are an important source of waste. Much of this waste is organic.

Industrial waste is generated by sources such as construction sites, demolition debris, food processing industries, slaughterhouses, manufacturing establishments and breweries, leather industries, carpet factories, chemical plants and tourist facilities. Service companies such as telephone, electricity, water, road, and drainage and sewerage are included in this category.

Construction and demolition waste consisting of earth, brickbats, stones, sand and wood, packaging materials, food wastes, hides, discarded metal, plastic, rags, ashes, special waste, bones, feathers, hazardous waste, and old machine parts are among the waste in this category.

Agricultural waste is produced by dairies, chicken farms, and livestock, for example. Urban areas in Nepal still include some agriculture activities within their city limits. Waste from this source is almost 100 per cent organic.

Waste from institutions is generated by schools, banks, offices, hospitals, community halls, and religious places. Waste from this source usually contains paper, food wastes, boxes, glass, plastic, crockery, hazardous solids, and pathological waste.

Temple areas accumulate wastes associated with religious and community activities and temple animals such as monkeys, dogs, and pigeons. Temples form an important part of Nepalese life and for that reason need special management attention. The wastes found here include food, hair, ashes, crockery, leaves, sweepings, and faecal matter.

Natural waste comes from trees and plants along roadsides and parks and stray animals. Leaves, tree branches, seeds, and carcasses of animals are among the waste produced in this category.

Table 10 shows the relationship between the different types of waste and the source classification.

Table 10: Solid waste types associated with various source classifications

Sources	Types of Solid Waste
Domestic	garbage, rubbish, ashes, sewage, some special waste
Commercial	garbage, rubbish, ashes, sewage, some special waste, sreet wastes
Industries	Construction, demolition waste, special waste, industrial waste, sewage, rubbish, street waste
Agriculture	garbage, rubbish, special waste, rubbish, sewage, ashes
Institutions	special waste, street wastes,, sewage, garbage, ashes
Nature	street waste, dead animals

Disposal Practices of Solid Waste Sources

Knowledge about waste sources and disposal practices is important in solid waste management. Different categories of waste sometimes require different handling, collection, and disposal equipment. As previously mentioned, it seems like domestic waste accounts for the bulk of waste that has to be collected, followed by commercial waste and waste from institutions (Attarwala,1986). Domestic, commercial, and "open areas' waste" -- waste that collects on streets, alleys, courtyards, vacant lots, playgrounds, and recreation sites -- accounts for approximately 90 per cent of the total waste generated (UNCHS, 1988).

Data concerning the waste disposal practices of different source communities are not abundant. Domestic waste is reused, burned, used as compost, and thrown into a container or on the street.

Some information is available on the disposal practices of certain industries in the Kathmandu valley. To date, no specific efforts have been made to control and regularise the waste from industries. Surveys of some industries reveal that waste is reused and/or sold but also dumped on hilltops or on the banks of rivers (Table 11).

The amounts of industrial waste in the Nepalese urban areas are currently not significant in comparison with residential or commercial solid waste, although it is a localised and growing problem. Research and action taken now can avoid an intractable and prohibitively expensive waste management problem in the future.

Table 11: Disposal practices of some industries in the Kathmandu valley

Name of Industry	Solid Waste
Bansbari Leather and Shoe Factory	Open dumping on hill top
Harishiddi Brick and Tile Factory	Sold for reuse and as soil conditioner
Kathmandu Milk Supply	Sold for reuse
Modern Slipper Industry	Dumped on river banks
Pan Himalaya Carpet	Sold for reuse to make industry mattresses
Nepal Poultry	Dumped on hill tops
Nepal Foam Industry	Burned
Royal Drugs	SWMP tank
Photo Concern	Burned
Nepal Distillery	Sold for reuse
Nepal Battery	Selling/on site holding and dumping in the Bishnumati river

Source: Banskota et al., 1990

Table 11 describes only a number of the larger industries. No information is available on the waste management practices of Nepal's numerous small-scale (unregistered) factories/workshops.

Tourism is a special kind of industry. In a span of about 30 years, between 1958 and 1988, the annual number of recorded visitors to Nepal has risen from 2,000 to around 266,000 (Hosken, 1974; Banskota et al., 1990). These visitors generate solid wastes in both rural and urban areas.

Trekking and mountaineering activities, the main purpose of 14 per cent of the visitors to Nepal, pose a threat to the environment. The most famous trekking routes in Nepal (Everest, Annapurna, and Langtang) lie in regions that are ecologically very fragile and fall partly within a conservation area or national park (Banskota et al., 1990). These routes are frequently referred to as the "toilet paper trails" (Luhan, 1989).

Major mountaineering expeditions transport considerable quantities of food, fuel, clothing, and equipment into remote areas. The quantity of material transported depends upon the size of the expedition. For example, a 1972 Everest expedition transported 105 tonnes of material and equipment (Cullen, 1986). Packaging material, malfunctioning equipment, and other wastes are rarely transported back to the base camp and instead are left along the trails.

Some of the equipment that is left, such as tents, ice screws, and ropes, which would be valuable commodities in Kathmandu, are considered to be waste in the mountains because of the cost and effort of removing them.

The need for food and accommodation for tourists, while creating income earning opportunities for villagers, also results in increased waste production.

A special problem with waste in an alpine area is slow natural decomposition. Materials that decompose quickly in a warmer climate, such as paper, persist for years in alpine areas. More persistant materials, such as tin and fuel containers, may remain unchanged for decades. As a result, popular camp sites along Himalayan treks now have large and growing solid waste heaps. Although climbing permits stipulate the appropriate disposal of garbage, enforcement has proved to be difficult and depends until now on local and NGO effort (cleaning up campaigns).

Almost 80 per cent of the tourists arriving in Nepal enter the country through Kathmandu. Kathmandu remains the central tourist attraction for those coming for pleasure and sightseeing (75.5 per cent of all tourists). Pokhara is the second urban area most visited by tourists.

The majority of tourists never leave urban areas (Banskota et al., 1990). Tour and trekking agencies, hotels, lodges, shops, and restaurants are therefore the main beneficiaries both in terms of employment and income. They are also major contributors to solid waste in urban areas.

According to Thapa (1989) there seems to be no problem with agricultural wastes but he considers that further study on the nature and extent of waste from this source is required.

Not much information is available on the disposal practices of institutions. A proper system of handling the daily output of hospitals (containing pathogens) does not exist. Only two of the larger hospitals have their own incinerators. However, these are not used regularly as fuel is expensive and there is no law enforcing the proper treatment of solid waste. Hospital waste is thus either thrown in a yellow container or it is simply dumped outside the hospital premises on the assumption that it will eventually be picked up by the public waste collection services. Some steps have been taken to work together with SWMRMC and the Ministry of Health to handle hospital waste (GTZ & SWMRMC, 1988).

The Everest Paper Mill has signed a contract with Tribhuvan University to collect the University's used paper. Some other schools give their paper waste to scavengers or burn it together with other waste on their compound. Most offices and banks do the same, although paper can be found dumped haphazardly on institutional compounds.

Waste found around temples ends up in the street or in nearby rivers. A good example is the area around Pashupatinath, one of the most famous temples in Nepal. Here sweepings and temple offerings are thrown into the Bagmati river where people are bathing, brushing their teeth, and washing clothes.

Natural waste, like leaves, ends up haphazardly in the environment and is spread by the wind or vehicular traffic. Dead animals lie rotting at the place of death or are collected by the Centre or municipality. Sometimes they are eaten by other animals such as rats, crows, or street dogs.

Uncollected Solid Waste constitutes a massive threat to the environment and public health. The impacts of uncollected solid waste are discussed in the next chapter.

CHAPTER VII

The Consequences of Uncollected Solid Waste

Environmental Impacts

The negative effects of uncollected waste in the urban environment are given in the following passages.

Land:

Waste dumps pollute land chemically and mechanically and can make it useless for agriculture, living and recreation. Landfill areas can become a problem in the future as they decompose over the decades producing toxic and flammable gases and effluents.

Water:

Surface water: Drains, streams, and rivers are blocked and polluted by runoff from dump sites and the contents diverted.

Groundwater: is affected by seepage from decomposing wastes and hazardous materials.

Air:

Burning of city waste means spreading heavy metals, gases, and soot as smoke over residential areas. Another problem is the waste and dust picked up by the wind and the gases formed during decomposition and putrefaction.

The most obvious environmental damage caused by solid waste is aesthetic; the dumping of waste results in unsanitary, unsightly, and odour-producing conditions (Thapa and Ringeltaube, 1981).

Solid Waste and Health

There are potential health risks associated with the poor management of solid waste. Children are particularly susceptible to respiratory problems caused by dust from dump sites but also to diarrhoea, skin and eye infections, and other diseases. The major child-killing diseases in developing countries are related to unsanitary conditions such as those associated with uncollected solid waste (UNEP/UNICEF, 1990).

At risk also are the waste workers (including women and children) and the waste pickers or scavengers. Typically they work barefooted, barehanded, and without masks.

For the general public, the main risks to health are indirect and arise from the breeding of vectors (e.g., flies and mosquitoes) and the attraction of rodents and stray animals to waste. These animals become infected with diseases that are then passed on to humans. This is especially true for chickens, pigs, buffaloes and ducks which are food sources in Nepal. Pigs, for example, eat faecal matter and can become infected with a parasite (cyst of the tapeworm). Humans who eat infected pork run the risk of brain damage from the parasite, which can prove fatal in the long run.

Burning waste can contribute to air pollution and respiratory infections; windblown dirt and dust particles from waste heaps can have the same effect (Forestry Service, 1983). Dust can contain heavy metals such as lead, mercury, cadmium and arsenic which are harmful to human health (Sharma, 1987; Pandey, 1987).

Another serious problem, and an often unrecognised one, is the pollution of drinking water, either directly by solid waste dumping or indirectly via leachate. This can cause problems like diarrhoea, gastroenteritis, cholera, typhoid fever, and dysentery (Sharma, 1987).

In the case of the Gokarna landfill site, 16 km east of Kathmandu, it is claimed that the site is equipped with all the necessary technologies and therefore safe from leachate (SWMRMC, 1989). No data are available for other dumpsites.

During the monsoon period drainage systems clogged with solid waste cause overflow or stagnant water which then forms breeding places for mosquitoes and disease or creates smelly borders along roadsides.

CHAPTER VIII

Conclusion

It is currently unrealistic to suggest that larger budgets should be allocated to solid waste management. The main way to extend solid waste services is to render these services more effective and efficient.

Probably the most common problem in all the urban areas is a lack of cooperation from the inhabitants, who often put their waste out on the wrong times, in open piles or inappropriate containers such as plastic bags. The SWMRMC in Kathmandu reports that street-sweeping costs are growing every year. Street-sweeping currently accounts for 27 per cent of the current spending on the Centre's solid waste management budget, largely the result of inadequate disposal practices.

People do not dispose of their waste in a proper manner because they fail to see uncollected waste as a problem. Education is therefore important. The people's involvement is essential in the complex task of cleaning urban areas.

Generally speaking, the waste management system functions poorly, but the impact of the Solid Waste Management and Resource Mobilisation Centre in Kathmandu, Patan, and Bhaktapur is appreciable and encouraging. An outstanding feature of its programme includes a vigorous public awareness and education campaign without always the desired end result: a clean city.

Proposal for Future Action

A sustainable urban development and the environment must be firmly linked if Nepal is to meet the needs and improve the quality of urban life of its present and future generations. Nepal faces, and will continue to face, an increase in its urban population. It is, therefore, essential that urban growth be managed in such a way that the conservation of a healthy living environment can be guaranteed.

The National Conservation Strategy for Nepal provides a framework for improving conservation activity. However, it also suggests that, for any conservation strategy to be useful, it must be implemented and to be implemented it must be understood by and have the active support of the people. This principle applies to solid waste management which will not be successful unless it has the understanding and support of the people.

One way to gain that understanding and support is to provide communities with relevant knowledge and skills to improve and protect their living environment through intensive and long-term education programmes.

Target Groups

Given the state of urban areas in regard to solid waste, it is apparent that the public at large could benefit from more knowledge and skills and a better understanding of how to dispose of waste in a proper way. The 'targets' for educational programmes on waste disposal can be divided into three categories. The first includes all those whose jobs are to remove waste, manage waste and waste-related problems; municipal workers; solid waste workers; teachers; and community and health workers.

The second category is children of primary school age; and the third, and most important, target group is the community at large.

Each of these target groups require an approach tailored to their specific needs but the basic aim remains the same: to improve urban living conditions and reduce the amount of waste.

Through education, people can acquire appropriate knowledge and skills to help them to adopt socially and environmentally responsible lifestyles that do not endanger other people or future generations and entail people managing the disposal of waste in such a way that it does not threaten the survival of other species or natural systems.

It is essential to bring people to realise that it is in their own interests to change habits and attitudes and to participate in managing the growing and changing amounts of waste.

Every member of a society, whether poor or wealthy, young or old, male or female needs to be involved and to be aware that managing waste results in personal benefits, helps solve existing problems, and prevents new ones.

Education programmes on waste disposal should *not* concentrate only on the poor and illiterate. It is also the wealthy and literate members of society who have yet to adopt proper waste disposal practices.

Domestic waste accounts for up to 75 per cent of the total waste collected. Women and children need to be a primary focus of the community educational effort. Women are responsible for the cleanliness of the house and for disposing of wastes. This is an activity passed on from mothers to children and, in particular, to daughters. Young children first learn to see and understand what is happening around them through contact with their mother. Environmental education starts in a child's home and immediate neighbourhood.

Formal schooling can contribute much to increase children's environmental awareness (UNEP/UNICEF, 1990). Undoubtedly, in some families, the demand for the assistance of girls in household labour, particularly in childcare and farming activities, reduces the likelihood of their attending school. In other families it seems likely that girls do not attend school because parents do not feel that education is a necessary attribute for females. Daughters master skills for managing a household and its wastes at home, skills which they later apply in their husband's home and hand down to their children, especially daughters. Therefore community education programmes should get necessary primary attention.

The message of waste management is closely tied to decentralising the responsibilities of managing solid waste from the municipalities (and the Solid Waste Centre) to the local residents. It has everything to do with educating, guiding, and motivating local communities to help themselves, to solve their own problems and not to depend entirely on the municipality or Solid Waste Centre.

Waste management should not, however, be considered a purely community-level task. Waste management always includes a certain amount of public responsibility. The borderline between public and private responsibilities is variable. Yet waste management cannot work without public facilities and participation. According to Hosken (1974), the majority of the people of Nepal had, until 1951, no experience with public institutions providing public services. Research undertaken by CEDA in 1989 found that people, especially in Kathmandu, still feel that the municipality was inefficient in sanitation activities. Nepal's future waste management system, therefore, must include bringing municipalities and residents to create an efficient solid waste managing system.

Practical Principles

Waste management education should be guided by a few practical principles.

The first is that it should have a **community focus**. Community problems, knowledge, and solutions are seldom built into overall strategies, although such elements are often very important in achieving successful implementation of strategies.

Waste education should also be **action-oriented**, addressing waste-related problems, and ways to overcome these problems.

The educational methods should be **participatory and interactive** so that people have a role to play in planning their own solutions and in working together to give them a practical long-term effect. The principle of "learning by doing" is inherent in effective waste education.

In summary, waste education should be community focused, action-oriented, and participatory, giving particular attention to the long-term effects.

Two conservation motivators mentioned in the National Conservation Strategy for Nepal are to be given special focus in waste education -- the local non-governmental organisations and women's organisations. NGOs have an increasingly important role to play in working towards raising awareness, improving living conditions, and providing skills to communities. The role of women will need particular emphasis in waste management education. Their potential contribution in effective waste management is of prime importance.

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Preface

Central Bureau of Statistics (CBS) is pleased to publish the Report on Waste Management Baseline Survey. Solid waste management is a crosscutting issue that affects and impacts various areas of sustainable development in each of the three sustainability domains: environment, economy and society. The quantity of solid waste is increasing every year in all the urban municipalities and in emerging rural municipalities mainly due to fast population growth and changing livelihood.

CBS conducted the waste management baseline survey in 2019/20. The major objective of the survey is to generate the baseline data and information on solid waste management including the quantity and composition of municipal solid waste and other vital information about the state of solid waste management in different urban municipalities of Nepal. Data obtained from the survey is expected to be a milestone for the planning, monitoring and evaluation of the national development plans and programs related to solid waste management.

I would like to express my gratitude to all urban municipalities of Nepal for providing valuable data and supports to bring out this publication in its present form.

I am thankful to Mr. Hem Raj Regmi, Deputy Director General of the Bureau for his overall guidance in bringing out this publication. Mr. Pramod Raj Regmi and Mr. Sushil Kumar Sharma, Directors, Environment Statistics Section deserve special thanks for shouldering the responsibility to accomplish the whole tasks of the data compilation and bringing out this publication in time. Statistics Officer Mr. Tulasi Prasad Paudel and Statistics Assistant Mr. Bhim Bahadur Shakha also deserve thanks for their sincere involvement in data collection and management for the preparation of this report.

The Accelerating Implementation of the SDGs Nepal Project of UNDP/NPC deserves our special appreciation for providing technical support for the data management of this survey and publication. Similarly, I would like to express my sincere thanks to the data management and analysis team of TEAC Consultancy led by Mr. Binod Chandra Devkota and reviewer Dr. Ramesh Sapkota for their inputs in various stages of the survey and finalization of this report.

CBS always welcomes comments and suggestions from users, stakeholders and all well-wishers for the implementation of similar surveys and publication in the future.

February, 2021

Nebin Lal Shrestha
Director General
Central Bureau of Statistics

Executive Summary

The Central Bureau of Statistics (CBS) with the main objective of deriving systematic and comprehensive data and information on state of solid waste management (SWM), including the categorization of quantity and composition of the municipal solid waste (MSW) collected by the municipalities, executed this waste management baseline survey in the municipalities of Nepal. The survey was conducted in 2019/20 and has covered 271 municipalities of Nepal.

The survey found the overall average human resource available in the municipalities to be 114 per municipality, with the higher number (477) in the metropolitan cities and the lower (99) in the municipalities. The average number of human resources assigned for waste management was 118 per metropolitan city, followed by 59 and 12 in the sub-metropolitan cities and municipalities, respectively. The survey revealed very limited technical human resources in the municipalities.

The survey revealed three broad categories of wastes generated from the municipalities. These were: organic waste, inorganic waste and other waste. The organic waste mainly consists of paper, textile and agricultural waste; whereas inorganic waste comprised of plastic, glass, rubber, metals and minerals; and other wastes composed of waste that were not included in either of these two categories. The annual average total waste collected per municipality amounted to 2231.0 mt in 2073/74, 2164.4.0 mt in 2074/75 and 2232.7 mt in 2075/76. These figures convert to an average daily waste collection per municipality equals to 6.1 mt, 5.9 mt and 6.1 mt, respectively for the three years. By waste type, the organic waste accounted for higher share compared to the inorganic and other wastes. The organic waste composition was highest (54.0%) in 2075/76 compared to the inorganic waste (33.3%) and other wastes (12.7%). The municipal waste is generated from varied sources such as households, institutions, business/commercial complex, hospitals, etc. Among the metropolitan cities, the quantity of daily waste collection was highest in the household (15900 kg/day), followed by business complex (7700 kg/day) and the educational institutes (4680 kg/day). Similarly, the households remained the major sources of waste generation in the sub-metropolitan cities (3300 kg/day) and municipalities (1440 kg/day).

The waste collection of the municipalities varied in terms of coverage. The highest coverage was made by the metropolitan cities in terms of wards, households and population coverage mainly because of their higher capacities in all respects. The sub-metropolitan cities and municipalities stood in second and third position, respectively in terms of coverage of wards, households and population. Considering coverage with respect to the ecological zones, municipalities of Terai region reported higher waste collection coverage, followed by the hill and mountain regions.

Among the municipalities, only 12 (4.4%) municipalities (1 metropolitan city, 1 sub-metropolitan city and 10 municipalities) were using transfer stations for processing of municipal solid waste. The size and capacity of the transfer stations varied considerably among the municipalities with the higher among the metropolitan cities and lower among the municipalities. The capacity of waste transfer stations was 10000 cu. m for the metropolitan city and lower for the sub-metropolitan cities and municipalities. Among the municipalities, only 5 municipalities (1 metropolitan city, 1 sub-metropolitan city and 3 municipalities) were having weighing machine for recording weight of waste at the transfer station. Out of the total, only 15 municipalities were using different facilities/methods for managing the waste in their transfer stations. Similarly, only 5 municipalities reported that they have measures to prevent the foul smell of the transfer stations.

A total of 232 (85.6%) municipalities reported at least one or other type of means of transportation for transporting waste. The higher number (70.7%) of the municipalities were having tractor/power tiller, 61.6% municipalities were having tippers/trucks and 23.7% of municipalities were having dozer for mobilization of the solid waste. Other waste means of transportation of the municipalities were mini trucks/pick up, loader, excavator, boomer, jet machine, rickshaw, etc. Among other, tractor/power tillers and tripper/trucks were the major transportation means used commonly by the municipalities. The municipalities, on average, were having more than 1 tractor/power tiller and most of them were having one tripper/truck.

The survey revealed different waste handling practices adopted by the municipalities. The three main methods of waste handling were, i) piling up in landfill site by 48.6%, ii) burning by 32.1%, and iii) piling up in the river side by 27.4%. Among the municipal categories, 60% each metropolitan cities and sub-metropolitan cities and 47.7% of municipalities were adopting piling up in the landfill sites. Out of the total municipalities surveyed, 212 (78.2%) municipalities reported one or other practices of handling waste. Out of them, 30 (14.2%) municipalities were recycling their waste, which included 2 metropolitan cities, 5 sub-metropolitan cities and 23 municipalities. The recycling of waste was higher among metropolitan cities (50%) and sub-metropolitan cities (40%) as compared to the municipalities accounting only 11.7%. Although the municipalities were involved in recycling of waste, the quantity used for recycling was low. The recycled quantity of waste averaged 4.1% of the total waste produced which indicates a large potential of reuse and resource recovery for the municipalities.

Among the total municipalities surveyed, 114 (42.1%) municipalities were using the landfill sites, whereas 117 (43.2%) municipalities were not using landfill sites. Remaining 14.8% municipalities did not respond their status about the landfill sites. Among the municipalities using the landfill sites, 85.1% reported to have their own sites and 14.9% were using others' landfill sites. The average area of the landfill sites of the municipalities was 1.5 ha. However, the area varied considerably by the categories of the municipalities. The sub-metropolitan cities had the higher land area of landfill sites (3 ha per landfill site) in compared to 1.4 ha land area among the municipalities and 0.3 ha among the metropolitan cities. Out of the total 66 municipalities reported for the area of landfill sites, the average capacity of the landfill site for the municipalities was 29877 m3. The capacity, however, varied from 22516 m3 for the municipalities to 115000 m3 for the metropolitan cities, and 68293 m3 for the sub-metropolitan cities.

The survey revealed varied distances of landfill sites with different categories of the municipalities. The average distance of landfill sites was 4.3 km, with the higher average distance (17.5 km) among the metropolitan cities as compared to 4.4 km among the sub-metropolitan cities and 4.0 km among the municipalities. The average life span of the landfill sites was 16.3 years with the lowest (6.5 years) among the metropolitan cities. The low life span of the landfill sites in metropolitan cities is due to lower land area and capacity against relatively large volume of waste generation. The average life span of landfill sites of municipalities was nearly 3 times higher than that of the metropolitan cities. Out of the total 97 landfill sites under consideration, only 7 sites were having one or other type of treatment system. Very few landfill sites were having leachate treatment facilities among the municipalities suggesting need of activities of the municipalities for the leachate management for controlling further contamination of the surrounding environment. Only 6 sites had leachate control system, 5 had leachate drainage system and 3 had leachate treatment system.

Among the total (271) municipalities surveyed, 149 (55%) municipalities have prepared their plans which were the basis to implement the waste management activities. Among the municipalities, 109 municipalities had prepared annual plans, 37 municipalities prepared shorter plans for less than one-year period. Another 45 municipalities had periodic plans for the waste management. The surveyed municipalities differed in terms of having their plans and strategies and their implementation. Out of the total, 99 (36.5%) municipalities reported for having their plans and strategies on waste management against 57.2% of the municipalities without having such plans and strategies. Among the 271 municipalities, only 54 (19.9%) reported to have prepared the procedures (guidelines) for waste management.

In the present governance structure, waste management is largely the responsibility of the local governments. For the solid waste management, the local governments require adequate resources like human and financial resources. The survey revealed that 257 (94.8%) municipalities were expecting funds from the federal and provincial governments indicating resource constraint with municipalities. The surveyed municipalities reported that they have considered waste management as a major challenge. Out of the total, 247 municipalities reported solid waste management as the challenges. Among them, 147 (59.5%) municipalities reported the municipal waste management as a major challenge, 122 (49.4%) municipalities reported low awareness to be the major challenge, and 113 (45.8%) municipalities reported lack of the landfill sites as the major challenge of waste management.

It is expected that waste generation is likely to increase in the years to come and Nepal might face substantial challenge in managing these wastes with the existing waste management mechanisms. The government therefore needs to develop effective waste handling procedures and strengthen institutional mechanisms to respond solid waste management challenges. Moreover, there is also need to strengthen the capacity of the municipalities in waste data handling and management.

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Abbreviations

ADB	Asian Development Bank
BS	Bikram Sambat
CBS	Central Bureau of Statistics
CSPro	Census and Survey Processing System
EIA	Environmental Impact Assessment
e-waste	Electronic and Electrical Waste
FDES	Framework for the Development of Environment Statistics
FY	Fiscal Year
GoN	Government of Nepal
HHs	Households
ha	Hectare
IEE	Initial Environmental Examination
km	Kilometer
m	Meter
MSW	Municipal Solid Waste
mt	Metric Ton
NPC	National Planning Commission
NRs	Nepalese Rupees
SDGs	Sustainable Development Goals
SWM	Solid Waste Management
UNDP	United Nation Development Program

1. INTRODUCTION

1.1 BACKGROUND

Solid Waste Management (SWM) is a crosscutting issue that impacts various areas of sustainable development. The SWM strategies and approaches affect ecological, economic and societal sustainability domains of each country (Rodic & Wilson, 2017). The SWM may affect livelihood, sanitation, public health, freshwater and terrestrial ecosystems, access to decent jobs and sustainable use of natural resources which are intricately linked with societal wellbeing. Thus, Government of Nepal (GoN) has given high priority in SWM. Accordingly, GoN has taken various initiatives in devising appropriate policies, programmes, institutional and financial arrangements to accelerate implementation of the Sustainable Development Goals (SDGs) in Nepal. The National Planning Commission (NPC) is the focal institution for the SDG monitoring for achieving the set goals and targets. GoN has set number of goal and targets as well as key milestones and achievements for the 2015-2030 period. It is expected that the public, private and cooperative sectors will work together to enhance commitments to achieve social, economic and environmental goals and targets set by the SDGs in Nepal.

In Nepal, the local governments are facing serious challenges to manage solid waste generated in the cities, and keep cities clean. Among the 753 local governments, 293 are urban that include metropolitan and sub-metropolitan cities, and municipalities, and rest 460 are rural municipalities (CRISIL, 2020). Among other, the SWM is one of the most prioritized responsibilities of the local governments. The Solid Waste Management Act, 2068 of Nepal has made the local governments responsible for the operation and management of infrastructure for collection, treatment and final disposal of the Municipal Solid Waste (MSW). Yet, it has largely remained a socially complex and technically ever-challenging task for the municipal authorities due to limited information on solid waste status, inadequate financial resources and insufficient well-trained human resources to address the issue. After state re-structuring, the most of the newly constituted municipalities are managing MSW on temporary basis due to lack of engineered, well planned SWM facilities to manage the wastes utilizing the sustainable management options. Many municipalities still lack integration of SWM issues in their periodic plan, strategic plan and action plans. The quantity of solid waste is increasing every year in all municipalities as well as newly emerging cities mainly due to rapid urban population growth, market development and changing lifestyles.

The Central Bureau of Statistics (CBS), the central authority for the collection, analysis, publication and dissemination of statistics in Nepal, has executed the waste management baseline survey in 293 municipalities (except rural municipalities) of Nepal in 2019/20. The survey was carried out with the major aim to derive systematic and comprehensive data and information on quantity and composition of collected solid wastes, and solicit other vital information on the state of SWM in the municipalities of Nepal. The baseline assessment is expected to provide support in finding appropriate low cost, locally appropriate, sustainable waste management solutions and to provide sustainable development benefits and ultimately create transformational change towards low carbon, resource efficient and climate resilient, sustainable cities. The present document briefly discusses the finding of the survey and also reviews the current policies and legal frames pertaining solid waste management.

1.2 POLICIES AND LEGISLATIVE FRAMEWORKS

The GoN is fully committed for the management of solid wastes in the country. The issue of waste disposal and management has been a major problem in most of the municipalities. Though the municipalities have placed waste disposal and management in high priority, many of them have not been able to handle their waste effectively primarily due to inadequate resources and technologies. Nevertheless, the GoN has formulated several policies and legislative frameworks for waste disposal and management which are briefly discussed in the following sections.

Solid Waste Management National Policy, 2053 (1996)

The national policy on solid waste management provides broader framework for the government including local government to manage the solid waste at local level. The main objectives of the policy are:

- To make solid waste management simple and effective,
- To minimize environmental pollution caused by the solid wastes and adverse effect and thereof to the public health,
- To mobilize the solid wastes as resources,
- To privatize the solid waste management, and
- To obtain public support by increasing public awareness in sanitation works.

The national policy on solid waste management is directed towards making the then local bodies competent in wastes management and enhancement of their capacity to provide more skilled human resources and effective sanitation services.

Clause 5.1 of the policy clearly spells out the involvement of the local level institutions in solid waste management. The policy stipulates that there shall be a separate unit concerning sanitation works in each municipal corporation, sub-municipal corporations, municipalities, and town-oriented the then village development committees where the solid wastes management has become a problem. The local body shall operate its works in close co-ordination with the national level institutions concerning solid waste management maintained by the then His Majesty's Government (now named as Government of Nepal). The responsibilities of those institutions include collection, preservation, mobilization, site management, transportation and final disposal of solid wastes in collaboration with the private sector, if necessary.

Solid Waste Management Act, 2068 (2011)

The Solid Waste Management Act, 2068 is the governing legislative statute that provides regulatory guidance for the solid waste management in the country. The Act is explicit on various aspects of waste management with clearly outlined roles and responsibilities on the solid waste management from central to local level. Chapter 1, Clause 2 (aa) defines the "Local Body" as concerned municipality, sub-municipality, city and the then Village Development Committee whose roles are critical in solid waste management. Chapter 3 of the Act charts out the responsibilities of local bodies in the solid waste management as follows.

- The local body shall be responsible for the management of solid waste by construction and operation of infrastructure like transfer station, landfill site, processing plant, compost plant, biogas-plant and also collection of waste, final disposal and processing,
- The local body shall be responsible for the arrangement of the solid waste collected in the course of cleaning, throwing or placing solid waste at the collection centre, transfer station or processing site, or its use in other ways.

Local Government Operation Act, 2074 (2018)

The waste management activities at the local level are largely guided by the Local Government Operation Act, 2074. The functions, roles and responsibilities of local government have been clearly spelled out in Section 3 of the Act. Clause 1.1 of the Chapter specifies the roles and responsibilities of the local governments. Sub-clause "Jha" of the clause specifies fundamental health and sanitation with particular focus on the followings.

- Awareness raising on sanitation and waste management,
- Collection, re-use, re-cycle and disposal of waste and fixation of tariff and its regulation,
- Coordination, collaboration and partnership with private sector and non-government agencies for waste management.

Clause 12 (Sub-clause 11) of the Act outlines that the Ward Committee of the local government about the collection and management of household level wastes, sanitation of Chowks and Gallies, sewerage management, management of dead animals, drainage of surface water and conservation of water sources. Likewise, Clause 26 states about partnership and collaboration by the municipalities for the disposal of wastes or development and operation of waste management system.

National Climate Change Policy, 2076 (2019)

The government of Nepal has issued the National Climate Change Policy, 2076 with the objective of providing policy guidance to government bodies for reducing the impact of climate change and developing climate resilient society. The goal of this policy is to make contribution to socio-economic prosperity of the nation by building climate resilient society. Section 8.7 of the policy contains health, drinking water and sanitation under which strategies and working policies (C) specifies that emphasis will be given to the proper management of harmful and hazardous waste and the use of biodegradable waste for energy production by segregating the wastes generated by households, hotels and hospitals at their sources.

Environmental Protection Act, 2076 (2019)

Environmental Protection Act, 2076 came into force recently by amending and consolidating the prevailing laws on environmental protection. The Act envisages:

- To protect the fundamental right of each citizen to live in a clean and healthy environment,
- To provide the victim with compensation by the polluter for any damage resulting from environmental pollution or degradation,
- To maintain a proper balance between environment and development,
- To mitigate adverse environmental impacts on environment and biodiversity, and
- To face the challenges posed by climate change.

Chapter-2 of the Act has provisioned for an Environmental Study, including Initial Environmental Examination (IEE) report and/or Environmental Impact Assessment (EIA) for a development project which shall be submitted and approved from the relevant authorities such as the Investment Board and/or by the Ministry of Forests and Environment of the GoN. Similarly, Chapter-3 refers about "Pollution Control" whereby the Government publishes notification in the Nepal Gazette, may determine necessary standards for the mitigation of the impacts of vehicular pollution, and pollution from equipment, industrial enterprises, hotels, restaurants or other places or from the disposal or emission of hazardous substances. According to sub-section-2, no person shall create pollution in such a manner as to cause significant adverse impacts on the public life, public health and environment or commit any act contrary to the standards determined by the Government of Nepal pursuant to sub-section-1.

Sustainable Development Goals (SDGs), 2016-2030

The SDG-11, target 6 stipulates to reduce the adverse per capita environmental impact of cities by paying special attention to air quality, and municipal and other waste management. In accordance with SDG-11, target 6, Nepal has set two targets and indicators in the municipal waste management. These targets include i) percentage of municipalities with sewerage services reaching 100% by 2020, and ii) private hospitals segregating waste attaining 100% by 2017.

1.3 SCOPE OF THE WORK

The present baseline survey of the solid waste management in the different municipalities of Nepal mainly consisted of two parts. The first part includes survey management for 293 municipalities and the second part includes data entry and analysis on MSW quantity and composition.

1.3.1 Survey Management

CBS conducted the waste management baseline survey in 2019/20 with the major aims of generating the baseline data and information on SWM including the quantity and composition of MSW, and other vital information about the state of SWM in different municipalities of

Fig 1.1: Distribution of the municipalities by their types

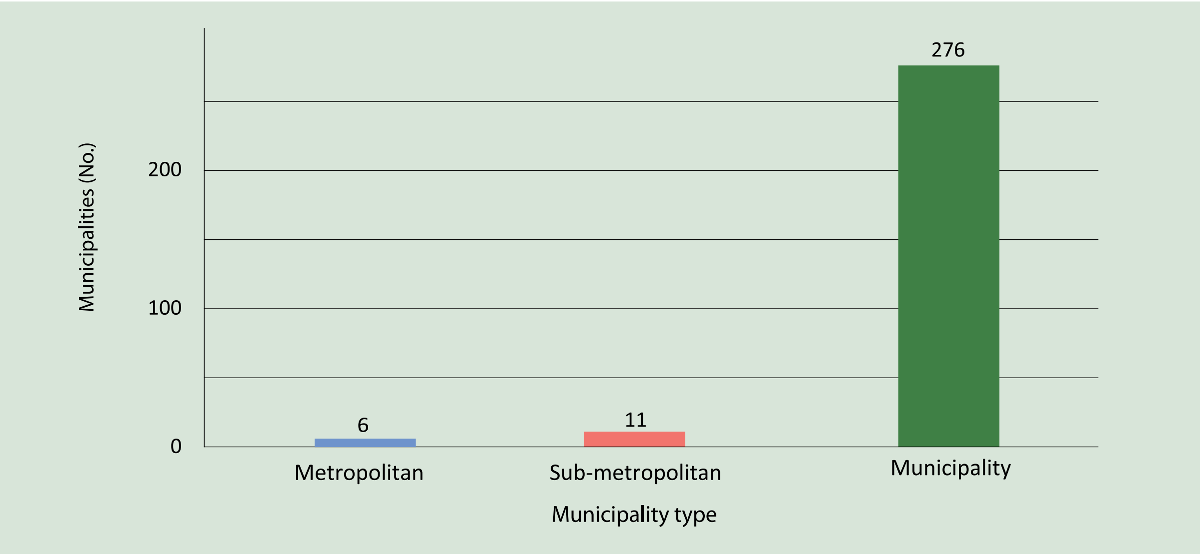


Table 1.1: Summary of Participating and Not Participating Municipalities

Type of Municipalities	Participating (%)	Not Participating (%)	Municipalities (No.)
Metropolitan City	5 (83.3)	1 (16.7)	6 (100)
Sub-metropolitan City	11 (100.0)	0 (0.0)	11 (100)
Municipality	255 (92.4)	21 (7.6)	276 (100)
Overall	271 (92.5)	12 (7.5)	293 (100)

Note: Figures in parenthesis indicate percentage.

Nepal. The study also aims to contribute in developing the SDG indicator 11.6.1 "Proportion of municipal solid waste collected and managed in controlled facilities out of the total municipal waste generated by cities", to develop the statistics on the solid waste sector in accordance with the Framework for the Development of Environment Statistics (FDES), and to provide recommendation for appropriate low cost and locally appropriate sustainable waste management solutions and ultimately create transformational change towards low carbon, resource efficient, climate resilient and sustainable cities.

During the course of survey, in the first phase, CBS organized a consultation workshop with the stakeholders for identifying the required information and availability of data in municipalities. Then the questionnaire was drafted in consultation with the experts working in the waste sector. The questionnaire was then tested in different places to collect the comments and feedback for improvement. The major contents of the questionnaire include: land use information, organizational, managerial and financial information, composition and collection of solid waste, information about transfer station, landfill site and challenges/needs of the municipal waste management. After finalizing the questionnaire, training was organized for supervisors and enumerators for making them acquaint about survey protocols to be adapted during field data collection. The field survey was planned for 293 municipalities (6 were metropolitan city, 11 were sub- metropolitan city and 276 municipalities) of Nepal (Figure 1.1). But of total, responses were not obtained from 22 municipalities, therefore only 271 municipalities data were used to prepare this report (Table 1.1). In addition, though 271 municipalities participated in the survey process, for some of the questions, responses were not obtained from all the municipalities.

1.3.2 Data Entry

Data entry programme was developed in the Census and Survey Processing System (CSPro). The data entry was based on double entry method. The CSPro comparison facility was used to ensure that the forms are entered correctly. Any inconsistencies identified were verified with the questionnaire filled by the municipalities.

1.3.3 Data Analysis

The data was analyzed by integrating the Visual FoxPro and the Microsoft Excel to produce the summary tables in the Microsoft Excel in an automated method. The data was tabulated with disaggregated output data on the basis of ecological zones (mountain, hill and Terai) and types of municipality (Metropolitan City, Sub-Metropolitan City and Municipality). All the charts presented in the report were prepared in the R-software, version 3.5.1 (R Core Team, 2016).

1.3.4 Limitations of the Survey

The survey aimed to cover 293 municipalities of Nepal. However, responses were not obtained from some of the municipalities, therefore, during data analysis only 271 municipalities were considered. In addition, about 80% of the municipalities formed after state re-structuring in 2070 BS do not have enough physical infrastructure and mechanisms for waste handling, management and record keeping system. Thus, from those municipalities, responses for some key questions were not obtained. Moreover, there was large variation in information among municipalities; thus average values of waste collections might have been overestimated or underestimated when relating it to a particular municipality's data.

II. SURVEY FINDINGS

2.1 GEOGRAPHICAL CHARACTERISTICS

In the present federal structure, Nepal has a total of 753 local governments including metropolis, sub-metropolis, municipalities and rural municipalities. Among the total, the metropolis, sub-metropolis and municipalities account to be 293 with 6 metropolitan cities, 11 sub-metropolitan cities and 276 municipalities. The six metropolitan cities are Kathmandu, the federal capital of the country, Lalitpur, Pokhara, Bharatpur, Birgunj and Biratnagar.

2.1.1 Distribution of the Municipalities

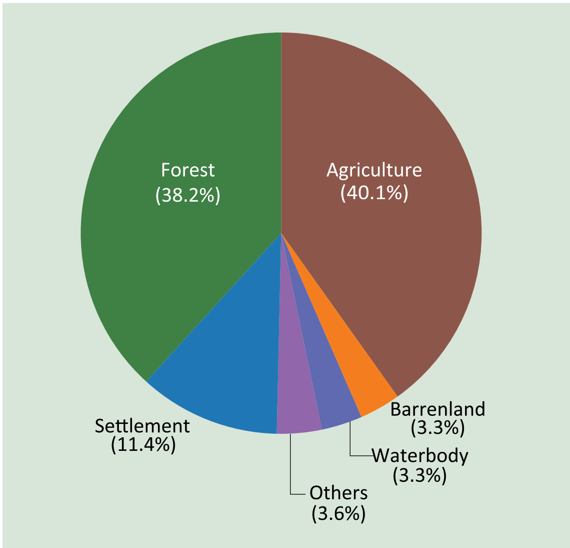
Geographically, the municipalities of Nepal are located in three different ecological zones, namely mountains, hills and Terai. Among the 271 municipalities considered in this study, the highest numbers (133) are located in Terai followed by hills (112) and mountains (26). Provincially, the Province-2 include the highest (60) number of municipalities followed by Province 1 (49) and Karnali Province (25).

In terms of area, the municipalities showed considerable variation in their size. The average area of 271 municipalities was 155.5 sq. km with higher (231.2 sq. km) average area for the metropolitan cities and lower average area (151.3 sq. km) for the municipalities. The average area for sub-metropolitan city was 219.7 sq. km. Among the 5 metropolitan cities considered for the present survey, 2 had land areas greater than 400 sq. km. Area wise, the large number (114) accounting 42.1% of municipalities fall under the area range of 200-300 sq. Km and only 1 sub-metropolitan city and 4 municipalities were having area above 500 sq. km. Among the 271 municipalities considered, 28 were established before 2051 BS, 24 municipalities were established in between 2051 BS and 2070 BS, and 219 municipalities after 2070 BS.

2.1.2 Land Use and Natural Resources

In terms of the land use, the lands within municipalities were categorised under six different types, viz. settlement, agriculture, forest, water body, barren land, and others. The highest (38.2%) proportion of municipal land is covered by forest followed by agriculture (40.1%), settlement (11.4%), other uses (3.6%), and water bodies and barren land (3.3% each). Among sub-metropolitan cities, metropolitan cities and municipalities, the distribution of land under settlement were 21.1%, 14.8% and 11.1%, respectively. Agricultural land area is still higher in metropolitan cities (53.2%), while the forest coverage is higher among the municipalities (38.7%).

Fig 2.1: Land Use Pattern of the Municipalities



2.2 INSTITUTIONAL CAPACITY

The municipalities have important role in the waste management of the urban areas. However, the different municipalities have varying capabilities for waste handling and management in terms of institutional frameworks and settings. Among the surveyed municipali-

Table 2.2: Number of Total Municipal Human Resources of the Municipalities

Categories	Average Number of Human Resources		
	Male	Female	Total
Metropolitan City	316.0 (66.2)	161.3 (33.8)	477.3 (100.0)
Sub-Metropolitan City	223.8 (71.2)	90.5 (28.8)	314.3 (100.0)
Municipality	68.8(69.5)	30.2 (30.5)	98.9 (100.0)
Overall	79.1 (69.5)	34.7 (30.5)	113.8 (100.0)

Note: Figures in parenthesis indicate percentage.

ties, only 103 (38.0%) municipalities reported to have separate units/divisions to look after waste management. Among them, 129 (47.6%) municipalities reported lack of such units/divisions, whereas 39 (14.4%) municipalities did not report about institutional capacity for the waste management. Details of the institutional features and capacities are presented in the following sub-sections.

2.2.1 Human Resources

The survey revealed that the average human resources available with the municipalities were 114 (Table 2.2). The metropolitan cities hold higher number of human resources (averaging 477 persons) compared to the sub-metropolitan cities and the municipalities. In the municipalities, 69.5% of the human resources available represented males and the rest females. Out of the total human resources, working in the waste management sector was reported to be16 persons. The human resources working in waste management largely represented males accounting 76% (Table 2.3).

The average number of human resources assigned for waste management in the metropolitan cities was 118, followed by 59 and 12 in the sub-metropolitan cities and municipalities, respectively (Figure 2.2). Gender wise, males were higher than females in all the municipalities (Table 2.3). Among the females, share of females working in waste management was higher (38%) in the metropolitan cities compared to the sub-metropolitan cities and municipalities.

In the municipalities, the human resources having engineering background recruited were environmental, civil and mechanical engineers. The survey revealed limited technical human resources in the municipalities. The average numbers of environmental, civil and mechanical

Table 2.3: Human Resources Working in Waste Management

Categories	Average Number					
	Male		Female		Total	
	No.	%	No.	%	No.	%
Metropolitan City	74	62	45	38	118	100.0
Sub-Metropolitan City	47	80	12	20	59	100.0
Municipality	9	78	3	22	12	100.0
Overall	12	76	4	24	16	100.0

Table 2.4: Municipalities Reporting Human Resource Working on Waste Management by Positions

Positions	Number of Municipalities Reporting			Average Number of Human Resources		
	Male	Female	Total	Male	Female	Total
Environmental Engineer	11(73.3)	4 (26.7)	15(5.5)	0.04 (73.3)	0.01 (26.7)	0.06 (100.0)
Civil Engineer	71 (100.0)	1 (1.4)	71(26.2)	0.42 (96.6)	0.01 (3.4)	0.44 (100.0)
Mechanical Engineer	5 (100.0)		5 (1.9)	0.03 (100.0)	-	0.03 (100.0)
Environmental Officer	43 (93.5)	4 (8.7)	46 (17.0)	0.17 (92.0)	0.01 (8.0)	0.18 (100.0)

Positions	Number of Municipalities Reporting			Average Number of Human Resources		
	Male	Female	Total	Male	Female	Total
Sub-engineer	59 (93.7)	13 (20.6)	63 (23.3)	0.48 (86.6)	0.07 (13.4)	0.55 (100.0)
Supervisor	70 (95.9)	5 (6.9)	73 (26.9)	0.60 (97.0)	0.02 (3.0)	0.62 (100.0)
Mechanics	12 (100.0)		12 (4.4)	0.07 (100.0)	-	0.07 (100.0)
Driver	197 (100.0)	1 (0.5)	197 (72.7)	2.29 (99.8)	0.00 (0.2)	2.30 (100.0)
Helper	135 (97.8)	31 (22.5)	138 (50.9)	2.06 (87.7)	0.29 (12.3)	2.34 (100.0)
Sweeper	134 (83.2)	103 (64.0)	161 (59.4)	4.55 (66.5)	2.29 (33.5)	6.85 (100.0)
Municipal (Nagar) Police	69 (98.6)	40 (57.1)	70 (25.8)	1.72 (83.7)	0.34(16.3)	2.06 (100.0)
Other	38 (88.4)	22 (51.2)	43 (15.9)	1.22(71.0)	0.50 (29.0)	1.72 (100.0)
Overall	228 (98.3)	144 (62.1)	232 (85.6)	13.66(79.4)	3.55 (20.7)	17.21 (100.0)

Note: Figures in parenthesis indicate percentage.

engineers available with the municipalities were very low. These numbers account about 1 engineer for 17 municipalities, less than 1 civil engineer for 2 municipalities and about 1 mechanical engineer for 34 municipalities. Similarly, each municipality lacks Environmental Officers which equates to about 1 environmental officer for 6 municipalities. The numbers of sub-engineer and supervisor were relatively high. Staffs like driver, helper, sweeper, etc. were relatively high in the municipalities. Among other, the sweepers accounted highest figure in all the municipalities with average ~ 7 per municipality or more than one third among the total human resources working in waste management sector (Table 2.4). Female workers represented mostly the lower level staff mainly working in city sanitation such as sweeping and cleaning. Gender wise, males were higher than females in all the positions. In overall, female employees accounted for about 20% of the total human resources working in waste management.

2.2.2 Annual Expenses

The annual average expenditures of the municipalities for three consecutive years amounted to Rs 363.1 million in 2074/75, which increased to Rs 691.8 million in 2075/76 and Rs 702.8 million in 2076/77 (Table 2.5). The information obtained regarding the annual expenditures made on en-

Table 2.5: Annual Expenditure of the Municipalities and Expenditure on Environment Sector

Categories	Average Annual Expenditure (Rs)		
	FY 2074/75	FY 2075/76	FY 2076/77 (Provisional)
Metropolitan City	3,541,894,360	5,535,409,971	5,494,277,346
Sub-Metropolitan City	500,320,043	1,237,202,831	1,379,133,620
Municipality	294,875,694	573,292,802	579,770,661
Overall	363,122,857	691,793,157	702,890,683
Average Annual Expenditure on Environment Sector (Rs)			
Metropolitan City	249,123,000	309,275,700	256,641,000
Sub-Metropolitan City	5,783,008	14,053,747	18,682,944
Municipality	1,658,411	4,732,922	4,803,750
Overall	6,426,788	10,774,717	10,052,290
Budget on Environment as % of Total Municipal Budget			
Metropolitan City	7.03	5.59	4.67
Sub-Metropolitan City	1.16	1.14	1.35
Municipality	0.56	0.83	0.83
Overall	1.77	1.56	1.43

Table 2.6: No. and Percentage of Municipalities Collecting Waste Collection Charge from the Waste Producers

Categories	Households	Office/ Institutions	Hotel/ Restaurant	Business house/ Commercial complex	Health Institutions/ Hospitals	Other specify	Total Reporting (N)
Metropolitan City	80.0	60.0	80.0	60.0	60.0	20.0	5
Sub-Metropolitan City	87.5	87.5	100.0	87.5	75.0	25.0	8
Municipality	94.3	70.0	91.4	82.9	65.7	24.3	70
Total/ Overall	92.8	71.1	91.6	81.9	66.3	24.1	83

vironmental sector were from 187, 239 and 252 municipalities for the year 2074/75, 2075/76 and 2076/77, respectively. The annual expenditures of the municipalities increased considerably over three years. The substantial increment in the expenditure in 2075/76 and 2076/77 reflect increased budgetary allocations after the execution of federal system under which local governments (municipalities) have increased roles in resource generation, budget allocation and utilization from their own sources.

The municipality's expenditure on the environment sector as percentage of the total expenditure varied markedly across the three types of municipalities. The expenditures of metropolitan cities on environmental sector were in the range of 4.7% to 7.0% of the total budget during the last three years. The corresponding values for sub-metropolitan cities were in the range of 1.1% to 1.4%, while that of municipalities was less than 1% for the years.

2.2.3 Sources of Revenue

In order to manage their wastes, the municipalities generated their resources through different sources. The large share of the municipalities' resources was obtained from the federal government, while limited revenue was generated from other sources. Out of the total, only 83 (30.6%) municipalities collected fees locally for waste management (Table 2.6). These included 5 metropolitan cities, 8 sub-metropolitan cities and 70 municipalities. The survey revealed that 112 (41.3%) municipalities were not collecting any fees, whereas 152 (56.1%) municipalities did not report about fee collection. The information indicates the possibility of revenue generation at local level by the municipalities for waste management.

The municipalities collected fees or charges against waste collection from various sources such as households, office/institutions, hotel/restaurants, business/commercial entities, health institutions, etc. Among the municipalities surveyed, all metropolitan cities (100%) collected fees from one or other sources, whereas 72.7% sub-metropolitan cities and only 27.5% municipalities collected fees from the above mentioned sources.

The monthly waste collection charges or service charges varied among three categories of the municipalities and also by sources. In general, the waste collection charges ranged from NRs 30/month per household to NRs 317/month for health institution. The waste collection charges

Table 2.7: Average Amount of Service Charge Collected

Categories	Households (Rs/Month)	Office/ Institutions (Rs/Month)	Hotel/ Restaurant (Rs/Month)	Business house/ Commercial complex (Rs/Month)	Health Institutions/ Hospitals (Rs/Month)	Other (Rs/ Month)
Metropolitan City	138	200	780	180	1128	300
Sub-Metropolitan City	106	764	986	2,500	909	91
Municipality	25	35	84	49	275	97
Overall	30	68	134	151	317	100

Table 2.8: Annual Revenue from Waste Collection Charge

Categories	Number of Municipalities Reporting		
	FY 2074/75	FY 2075/76	FY 2076/77
Metropolitan City	2 (40.0)	2 (40.0)	2 (40.0)
Sub-Metropolitan City	3 (27.3)	4 (36.4)	4 (36.4)
Municipality	31 (12.2)	55 (21.6)	59 (23.1)
Total	**36 (13.3)**	**61 (22.5)**	**65 (24.0)**
Average Annual Revenue (Rs)			
Metropolitan City	1,075,088	9,478,181	7,661,095
Sub-Metropolitan City	2,443,548	1,815,419	1,929,227
Municipality	835,488	930,273	940,071
Overall	964,394	1,360,198	1,335,481

Note: Figures in parenthesis indicate percentage.

in the metropolitan cities were higher (NRs 138) for households, NRs 1128 for health institutions/hospitals and NRs 300 for others; whereas sub-metropolitan cities charged higher (NRs 764) fees for the office/institutions, NRs 986 for hotels/restaurants, and NRs 151 for business/commercial complex (Table 2.7). In compared to the metropolis and sub-metropolis, the municipalities were charging less for all the sectors.

The overall annual revenue generated by the municipalities from waste collection amounted to NRs 0.96 million in 2074/75 which rose to NRs 1.36 million in 2075/76 (Table 2.8). However, this (provisional) amount decreased marginally to NRs 1.34 million in 2076/77. By the type of the municipalities, the annual revenues generated were higher among the metropolitan cities followed by the sub-metropolitan cities and the municipalities, including the provisional amount estimated for 2076/77.

The municipalities, although very small, also generated some revenue from fines and penalties charged against violation of the waste collection and management practices. The overall revenue collected under the fine and penalty was NRs 10362 in 2074/75 which increased marginally to over NRs 11000 in 2075/76 and fell down again to an estimated NRs 9582 in 2076/77 (Table 2.9). The amounts were higher for metropolitan cities for all the three years as compared to the sub-metropolitan cities and the municipalities.

At present, for the municipalities, grants from the federal and provincial governments are the major sources of revenue. However, there is limited information about the budget/revenue that municipalities have received from the federal and provincial governments. The survey showed information not available on the grants received by the metropolitan cities; whereas the provisional grant amount to a sub-metropolitan city was NRs 2.58 million for the year 2076/77 (Table 2.10). The average grant provided to the municipalities ranged from NRs 0.3 million to nearly NRs 0.6 million.

Table 2.9: Annual Revenue from Fine and Penalty

Categories	Number of Municipalities Reporting			Average Annual Revenue (NRs)		
	FY 2074/75	FY 2075/76	FY 2076/77	FY 2074/75 Actual	FY 2075/76 Actual	FY 2076/77 Provisional
Metropolitan City	2 (40.0)	2 (40.0)	2 (40.0)	91,200	124,613	132,875
Sub-Metropolitan City		2 (18.2)	1 (9.1)	-	35,833	16,667
Municipality	4 (1.6)	7(2.8)	7 (2.8)	4,648	3,286	2,244
Overall	6(2.2)	11(4.1)	10(3.7)	10,362	11,054	9,582

Note: Figures in parenthesis indicate percentage

Table 2.10: Annual Revenue from Federal/Provincial Grant

Categories	Number of Municipalities Reporting			Average Annual Revenue (NRs)		
	FY 2074/75	FY 2075/76	FY 2076/77	FY 2074/75 Actual	FY 2075/76 Actual	FY 2076/77 Provisional
Metropolitan City				-	-	-
Sub-Metropolitan City			1 (9.1)	-	-	2,577,415
Municipality	6 (2.4)	8 (3.1)	9 (3.5)	354,852	443,984	430,137
Overall	6 (2.2)	8 (3.0)	10 (3.7)	305,338	388,486	564,632

Note: Figures in parenthesis indicate percentage.

In addition to the federal and provincial government's support, foreign grant was also reported as a source of revenue for the municipalities. The survey showed that only one metropolitan city received grant amounting NRs 10.9 million in 2076/77 (Table 2.11). In case of the municipalities, very few have received the grant averaging NRs 0.26 million in 2074/75, Rs 0.05 million in 2075/76 and Rs 0.22 million (provisional) in 2076/77 (Figure 2.3). The average revenue equivalent to NRs 1.7 million in the year 2074/75, increased marginally to Rs 1.97 million in 2075/76 which substantially increased to 2.79 million (provisional) in 2076/77.

During the survey, the overall average revenues showed marginal increment over the last 3 years. However, these figures showed fluctuations among different types of municipalities. The metropolitan cities reported much higher share of revenue, compared to other two categories, with significant rise over 3 years which jumped from NRs 1.17 million in 2074/75 to NRs 18.7 million (provisional) in 2076/77 (Table 2.12). In case of sub-metropolitan cities, the revenues decreased in the second year and again rose in the third year, though by a much lower proportion. Similarly, the municipalities also reported increment in their revenue during the three years period, by lower growth rate in compared to the metropolitan cities.

2.3 TYPE OF WASTE

The wastes generated by the municipalities were broadly categorized in to three types, namely the organic waste, inorganic waste and other waste. Although different categories of solid

Table 2.11: Annual Revenue from Foreign Grant

Categories	Number of Municipalities Reporting			Average Annual Revenue (NRs)		
	FY 2074/75	FY 2075/76	FY 2076/77	FY 2074/75 Actual	FY 2075/76 Actual	FY 2076/77 Provisional
Metropolitan City			1 (20.0)	-	-	10,915,313
Sub-Metropolitan City				-	-	-
Municipality	4 (1.6)	4 (1.6)	5 (2.0)	255,960	49,063	219,014
Overall	4 (1.5)	4 (1.5)	6(2.2)	220,244	42,930	718,666

Note: Figures in parenthesis indicate percentage.

Table 2.12: Annual Revenue from Waste Related Activities - Combined of all the Sources

Categories	Number of Municipalities Reporting			Average Annual Revenue (Rs)		
	FY 2074/75	FY 2075/76	FY 2076/77	FY 2074/75 Actual	FY 2075/76 Actual	FY 2076/77 Provisional
Metropolitan City	3 (60.0)	3 (60.0)	4 (80.0)	1,166,288	9,602,794	18,709,283
Sub-Metropolitan City	3 (27.3)	6 (54.6)	6 (54.6)	3,643,548	2,451,253	5,123,308
Municipality	37 (14.5)	63 (24.7)	73 (28.6)	1,657,362	1,562,848	1,731,638
Overall	43 (15.9)	72 (26.6)	83 (30.6)	1,761,672	1,971,880	2,795,018

Note: Figures in parenthesis indicate percentage.

Table 2.13: Number of Municipalities Reporting Different Types of Organic Waste Collected

Categories	Textile	Leather	Paper	Agricultural/Garden Management	Other	Total Reporting
Metropolitan City	2 (100.0)	2 (100.0)	2 (100.0)	2 (100.0)	2 (100.0)	2 (40.0)
Sub-Metropolitan City	5 (71.4)	4 (57.1)	5 (71.4)	4 (57.1)	4 (57.1)	7 (63.6)
Municipality	98 (64.5)	68 (44.7)	96 (63.2)	85 (55.9)	77 (50.7)	152 (59.6)
Overall	105 (65.2)	74 (46.0)	103 (64.0)	91 (56.5)	83 (51.6)	161 (59.4)

Note: Figures in parenthesis indicate percentage.

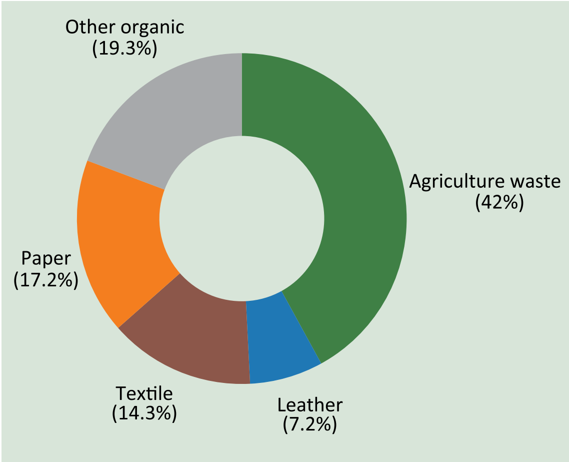
waste could be created, municipal solid wastes have been categorized in these three groups due to readily identifiable fractions, and ease of making consistent with categories cited in most researches and applications (Tchobanoglous et al., 1993). A total of 161, 164 and 140 municipalities reported organic waste, inorganic waste and other waste, respectively.

2.3.1 Organic Waste

The survey revealed organic waste as one of the major categories of waste generated from the municipalities. These categories include agricultural/garden waste, paper, textile, leather and other organic wastes (Figure 2.2). Among the 161 municipalities who reported qualitative information about the organic waste, 105 (65.2%) municipalities reported textile waste, 103 (64.0%) municipalities reported paper waste, 91(56.5%) municipalities reported agricultural/garden waste, 74 (44.7%) municipalities reported leather waste and 83 (51.6%) municipalities reported other categories (Table 2.13).

Among the different municipalities, some differences were noted on the organic waste collection. The overall annual collection of textile waste among the municipality and sub-metropolitan city averaged in the range of 106 mt to about 162 mt from 2073/74 to 2075/76 (Table 2.14). However, the average figures were con-

Fig 2.2: Overall Composition of Organic Waste in the Municipalities (2075/76)



siderably higher among the metropolitan cities in compared to the sub-metropolitan cities and municipalities. For instance, the average quantity of textile waste collection in the metropolitan cities stood at 2,514.5 mt in 2075/76 against 146.8 mt in the sub-metropolitan cities and only 124.2 mt among the municipalities.

Similarly, the average quantity of leather waste collection per municipality ranged from 114.2 mt in 2073/74 to 86.3 mt in 2075/76 (Table 2.15). The average quantity was higher among the metropolitan cities and lower among the sub-metropolitan cities during the three years period.

Table 2.14: Annual Organic Waste Collection – Textile

Categories	Number of Municipalities Reporting			Average Annual Collection of Textile (mt)		
	FY 2073/74	FY 2074/75	FY 2075/76	FY 2073/74	FY 2074/75	FY 2075/76
Metropolitan City	1 (20.0)	1 (20.0)	2 (40.0)	3,811.0	4,034.0	2,514.5
Sub-Metropolitan City	3 (27.3)	3 (27.3)	5 (45.5)	141.3	162.0	146.8
Municipality	53 (20.8)	73 (28.6)	93 (36.5)	117.0	106.3	124.2
Overall	57 (21.0)	77 (28.4)	100 (36.9)	183.1	159.5	173.1

Note: Figures in parenthesis indicate percentage.

Table2.15: Annual Organic Waste Collection – Leather

Categories	Number of Municipalities Reporting			Average Annual Collection of Leather (mt)		
	FY 2073/74	FY 2074/75	FY 2075/76	FY 2073/74	FY 2074/75	FY 2075/76
Metropolitan City	1 (20.0)	1 (20.0)	2(40.0)	2,018.0	2,136.0	1,342.0
Sub-Metropolitan City	3 (27.3)	3 (27.3)	4 (36.4)	16.3	20.3	19.8
Municipality	31 (12.2)	44 (17.3)	62 (24.3)	62.3	55.3	50.0
Overall	35 (12.9)	48 (17.7)	68 (25.1)	114.2	96.5	86.3

The survey revealed paper waste as one of the major constituents of waste material reported by the municipalities. The quantity of paper waste collected by the municipalities was increasing for the last 3 years (Table 2.16). The quantity of paper waste in the metropolitan cities was higher than that of the sub-metropolitan cities and municipalities. The survey revealed the agricultural/garden waste comprised an important fraction of waste with an average of 472.8 mt per municipality in 2073/74 which increased to 558.8 mt in 2074/75 and 506.3 mt in 2075/76 (Table 2.17). Agricultural/garden waste in this survey includes all the food related wastes from kitchen, vegetable wastes generated from vegetable markets and also the fraction of garden wastes collected from the households.

The organic waste other than paper, textile waste, agricultural waste and leather has been categorized as the other organic waste. The survey revealed that the quantity of other organic waste was higher in the range from 1243.5mt to

Table 2.16: Annual Organic Waste Collection - Paper

Categories	Number of Municipalities Reporting			Average Annual Collection of Paper (mt)		
	FY 2073/74	FY 2074/75	FY 2075/76	FY 2073/74	FY 2074/75	FY 2075/76
Metropolitan City	1 (20.0)	1 (20.0)	2 (40.0)	4,708.0	4,983.0	3,494.0
Sub-Metropolitan City	3 (27.3)	3 (27.3)	5 (45.5)	169.0	202.3	735.4
Municipality	48 (18.8)	69 (27.1)	92 (36.1)	131.7	137.9	107.1
Overall	52 (19.2)	73 (26.9)	99 (36.5)	221.8	207.0	207.3

Note: Figures in parenthesis indicate percentage.

Table 2.17: Annual Organic Waste Collection - Agricultural/Garden Management

Categories	Number of Municipalities Reporting			Average Annual Collection of Agricultural/Garden Waste (mt)		
	FY 2073/74	FY 2074/75	FY 2075/76	FY 2073/74	FY 2074/75	FY 2075/76
Metropolitan City	1 (20.0)	1 (20.0)	2 (40.0)	1,076.0	1,139.0	2,343.0
Sub-Metropolitan City	3 (27.3)	3 (27.3)	4 (36.4)	699.7	836.0	1,808.0
Municipality	45 (17.7)	63 (24.7)	79 (31.0)	444.2	536.4	393.9
Overall	49 (18.1)	67 (24.7)	85 (31.4)	472.8	558.8	506.3

Note: Figures in parenthesis indicate percentage.

Table 2.18: Annual Organic Waste Collection - Other Organic Waste

Categories	Number of Municipalities Reporting			Average Annual Collection of Other Organic Waste (mt)		
	FY 2073/74	FY 2074/75	FY 2075/76	FY 2073/74	FY 2074/75	FY 2075/76
Metropolitan City	1 (20.0)	1 (20.0)	2 (40.0)	1,121.0	1,186.0	976.0
Sub-Metropolitan City	2 (18.2)	2 (18.2)	4 (36.4)	1,243.5	1,823.5	1,378.3
Municipality	36 (14.1)	54 (21.2)	72 (28.2)	74.7	114.0	148.9
Overall	39 (14.4)	57 (21.0)	78 (28.8)	161.5	192.8	233.2

Note: Figures in parenthesis indicate percentage.

Table 2.19: Annual Average Organic Waste Collection per Municipality by Years

S.N.	Waste Type	FY	Metropolitan City	Sub-Metropolitan City	Municipality	Average
1	Textile (mt)	FY 2073/74	3,811.0	141.3	117.0	183.1
		FY 2074/75	4,034.0	162.0	106.3	159.5
		FY 2075/76	2,514.5	146.8	124.2	173.1
2	Leather (mt)	FY 2073/74	2,018.0	16.3	62.3	114.2
		FY 2074/75	2,136.0	20.3	55.3	96.5
		FY 2075/76	1,342.0	19.8	50.0	86.3
3	Paper (mt)	FY 2073/74	4,708.0	169.0	131.7	221.8
		FY 2074/75	4,983.0	202.3	137.9	207.0
		FY 2075/76	3,494.0	735.4	107.1	207.3
4	Agricultural/Garden management (mt)	FY 2073/74	1,076.0	699.7	444.2	472.8
		FY 2074/75	1,139.0	836.0	536.4	558.8
		FY 2075/76	2,343.0	1,808.0	393.9	506.3
5	Other Organic (mt)	FY 2073/74	1,121.0	1,243.5	74.7	161.5
		FY 2074/75	1,186.0	1,823.5	114.0	192.8
		FY 2075/76	976.0	1,378.3	148.9	233.2
6	Total of Organic Waste (mt)	FY 2073/74	12,734.0	2,269.8	829.8	1,153.3
		FY 2074/75	13,478.0	3,044.2	950.0	1,214.6
		FY 2075/76	10,669.5	4,088.2	824.2	1,206.1

1823.5 mt per sub-metropolitan cities in compared to the metropolitan cities (Table 2.18). The average quantity of other organic waste in the municipalities was in between 74.7 mt and 148.9 mt for the last 3 years.

The aggregated data pertaining different types of organic waste collected by the municipalities for the last 3 years revealed that the organic waste was increasing consistently over the last 3 years with higher quantity among the metropolitan cities in compared to the sub-metropolitan cities and the municipalities (Table 2.19). Among the five categories of wastes, paper, textile waste and agricultural/garden wastes were prominent in the metropolitan cities. For instance, paper and textile wastes were the major two organic wastes in the metropolitan cities amounting 3494 mt and 2515 mt, respectively in 2075/76. In sub-metropolitan cities and municipalities, agricultural/garden waste was the major waste that accounted 1808 mt and 394 mt, respectively in 2075/76. These data indicate difference in organic waste composition in different categories of the urban areas (Figure 2.3).

Fig 2.3: Composition of Organic Waste in the Municipalities (2075/76)

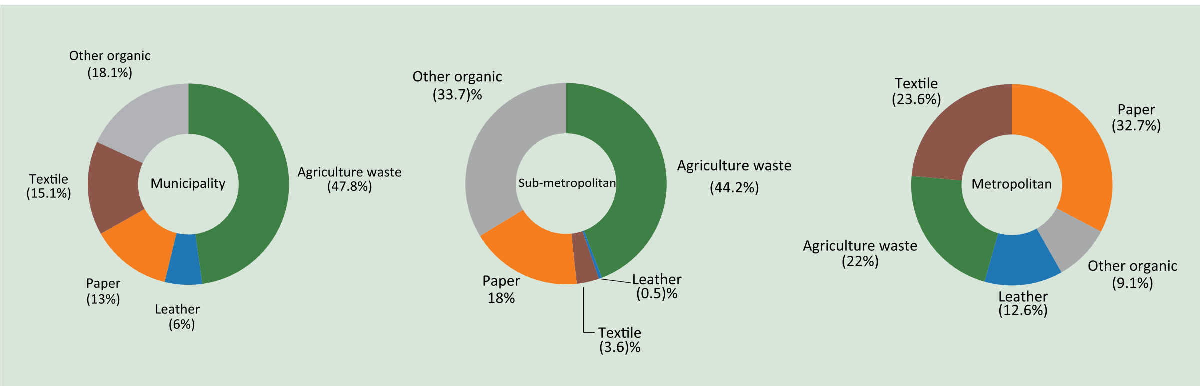
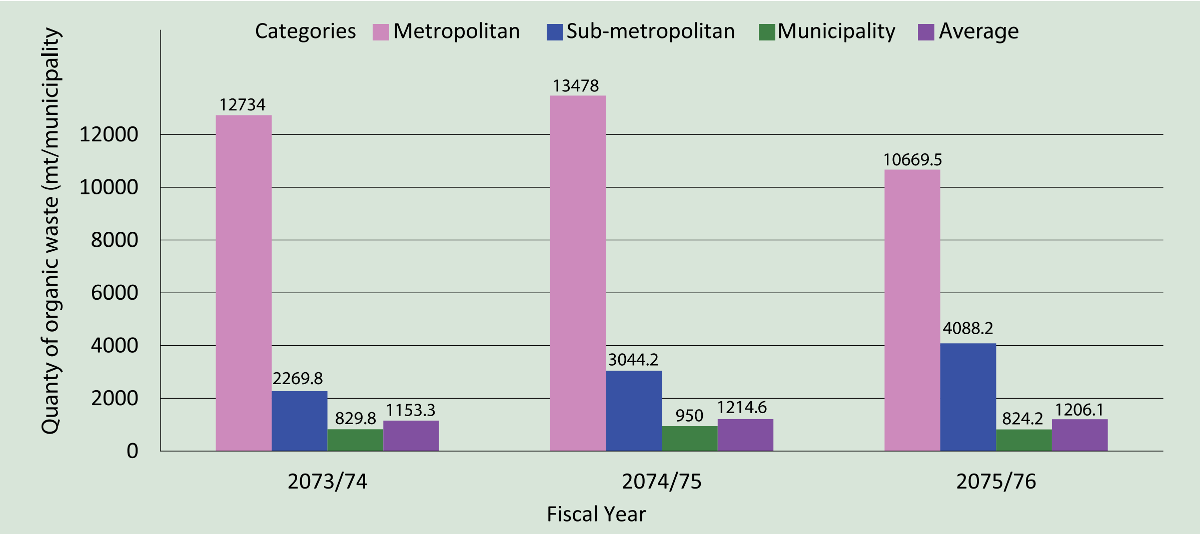


Fig 2.4: Average Annual Quantity of Organic Waste Collected by the Municipalities



The combined average quantity of organic waste varied considerably with the municipalities accounting higher share of the metropolitan cities in compared to the sub-metropolis and municipalities. The average quantity of organic waste per municipality amounted to 1153 mt in 2073/74 which increased to 1215 mt in 2074/75 and 1206 mt in 2075/76 (Figure 2.4).

2.3.2 Inorganic Waste

The survey revealed inorganic waste collected by the municipalities include plastic, glass, rubber, metals and minerals, and other inorganic waste. Among the surveyed municipalities, 164 municipalities reported about inorganic waste and these include 2 metropolitan cities, 7 sub-metropolitan cities and 155 municipalities (Table 2.20).

Among other, plastic was one of the major inorganic wastes in all the municipalities (Table 2.21). The average quantity of plastic waste was higher among the metropolitan cities as compared to the municipalities.

Like other waste components, the average quantity of glass was higher for the metropolitan cities in compared to the municipalities (Table 2.22).

Table 2.20: Number ofMunicipalities Reporting Different Types of Inorganic Wastes

Categories	Plastic	Glass	Rubber	Mineral	Other	Total Reporting
Metropolitan City	2 (100.0)	2 (100.0)	2 (100.0)	2 (100.0)	2 (100.0)	2 (40.0)
Sub-Metropolitan City	5 (71.4)	5 (71.4)	5 (71.4)	4 (57.1)	4 (57.1)	7 (63.6)
Municipality	104 (67.1)	101 (65.2)	88 (56.8)	87 (56.1)	68 (43.9)	155 (60.8)
Overall	111 (67.7)	108 (65.9)	95 (57.9)	93 (56.7)	74 (45.1)	164 (60.5)

Note: Figures in parenthesis indicate percentage.

Table 2.21: Annual Inorganic Waste Collection - Plastic

Categories	Number of Municipalities Reporting			Average Annual Collection of Plastic (mt)		
	FY 2073/74	FY 2074/75	FY 2075/76	FY 2073/74	FY 2074/75	FY 2075/76
Metropolitan City	1 (20.0)	1 (20.0)	2 (40.0)	3,950.0	4,182.0	3,172.0
Sub-Metropolitan City	3 (27.3)	3 (27.3)	5 (45.5)	716.0	930.0	803.2
Municipality	55 (21.6)	76 (29.8)	97 (38.0)	194.0	201.5	270.7
Overall	59 (21.8)	80 (29.5)	104 (38.4)	284.2	278.6	352.1

Note: Figures in parenthesis indicate percentage.

Table 2.22: Annual Inorganic Waste Collection - Glass

Categories	Number of Municipalities Reporting			Average Annual Collection of Glass (mt)		
	FY 2073/74	FY 2074/75	FY 2075/76	FY 2073/74	FY 2074/75	FY 2075/76
Metropolitan City	1 (20.0)	1 (20.0)	2 (40.0)	2,205.0	2,334.0	1,551.0
Sub-Metropolitan City	3 (27.3)	3 (27.3)	5 (45.5)	110.3	162.3	135.6
Municipality	53 (20.8)	73 (28.6)	93 (36.5)	98.4	97.4	90.4
Overall	57 (21.0)	77 (28.4)	100 (36.9)	136.0	129.0	121.8

Note: Figures in parenthesis indicate percentage.

Table 2.23: Annual Inorganic Waste Collection - Rubber

Categories	Number of Municipalities Reporting			Average Annual Collection of Rubber (mt)		
	FY 2073/74	FY 2074/75	FY 2075/76	FY 2073/74	FY 2074/75	FY 2075/76
Metropolitan City	1 (20.0)	1 (20.0)	2 (40.0)	1,746.0	1,848.0	1,281.0
Sub-Metropolitan City	3 (27.3)	3 (27.3)	5 (45.5)	54.7	75.7	67.8
Municipality	42 (16.5)	58 (22.8)	77 (30.2)	46.8	47.9	62.2
Overall	46 (17.0)	62 (22.9)	84 (31.0)	84.2	78.3	91.5

Note: Figures in parenthesis indicate percentage.

The municipalities also reported rubber as one of the major inorganic wastes. The average quantity of rubber waste was higher for the metropolitan cities ranging from 1746 mt/year in 2073/74 to 1848 mt/year in 2074/75 with a substantial fall to 1281 mt/year (Table 2.23). The amount of rubber waste was lower among the sub-metropolitan cities and municipalities as compared to the metropolitan cities.

Like other, the metals and minerals are other type of waste reported by the municipalities. The higher quantity of metals and minerals waste was collected by the metropolitan cities in compared to the sub-metropolitan cities and municipalities (Table 2.24).

The municipalities also reported other inorganic wastes. The average quantity of this waste ranged from 96.8 mt/day in 2073/74 to 90.5 mt/day in 2075/76 (Table 2.25). Like other types of wastes, this type of wastes was higher among the metropolitan cities in compared to the municipalities.

Table 2.24: Annual Inorganic Waste Collection –Metals and Minerals

Categories	Number of Municipalities Reporting			Average Annual Collection (mt)		
	FY 2073/74	FY 2074/75	FY 2075/76	FY 2073/74	FY 2074/75	FY 2075/76
Metropolitan City	1 (20.0)	1 (20.0)	2 (40.0)	427.0	875.0	656.0
Sub-Metropolitan City	3 (27.3)	3 (27.3)	4 (36.4)	61.0	82.7	102.0
Municipality	39 (15.3)	54 (21.2)	75 (29.4)	91.1	78.7	71.6
Overall	43 (15.9)	58 (21.4)	81 (29.9)	96.8	92.6	87.6

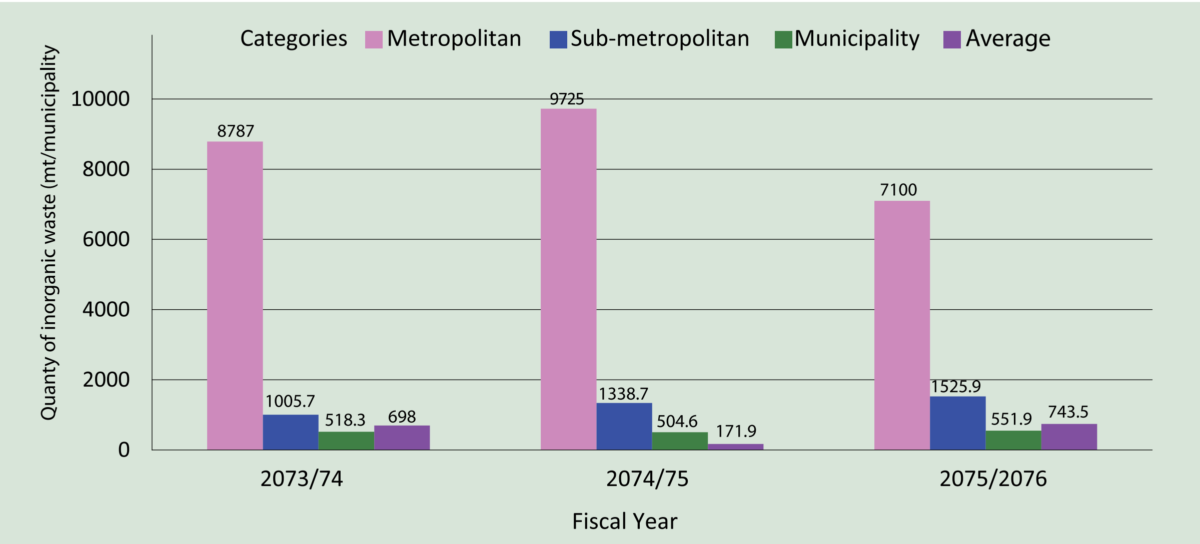
Note: Figures in parenthesis indicate percentage.

Table 2.25: Annual Inorganic Waste Collection - Other Inorganic Waste

Categories	Number of Municipalities Reporting			Average Annual Collection of Other Inorganic Waste (mt)		
	FY 2073/74	FY 2074/75	FY 2075/76	FY 2073/74	FY 2074/75	FY 2075/76
Metropolitan City	1(20.0)	1 (20.0)	2 (40.0)	459.0	486.0	440.0
Sub-Metropolitan City	3 (27.3)	3 (27.3)	4 (36.4)	63.7	88.0	417.3
Municipality	30 (11.8)	43 (16.9)	60 (23.5)	88.0	79.1	57.1
Overall	34 (12.6)	47 (17.3)	66 (24.4)	96.8	88.4	90.5

Note: Figures in parenthesis indicate percentage.

Fig 2.5: Average Annual Quantity of Inorganic Waste Collected by the Municipalities



The combined quantity of inorganic waste averaged to 698 mt in 2073/74 which was 666.8 mt in 2074/75 and about 743.5 mt in 2075/76 (Figure 2.5; Table 2.26). The figures showed higher growth rate among the metropolitan cities.

2.3.3 Other Waste

The waste like hospital waste, electronic and electrical waste (e-waste), toxic waste, other chemical waste and other wastes which are not included on the above two categories were considered as the other waste. In this survey, 140 (51.7%) municipalities reported one or other types of such wastes. The hospital waste was reported by 56% and toxic waste by 35% of the municipalities (Table 2.27).

The average quantity of wastes comprising hospital waste, e-waste, toxic and others wastes collection amounted to 380 mt in 2073/74, 283 mt in 2074/75 and 283 mt in 2075/76 (Figure 2.6). The quantity of waste collected by metropolitan cities was more than 20 times higher than the quantity collected by the municipalities. Managing these wastes poses further challenge to the respective municipalities as these wastes are riskier and more hazardous for people and the environment.

Table 2.26: Annual Inorganic Waste Collection of All Types

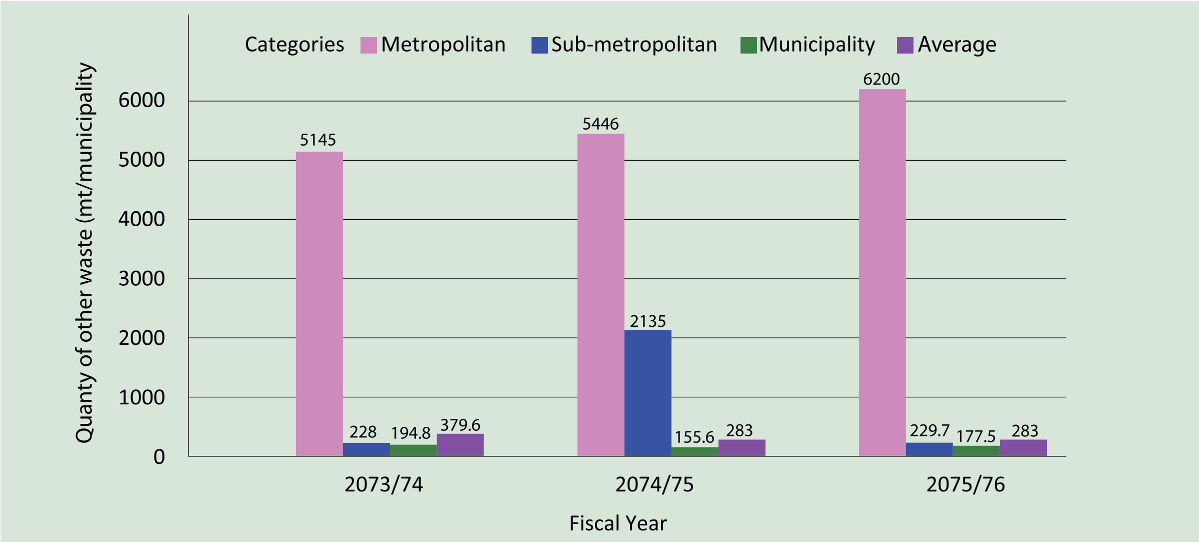
Categories	Average Annual Collection of Inorganic Waste (mt)		
	FY 2073/74	FY 2074/75	FY 2075/76
Metropolitan City	8,787.0	9,725.0	7,100.0
Sub-Metropolitan City	1,005.7	1,338.7	1,525.9
Municipality	518.3	504.6	551.9
Overall	698.0	666.8	743.5

Table 2.27: Number of Municipalities Reporting Different Types of Other Waste Collected

Categories	Toxic	Hospital Waste	Electronic and Electrical Waste	Other Chemical Waste	Other	Total Reporting
Metropolitan City	1 (33.3)	1 (33.3)	1 (33.3)	2 (66.7)	2 (66.7)	3 (60.0)
Sub-Metropolitan City	2 (33.3)	2 (33.3)	3 (50.0)	2 (33.3)	5 (83.3)	6 (54.6)
Municipality	46 (35.1)	75 (57.3)	63 (48.1)	52 (39.7)	119 (90.8)	131 (51.4)
Overall	49 (35.0)	78 (55.7)	67 (47.9)	56 (40.0)	126 (90.0)	140 (51.7)

Note: Figures in parenthesis indicate percentage.

Fig 2.6: **Other Wastes Collection by the Municipalities**



2.3.4 Total Annual Waste Collection

Table 2.28, and Figures 2.7, 2.8 and 2.9 presents comprehensive picture on waste collection by their type in the municipalities for the last three years. The data indicate that for all municipalities organic waste was higher than inorganic and other types of waste. The annual average total waste collected per municipality amounted to 2231.0 mt in 2073/74, 2164.4.0 mt in 2074/75 and 2232.7 mt in 2075/76. These figures convert to an average daily waste collection per municipality equals to 6.1 mt, 5.9 mt and 6.1 mt, respectively for the three years. By waste type, organic waste accounted higher share as compared to inorganic and other type of waste. For instance, organic waste constitutes 54.0% in 2075/76 against 33.3% inorganic waste and 12.7% other waste. ADB (2012) reported the percentage of organic waste to be 56% (excluding agriculture waste).

In terms of per capita waste generation, the Asian Development Bank reported 317 g/capita/day solid waste generation in 2012. Based on this per capita waste and the population data

Table 2.28: Annual Average Waste Collection per Municipality by Waste Types and Categories

S.N.	Waste Type	FY	Metropolitan City (mt/Year)	Sub-Metropolitan City (mt/Year)	Municipality (mt/Year)	Annual Average of Municipalities (mt/Year/Municipality)	Daily Average of Municipalities (mt/Day/Municipality)
1.	Organic	FY 2073/74	12,734.0	2,269.8	829.8	1,153.3	3.2
		FY 2074/75	13,478.0	3,044.2	950.0	1,214.6	3.3
		FY 2075/76	10,669.5	4,088.2	824.2	1,206.1	3.3
2.	Inorganic	FY 2073/74	8,787.0	1,005.7	518.3	698.0	1.9
		FY 2074/75	9,725.0	1,338.7	504.6	666.8	1.8
		FY 2075/76	7,100.0	1,525.9	551.9	743.5	2.0
3.	Other	FY 2073/74	5,145.0	228.0	194.8	379.6	1.0
		FY 2074/75	5,446.0	213.5	155.6	283.0	0.8
		FY 2075/76	6,200.0	229.7	177.5	283.0	0.8
4.	Total	FY 2073/74	26,666.0	3,503.5	1,543.0	2,231.0	6.1
		FY 2074/75	28,649.0	4,596.3	1,610.2	2,164.4	5.9
		FY 2075/76	23,969.5	5,843.7	1,553.6	2,232.7	6.1

Fig 2.7: Composition of Collected Waste for the Metropolitan Cities with Years

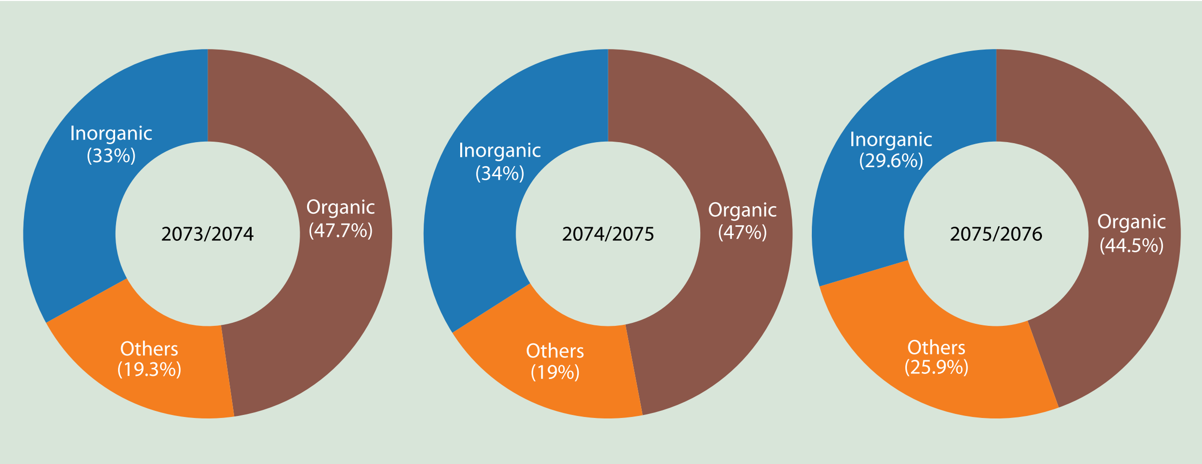


Fig 2.8: Composition of Collected Waste for the Sub-metropolitan City with Years

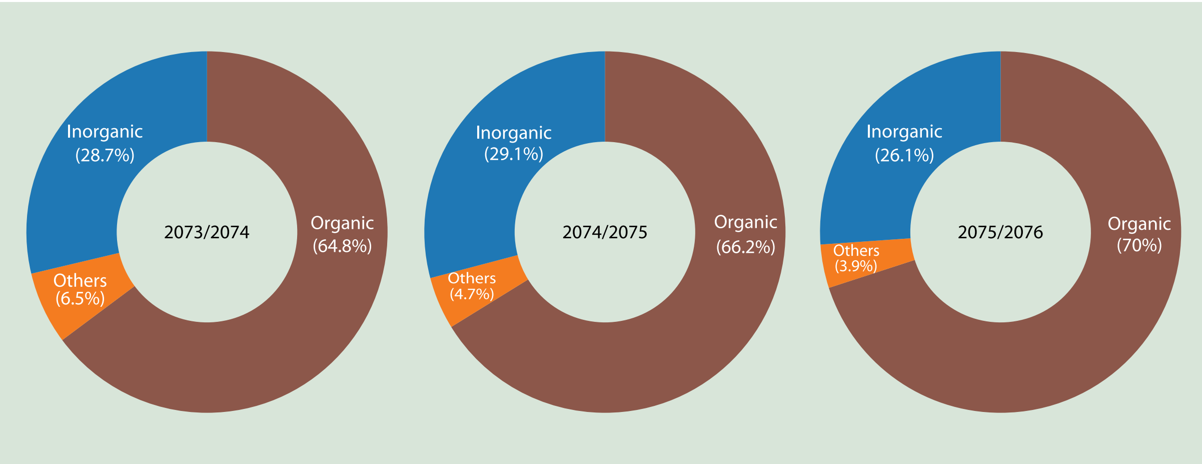


Fig 2.9: Composition of Collected Waste for the Municipality with Years

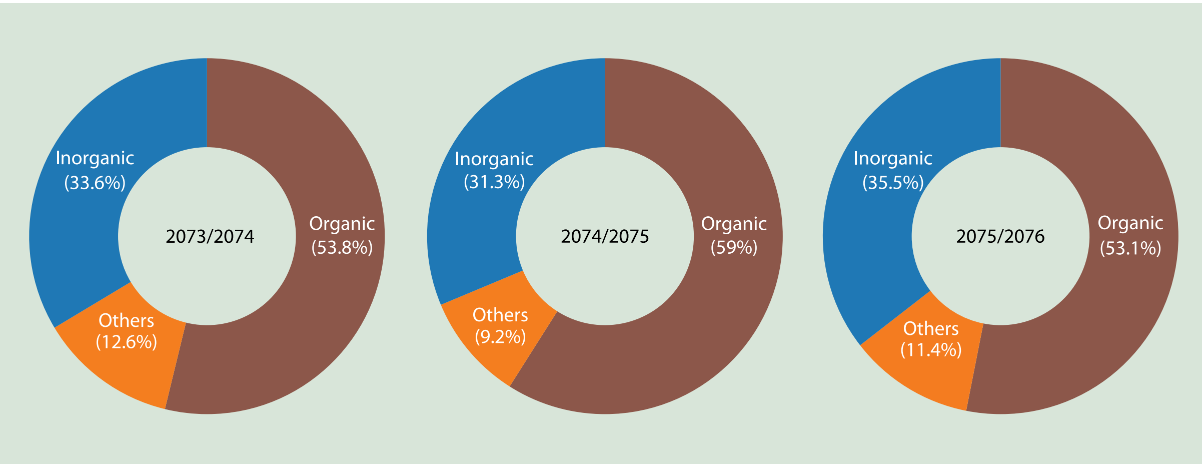


Table 2.29: Number of Municipalities Categorizing Waste

Categories	Household waste	Business house/ Commercial Complex waste	Industrial House waste	Educational Institutes waste	Health institutions/ Hospitals waste	Other	Total Reporting
Metropolitan City	3 (100.0)	3 (100.0)	3 (100.0)	3 (100.0)	3 (100.0)		3 (60.0)
Sub-Metropolitan City	7 (87.5)	8 (100.0)	5 (62.5)	8 (100.0)	6 (75.0)	6 (75.0)	8 (72.7)
Municipality	131 (94.2)	132 (95.0)	67 (48.2)	99 (71.2)	107 (77.0)	49 (35.3)	139 (54.5)
Overall	141 (94.0)	143 (95.3)	75 (50.0)	110 (73.3)	116 (77.3)	55 (36.7)	150 (55.4)

Note: Figures in parenthesis indicate percentage.

of 2011 census, the total municipal solid waste generation of the 58 municipalities was estimated to be 1,435 tons/day which equals to 24.7 mt per day per municipality or 9030 mt per year per municipality (ADB, 2013).

2.4 SOURCES OF WASTE

The municipal wastes are generated from different sources. Out of the surveyed municipalities, 3 (60%) metropolitan cities, 8 (72.7%) sub-metropolitan cities and 139 (54.5%) municipalities categorized the municipal wastes into six different categories based on the waste sources (Table 2.29). These categories include household waste, business/commercial waste, industrial waste, waste produced from educational institutions and waste from health institutions and from other sources.

The waste collected from the different municipalities varied considerably. The quantity of waste collected was higher among the metropolitan cities accounting 37300 kg/day per metropolitan city (Table 2.30). The corresponding figures were lower that account 11000 kg/day for sub-metropolitan cities and 3700 kg/day for the municipalities. Among the metropolitan cities, the quantity of daily waste collection was higher in the household (15920 kg/day), followed by business complex (7720 kg/day) and the educational institutes (4680 kg/day). Similarly, the households were the major sources of waste generation in the

Fig 2.10: Average Total Waste Collection by the Municipalities

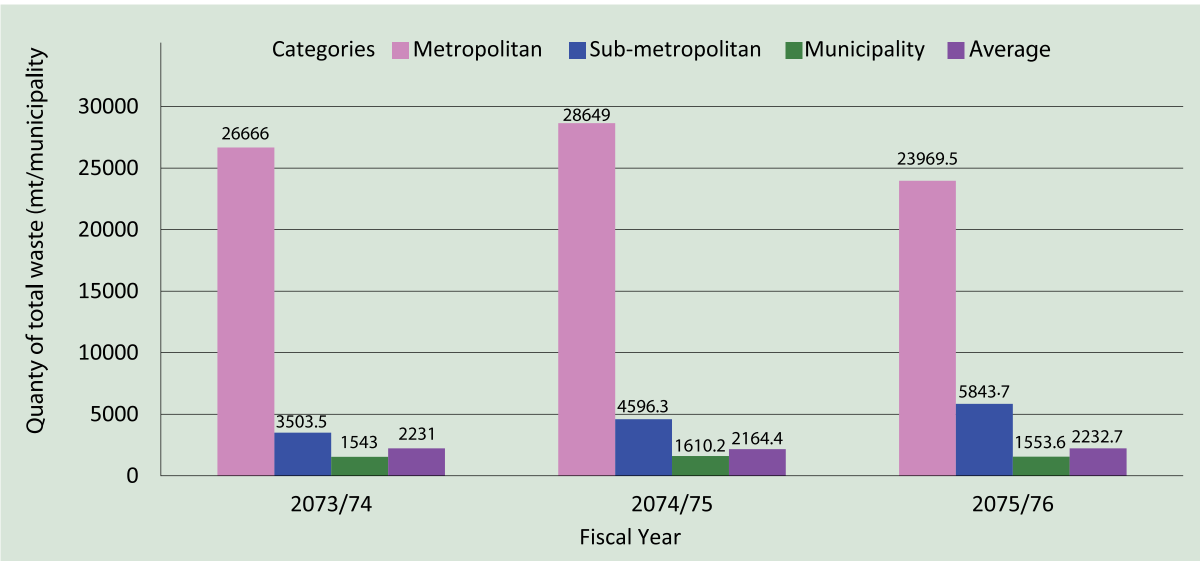


Table 2.30: Average Quantity of Waste Collected from Different Sources and Municipal Categories

Categories	Household waste (kg/day)	Business House/Commercial Complex waste (kg/day)	Industrial House/ District waste (kg/day)	Educational Institutes waste (kg/day)	Health Institutions/ Hospitals waste (kg/day)	Other(kg/day)	Total Quantity (kg/day)
Metropolitan City	15920 (42.6)	7720 (20.7)	4460 (11.9)	4680 (12.5)	4560 (12.2)	-	37340 (100.0)
Sub-Metropolitan City	3316 (30.2)	3025 (27.6)	1544 (14.1)	1322 (12.1)	594 (5.4)	1171 (10.7)	10973 (100.0)
Municipality	1441 (38.9)	932 (25.2)	310 (8.4)	358 (9.7)	381 (10.3)	282 (7.6)	3704 (100.0)
Overall	1784 (38.6)	1142 (24.7)	436 (9.5)	477 (10.3)	467 (10.1)	313 (6.8)	4619 (100.0)

Note: Figures in parenthesis indicate percentage.

sub-metropolitan cities (3316 kg/day) and the municipalities (1441 kg/day).

The quantity of daily waste collected from all sources was higher for the metropolitan cities, and the higher amount waste was originated from the households. From all sources, the daily waste collection was higher for metropolitan cities in compared to the sub-metropolitan cities and municipalities.

In terms of ecological zones, the municipalities of the Terai region were collecting the larger quantity of daily waste (5267 kg/day) followed by the hill region municipalities (4424 kg/day) and the mountain region municipalities (2147 kg/day) (Table 2.31). It is notable that municipalities in the Terai region collected more waste from the sources like business complex, industrial areas and health institutions. Among the hill region municipalities, the first and second major sources of waste were reported to be come from households (1775 kg/day) and from business house/commercial complex (1203 kg/day), respectively.

The survey findings indicate households as the first major source of waste generation which accounting 38.6% (Table 2.31). This figure however varied with the ecological regions. According to ADB (2012), the household wastes in general contribute 50% to 75% of the total MSW.

2.5 CLEANING PRACTICES

In connection to cleaning the public areas within the municipalities, 175 (64.6%) of the municipal-

Table 2.31: Average Quantity of Different Waste by Sources in Different Ecological Belts

Categories	Household waste (kg/day)	Business House/ Commercial Complex waste (kg/day)	Industrial House/ District Produced(kg/day)	Educational Institutes waste (kg/day)	Health Institutions/ Hospitals waste (kg/day)	Other(kg/day)	Total (kg/day)
Mountain	884 (41.2)	825 (38.4)	028 (1.3)	109 (5.1)	132 (6.2)	170 (7.9)	2147 (100.0)
Hill	1775 (40.1)	1203 (27.2)	419 (9.5)	264 (6.0)	370 (8.4)	393 (8.9)	4424 (100.0)
Terai	1967 (37.4)	1153 (21.9)	531 (10.1)	729 (13.8)	613 (11.6)	274 (5.2)	5267 (100.0)
Overall	1784 (38.6)	1142 (24.7)	436 (9.5)	477 (10.3)	467 (10.1)	313 (6.8)	4619 (100.0)

Note: Figures in parenthesis indicate percentage.

Table 2.32: Number of Municipalities Cleaning Roads and Public Places

Categories	Yes	No	Not Reported	Total Municipalities	% Coverage
Metropolitan City	5 (100.0)			5 (100.0)	33.6
Sub-Metropolitan City	11 (100.0)			11 (100.0)	36.9
Municipality	159 (62.4)	60 (23.5)	36 (14.1)	255 (100.0)	22.9
Overall	175 (64.6)	60 (22.1)	36 (13.3)	271 (100.0)	24.0

Note: Figures in parenthesis indicate percentage.

Table 2.33: Number of Municipalities Reporting the Coverage (Wards and Population)

Categories	Ward Coverage		Household Coverage		Population Coverage	
	Number Reporting	Number of Wards Covered	Number Reporting	Number HHs Covered	Number Reporting	Population Covered
Ecological Zones						
Mountain	22 (84.6)	2.8	21 (80.8)	1,399.5	20 (76.9)	9,864
Hill	91 (81.3)	5.9	85 (75.9)	4,592.4	80 (71.4)	25,703
Terai	112 (84.2)	8.0	89 (66.9)	7,047.1	91 (68.4)	33,375
Overall	225 (83.0)	6.6	195 (72.0)	5,368.9	191 (70.5)	27,700
Type of Municipalities						
Metropolitan City	5 (100.0)	29.0	2 (40.0)	40,517.5	3 (60.0)	275,867
Sub-Metropolitan City	11 (100.0)	15.6	9 (81.8)	18,673.8	9 (81.8)	86,374
Municipality	209 (82.0)	5.6	184 (72.2)	4,336.0	179 (70.2)	20,590
Overall	225 (83.0)	6.6	195 (72.0)	5,368.9	191 (70.5)	27,700

Note: Figures in parenthesis indicate percentage.

ities were cleaning their roads and public places, which is an important indicator revealing the practices of cleanliness of the cities (Table 2.32). Among the municipalities which were involved in cleaning the roads and public places, only 24% municipalities were cleaning, leaving the large percentage of the municipal areas uncleaned, reflecting poor level cleanliness.

Regarding the scope of waste collection, 225 (83%) municipalities reported ward level collection, 195 (72%) municipalities reported household level coverage and 191 (70.5%) municipality reported population level coverage (Table 2.33). The higher coverage was made by the metropolitan cities in terms of wards, households and population mainly because of their better capacities in all the aspects. The sub-metropolitan cities and municipalities stood in second and third position, respectively in terms of wards, households and population level coverage. By ecological regions, municipalities of Terai region reported higher waste collection coverage followed by hill and mountain regions municipalities.

In terms of waste collection by the municipality categories, higher number (60%) of the metropolitan and sub-metropolitan cities (63.6%) were collecting 61% - 80% of their waste; whereas 25.5% of the municipalities reported no waste collection at all. The average waste collection was higher among the sub-metropolitan cities (67.8%) and less (48.4%) among the municipalities (Table 2.34).

2.6 TRANSFER OPERATIONS

Waste management of the cities depends largely on the available facilities and also their capacities and practices. Use of waste transfer station helps in reducing and segregating waste before reaching landfill sites. Among the surveyed municipalities, only 15 (5.5%) municipalities were using transfer stations; whereas a large majority (82.3%) of the municipalities did not have such facility and 12.2% of the municipalities did not respond about whether they are having this facility.

Table 2.34: Distribution of Municipalities by Percentage of Waste Collected

Categories	Not at All	1-20 %	21-40%	41-60%	61-80%	81-100%	Total Reporting	Average % of Waste Collected
Metropolitan City			2 (40.0)		3(60.0)		5(100.0)	60.0
Sub-Metropolitan City		1 (9.1)	1(9.1)		7(63.6)	2(18.2)	11(100.0)	67.8
Municipality	65(25.5)	39(15.3)	48(18.8)	41(16.1)	62(24.3)	22(8.6)	255(100.0)	48.4
Overall	65(24.0)	40(14.8)	51(18.8)	41(15.1)	72(26.6)	24(8.9)	271(100.0)	49.7

Note: Figures in parenthesis indicate percentage.

Table 2.35: Number of Municipalities Managing Transfer Stations

Categories	Area of Transfer Station		Capacity of Transfer Station	
	Number Reporting	Size of Station (m2)	Number Reporting	Capacity (m3)
Metropolitan City	1 (20.0)	20,000	1 (20.0)	10,000
Sub-Metropolitan City	1 (9.1)	2,000	1 (9.1)	200
Municipality	10 (3.9)	3,169	4 (1.6)	1,517
Overall	12 (4.4)	4,474	6 (2.2)	2,711

Note: Figures in parenthesis indicate percentage.

2.6.1 Facilities Available in the Transfer Stations

The survey revealed 12 (4.4%) municipalities were using transfer stations for processing of municipal solid waste (Table 2.35). These included 1 metropolitan city, 1 sub-metropolitan city and 10 municipalities. The size and capacity of the transfer stations varied considerably with municipalities showing better position for the metropolitan cities in compared to the municipalities. The capacity of waste transfer stations was 10,000 m3 for the metropolitan and less than 1517 for sub-metropolitan cities and municipalities (Table 2.35).

2.6.2 Activities in the Transfer Stations

Out of the total, only 15 municipalities were using different facilities/methods for managing their waste in the transfer station. Among them, 5 municipalities were having compaction facilities, 4 were having segregation facilities, 3 were having sorting facilities and 2 municipalities

Table 2.36: Number of Municipalities with Waste Weighing Facility in Transfer Centre

Categories	Yes	No	Total	Daily Waste Transported from Transfer Centre to Waste Management Centre	
				Number Reporting	Quantity (Ton/ Day)
Metropolitan City	1 (100.0)		1 (100.0)	1 (100.0)	150.00
Sub-Metropolitan City	1 (100.0)		1 (100.0)	1 (100.0)	6.00
Municipality	3 (17.7)	14 (82.4)	17 (100.0)	3 (17.7)	9.10
Overall	5 (26.3)	14 (73.7)	19 (100.0)	5 (26.3)	36.66

Note: Figures in parenthesis indicate percentage.

Table 2.37: Number of Municipalities Reporting Different Facilities in the Transfer Centre

Categories	Compaction	Segregation	Sorting	Other	Reporting at Least One	Total Using Transfer Centre
Metropolitan City	1 (100.0)				1 (100.0)	1 (20.0)
Sub-Metropolitan City		1 (100.0)		1 (100.0)	1 (100.0)	1 (9.1)
Municipality	4 (100.0)	3 (75.0)	3 (75.0)	1 (25.0)	4 (30.8)	13 (5.1)
Overall	5 (83.3)	4 (66.7)	3 (50.0)	2 (33.3)	6 (40.0)	15 (5.5)

Note: Figures in parenthesis indicate percentage.

Table 2.38: Number of Municipalities Taking Measures to Prevent Foul Smell at the Transfer Station

Categories	Yes	No	Not Reporting	Total Reporting
Metropolitan City	1 (100.0)			1 (100.0)
Sub-Metropolitan City	1 (100.0)			1 (100.0)
Municipality	3 (23.1)	8 (61.5)	2 (15.4)	13 (100.0)
Overall	5 (33.3)	8 (53.3)	2 (13.3)	15 (100.0)

Note: Figures in parenthesis indicate percentage.

were having other facilities to reduce the volume of wastes (Table 2.37). The limited facilities available with the municipalities are an indication of inadequate waste management practices of the municipalities.

In order to control the foul smell of the wastes, transfer stations are essential in waste management as these are located close to the settlements, market centres, roads, health facilities (hospitals, health centres, clinics), educational institutes, etc. In this survey, only 5 municipalities reported that they are having the transfer stations for controlling the foul odour indicating large number of municipalities not having transfer stations for controlling bad smells of the wastes (Table 2.38).

In solid waste management, other necessary equipment/facilities include front end loaders, cranes, conveyor, walking floors, compactors, etc. But these equipment were available for very few municipalities, i.e. only 2 municipalities reported to have front end loaders, 2 were having conveyors, 3 were having walking floors and 3 were having compactors. Among the municipalities, 8 municipalities were adopting measures to prevent negative effects in the environment while transporting the waste from transfer sites. These included 1 metropolitan city, 1 sub-metropolitan city and 6 municipalities.

2.6.3 Waste to Energy

Waste to energy is a process to covert the waste into energy which is becoming popular globally. But, this process requires use of effective technological processes. Among the surveyed municipalities, only 3 municipalities were producing energy from waste. These were Kathmandu and Lalitpur Metropolitan cities from Bagmati Province, and Pokhara Metropolitan City from Gandaki Province.

2.7 RESOURCES AVAILABLE FOR WASTE MANAGEMENT

The survey revealed that the most of the municipalities own one or other types of vehicles for transporting the wastes. Out of the total surveyed municipalities, 232 (85.6%) were having at least one or other type of transportation means. The higher numbers of municipalities (70.7%) were having tractor/power tiller followed by 61.6% municipalities were having tippers/trucks and (23.7%) municipalities were having dozer. Other means of waste transportation pose by the municipalities include mini trucks/pick-ups, loaders, excavators, boomers, jet machines, rickshaw, etc. Among others, tractor/power tillers and tripper/trucks were the major means of transportation commonly used in the municipalities. In average, most of the municipalities were having more than 1.0 tractor/power tiller and 1 tripper/truck. The limited waste transportation facilities with the municipalities clearly suggest their constraint in the solid waste management.

2.8 WASTE MANAGEMENT METHODS

The survey revealed different waste management practices adopted by the municipalities. Most of the municipalities were adopting one or more methods of waste management. The three main methods of waste management adopted by all the municipalities were: i) piling up in landfill site by 48.6% municipalities, ii) burning by 32.1% municipalities, and iii) piling up in the

Table 2.39: Percentage of Municipalities Reporting the Management of Waste Collected

Categories	Percentage of Municipalities Reporting							Municipalities Reporting (N)
	Manure Making	Pile-up in Landfill Site	Pile-up in the River Side	Open Dumping	Burning	Send for Re-cycle	Excavator	
Metropolitan City	40.0	60.0	20.0		40.0	40.0		5
Sub-Metropolitan City	20.0	60.0	20.0	30.0	30.0	50.0	10.0	10
Municipality	8.6	47.7	27.9	20.8	32.0	11.7	10.2	197
Overall	9.9	48.6	27.4	20.8	32.1	14.2	9.9	212

(Due to multiple responses, total may not add-up to 100)

river side by 27.4% municipalities (Table 2.39). Among the municipal categories, the 60% of the metropolitan cities and sub-metropolitan cities and 47.7% of municipalities were adopting pile up of the wastes in the landfill sites.

2.9 RECYCLE AND REUSE OF WASTE

Among the total municipalities surveyed, 212 (78.2%) municipalities reported handling wastes in different ways. Out of them, 30 (14.2%) municipalities were recycling their waste and those included 2 metropolitan cities, 5 sub-metropolitan cities and 23 municipalities. By municipality categories, 50% metropolitan cities, 40% sub-metropolitan cities and 11.7% municipalities were recycling their wastes. Although, the municipalities were involved in recycling of waste, the quantity used for recycling was low. The recycled quantity of the waste account only 4.1% of the total waste collected. In the present context of involvement of less number of the municipalities in recycling of waste using fewer amounts of waste materials, there is a good opportunity to scale up the waste recycling in the municipalities. Similarly, manure making was also low among all the municipalities with an average of 9.9%. The practice of manure making was higher among the metropolitan cities (40%) followed by the sub-metropolitan cities (20%) and the municipalities (8.6%).

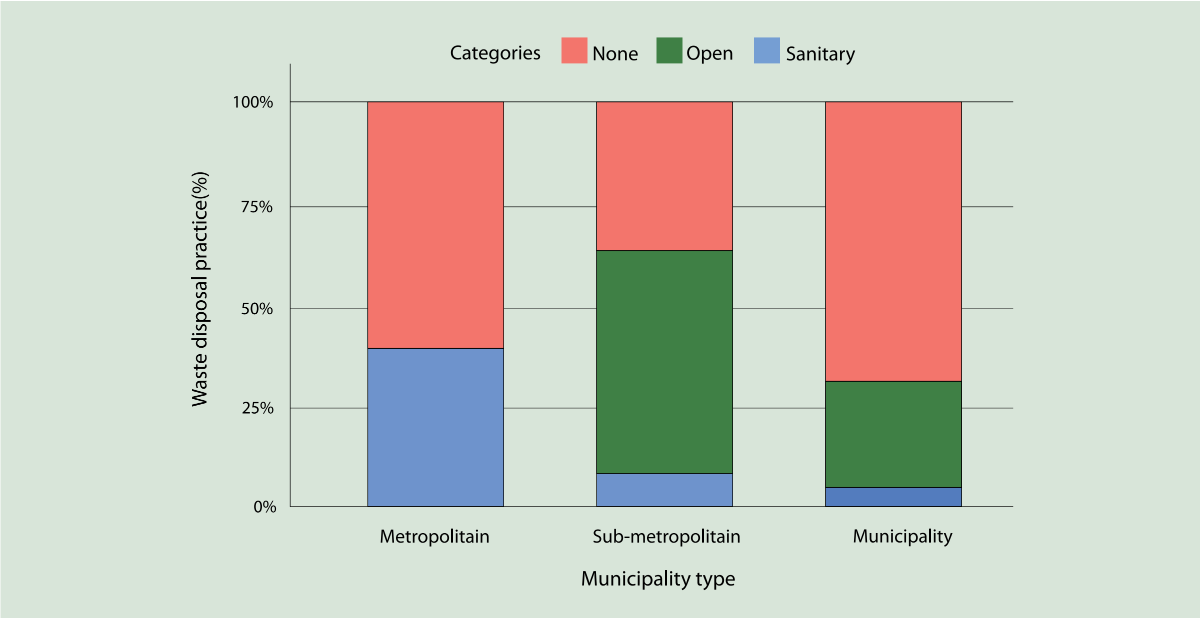
2.10 LANDFILL SITES

Among the total municipalities surveyed, 114 (42.0%) municipalities were using the landfilling practices, 117 (43.2%) municipalities were not practicing the approaches and remaining 40 (14.8%) municipalities did not respond about the landfill sites. In this connection, 60% of the metropolitan cities, 63.3% of sub-metropolitan cities and 40.8% of the municipalities were using landfilling practices. Among the municipalities using the landfilling practices, 85.1% were having their own landfilling sites against 14.9% who were using others' landfilling sites.

Among 117 municipalities reporting landfilling practices, only 88 municipalities further reported about nature of landfilling they were practicing (i.e., landfill sites and open dumping). Out of them, 72 municipalities (6 sub-metropolitan and 66 municipalities) were using open dumping, whereas 16 municipalities (2 metropolises, 1 sub-metropolis and 13 municipalities) were practicing sanitary landfill (Figure 2.11). Out of the total (5), 40% metropolitan cities reported that they are using sanitary landfill, 9.1% sub-metropolitan and 5.1% municipalities were using the sanitary landfills. The less reporting of landfill sites and their use by the municipalities is a clear reflection of need of increasing the practice of sanitary landfill for wastes and their proper management in the municipalities.

In the sanitary landfills, for the municipalities, adequate area for landfill sites is critically important for waste management. Among the municipalities which reported the information, the average area of their landfill sites was 1.5 ha (Table 2.40). However, the area varied with the type of municipalities. The sub-metropolitan cities showed the higher land area (3 ha per landfill site) followed by the municipalities with hav-

Fig 2.11: Use of Landfill Sites by the Municipalities



ing 1.4 ha and metropolitan cities with having 0.3 ha. These data suggest that the metropolitan cities have been greatly constrained by limited land area available for landfill sites.

In terms of capacity of landfill sites, the capacity varied from 22516 m3 for the municipalities to 115000 m3 for the metropolitan cities and 68293 m3 for the sub-metropolitan cities. The average capacity of the landfill site for the municipalities was 29877 m3. Among the surveyed municipalities, only 66 municipalities reported about the area of landfill sites.

In terms of landfill sites capacity, it also varied with the municipalities located in different ecological zones. In terms of their waste disposal capacities, the landfill sites of Terai revealed higher capacity in compared to the municipalities of the mountains (Table 2.41).

Table 2.40: Number of Municipalities Reporting the Area of Landfill Site and their Capacity

Categories	Municipalities Reporting Area of Landfill Site			Average Area of Landfill Site (ha)	Average Capacity of Landfill Site (m3)
	Reporting Area	Not Reporting Area	Total Reporting		
Metropolitan City	2 (100.0)		2 (100.0)	0.3	115,000
Sub-Metropolitan City	5 (71.4)	2 (28.6)	7 (100.0)	3.0	68,293
Municipality	59 (67.1)	29 (33.0)	88 (100.0)	1.4	22,516
Overall	66 (68.0)	31 (32.0)	97 (100.0)	1.5	29,877

Note: Figures in parenthesis indicate percentage.

Table 2.41: Number of Municipalities Reporting the Area of Landfill Site in Different Ecological Zones

Categories	Municipalities Reporting Area of Landfill Site			Average Area of Landfill Site (ha)	Average Capacity of Landfill Site (m3)
	Reporting Area	Not Reporting Area	Total Reporting		
Mountain	6 (54.6)	5 (45.5)	11 (100.0)	1.9	18,586
Hill	39 (78.0)	11 (22.0)	50 (100.0)	1.4	25,630
Terai	21 (58.3)	15 (41.7)	36 (100.0)	1.7	43,817
Overall	66 (68.0)	31 (32.0)	97 (100.0)	1.5	29,877

Note: Figures in parenthesis indicate percentage.

Table 2.42: Distribution of Landfill Sites by Distance from Main City

Categories	Distance from Main City (km)					Average Distance from Main City (km)
	Up to 1 km	1 - 5 km	More than 5 km	Not Reporting	Total Reporting	
Metropolitan City			2 (100.0)		2 (100.0)	17.5
Sub-Metropolitan City	1 (14.3)	3 (42.9)	3 (42.9)		7 (100.0)	4.4
Municipality	13 (14.8)	53 (60.2)	15 (17.1)	7 (8.0)	88 (100.0)	4.0
Overall	14 (14.4)	56 (57.7)	20 (20.6)	7 (7.2)	97 (100.0)	4.3

Note: Figures in parenthesis indicate percentage.

Among other, location of landfill sites is very important for the municipalities. The landfill sites close to the city areas and settlements are often problematic in many ways. The survey revealed varied distances of landfill sites with different categories of the municipalities. The average distance of landfill sites was 4.3 km with the higher average distance (17.5 km) for the metropolitan cities as compared to the sub-metropolitan cities (4.4 km) and the municipalities (4.0 km) (Table 2.42). Out of the total landfill sites, the higher numbers (57.7%) of landfills were 1-5 km away, whereas 20.6% of the landfill sites were located more than 5 km away from the main city areas.

The landfill sites of the municipalities were established in different periods. In this connection, 86 municipalities could specify the years of establishment of landfill site. As a whole, the average year of landfill site establishment was 5.7. However, the corresponding figure for the metropolitan city was higher (15.5 years) as compared to the sub-metropolitan cities and municipalities. It is to be noted that maximum numbers (71) of landfill sites of the municipalities were established after 2070 BS.

Similarly, the survey revealed the average life span of the landfill sites to be 16.3 years with the lower value (6.5 years) for the metropolitan cities which has been attributed to the lower land area and capacity against relatively large volume of waste generation. The average life span of landfill sites of municipalities was nearly 3 times higher than that of the metropolitan cities. The capacity of the landfill sites is normally determined by their land size as well as the depth that holds the waste. In case of the considered landfill sites, the average depth was 14.2 m (Table 2.43).

The landfill sites of the municipalities were located at varied distance from the permanent settlements. The average distance of the landfill sites was 1.7 km from the main settlements (Table 2.44). About 41% landfill sites were located more than 1 km away from the main settlements.

Considering the facilities available in the landfill sites, very few landfill sites consisted of leachate treatment facility. Out of the total 97 landfill sites under operation, only 7 sites were having treatment facilities (Table 2.45). Only 6 sites were having leachate control system, 5 were having leachate drainage system and 3 were having leachate treatment system. The few landfill sites with leachate treatment facilities with the municipalities reflect the need of activities for the

Table 2.43: Distribution of Landfill Sites by Average Depth of Waste

Categories	Average Depth of Waste (m3)					Average Tentative Life Span of Landfill Sites (Year)
	Up to 10	11 to 20	More than 20	Not Reporting	Total Reporting	
Metropolitan City				2 (100.0)	2 (100.0)	-
Sub-Metropolitan City	2 (28.6)	1 (14.3)		4 (57.1)	7 (100.0)	11.2
Municipality	22 (25.0)	2 (2.3)	6 (6.8)	58 (65.9)	88 (100.0)	14.5
Overall	24 (24.7)	3 (3.1)	6 (6.2)	64 (66.0)	97 (100.0)	14.2

Note: Figures in parenthesis indicate percentage.

Table 2.44: Distribution of Landfill Sites by Distance from Permanent Settlement

Categories	Distance from Permanent Settlement (km)					Average Distance from Permanent Settlement (km)
	Up to 0.5 km	0.5 to 1.0 km	More than 1.0 km	Not Reporting	Total Reporting	
Metropolitan City	1 (50.0)	1 (50.0)			2 (100.0)	0.75
Sub-Metropolitan City	3 (42.9)	3 (42.9)	1 (14.3)		7 (100.0)	0.81
Municipality	16 (18.2)	24 (27.3)	39 (44.3)	9 (10.2)	88 (100.0)	1.79
Overall	20 (20.6)	28 (28.9)	40 (41.2)	9 (9.3)	97 (100.0)	1.69

Note: Figures in parenthesis indicate percentage.

Table 2.45: Number of Municipalities Reporting Leachate Control, Leachate Drainage and Leachate Treatment System

Categories	Leachate Control System	Leachate Drainage System	Leachate Treatment system	Reporting at Least One	Total Operating Landfill Sites
Metropolitan City	1 (50.0)	1 (50.0)	1 (50.0)	1 (50.0)	2
Sub-Metropolitan City	1 (14.3)	1 (14.3)		1 (14.3)	7
Municipality	4 (4.6)	3 (3.4)	2 (2.3)	5 (5.7)	88
Overall	6 (6.2)	5 (5.2)	3 (3.1)	7 (7.2)	97

Note: Figures in parenthesis indicate percentage.

leachate management and control further contamination of the surrounding environment.

The survey also provided important information about the future planning of the municipalities on establishing landfill sites and waste management. Out of the total (271) municipalities surveyed, 102 (37.6%) municipalities reported their plans to construct landfill sites. Among the 102 municipalities, 42.2% were planning to construct the landfill sites in the existing sites; whereas 57.8% municipalities were planning to construct the landfill sites in new area. Only 10 (9.8%) municipalities reported that they were planning to have 2 landfill sites in future. The planned landfill sites of the municipalities were estimated to have an average area of 0.5 ha and will be at 3.3 km average distance from the main city. Among the 102 municipalities, 41.2% have plans to complete the landfill sites by 2078 BS; whereas remaining municipalities reported to complete the sites in or after 2079 BS. The estimated lifetimes of the planned landfill sites vary substantially. Among the total planned landfill sites, 26.5% will have the lifespan less than 10 years, 30.4% will have 11 to 20 years and 22.6% will have more than 20 years lifespan.

2.11 WASTE MANAGEMENT PLANS

2.11.1 Waste Management Planning and Monitoring

The survey revealed that municipalities have formulated various plans for the solid waste management. These plans are important tools in providing guidance for waste management. In total, 149 (55%) municipalities have prepared their plans which were the basis to implement the waste management activities (Table 2.46).

Table 2.46: Number of Municipalities Reporting the Type of Waste Management Plan

Categories	Short (less than a year) Plan	Annual Plan	Periodic	Reporting at Least One	Total Operating Landfill Sites
Metropolitan City	2 (40.0)	3 (60.0)		4 (80.0)	5
Sub-Metropolitan City	2 (33.3)	4 (66.7)	3 (50.0)	6 (100.0)	6
Municipality	33 (23.9)	102 (73.9)	42 (30.4)	131 (94.9)	138
Overall	37 (24.8)	109 (73.2)	45 (30.2)	141 (94.6)	149

Note: Figures in parenthesis indicate percentage.

Table 2.47: Training and Awareness Campaign on Waste Management Conducted by Municipalities During 2075/76

Categories	Average Number of Trainings Conducted	Average Number of Persons Trained	Average Number of Awareness Campaigns Conducted
Metropolitan City	13.67	927	6.0
Sub-Metropolitan City	6.43	221	11.2
Municipality	4.63	322	18.8
Overall	4.96	332	18.1

The majority (109) of the municipalities showed annual plans, 37 municipalities reported shorter plans of less than one-year period and 45 municipalities reported to have periodic plans.

In waste management, monitoring is crucial as it provides feedback to the decision makers of the municipalities on various aspects of waste management. In this connection, 177 (65.3%) municipalities were monitoring of waste management. All the metropolitan and sub-metropolitan cities were performing monitoring; however only 63.1% of the municipalities reported their engagement in waste monitoring activities. The municipalities were monitoring and supervising different activities related to waste management including the employee performance and transportation of waste materials.

2.11.2 Awareness Raising for Waste Management

The survey found many municipalities conducting training to enhance the skills and capacity of the staff for waste management. In total, 182 (67.2%) municipalities were conducting training program for their staff. On average, the municipalities conducted about 5 training programs to their staff in 2075/76 with higher number (about 14) by the municipalities (Table 2.47). The average numbers of persons trained were 332 per municipality. In 2075/76, each municipality organized on average 18.1 awareness campaigns.

2.11.3 Waste Management Plans and Strategies

The waste management plans and strategies are important for day to day operations of waste management activities. The surveyed municipalities varied in terms of availability of their plans and provisions and their implementation. Among the surveyed municipalities, only 99 (36.5%) municipalities reported their plans and strategies on waste management. However, higher (57.2%) proportion of the municipalities showed lack of such plans and strategies (Table 2.48) and 6.3% municipalities did not respond in this aspect.

In the solid waste management, having strategies in place are not enough to implement the activities effectively. The provisions need to be supported by operational level regulations and procedures. Among 271 surveyed municipalities, only 54 (19.9%) of municipalities were having the procedures (guidelines) on waste management. Among the municipal categories, only 1 metropolitan city, 3 sub-metropolitan cities and 50 municipalities were managing their solid waste based on the guidelines. The survey showed the lack of municipal level mea-

Table 2.48: Number of Municipalities Formulating Solid Waste Management Related Plans and Strategies

Categories	Yes		No		Not Reporting		Total	
Metropolitan City	5	(100.0)					5	(100.0)
Sub-Metropolitan City	6	(54.6)	5	(45.5)			11	(100.0)
Municipality	88	(34.5)	150	(58.8)	17	(6.7)	255	(100.0)
Overall	99	(36.5)	155	(57.2)	17	(6.3)	271	(100.0)

Note: Figures in parenthesis indicate percentage.

Table 2.49: Number and Percentage of Municipalities Imposing Punishment against Violators of Solid Waste Related Laws by Type of Beneficiary

Categories	Municipalities Reporting						Average Number Fined			
	Households/ Families	Institutions	Business House/ Commercial Complex	Other	Not Reporting	Total	Households/ Families	Institutions	Business House/ Commercial Complex	Other
Metropolitan City	2 (40.0)		2 (40.0)	1 (20.0)	2 (40.0)	4 (80.0)	31.0	-	52.0	1.0
Sub-Metropolitan City	2 (18.2)	2 (18.2)	3 (27.3)	1 (9.1)	2 (18.2)	5 (45.5)	7.5	4.5	137.0	11.0
Municipality	12 (5.1)	6 (2.6)	9 (3.8)	2 (0.9)	12 (5.1)	26 (11.1)	47.9	8.7	43.0	12.5
Overall	16 (6.4)	8 (3.2)	14 (5.6)	4 (1.6)	16 (6.4)	35 (13.9)	40.8	7.6	64.4	9.3

Note: Figures in parenthesis indicate percentage.

sures and guidelines as a major issue prevailing among the majority of the municipalities.

The survey revealed that some of the municipalities have punitive measures in place and implementing; but numbers of such municipalities were few. For instance, 35 (12.9%) municipalities were found to impose fines/punishments for the violation of the rules, whereas nearly 80% of the municipalities did not enforce any measures and 7.4% of the municipalities did not respond this aspect. In total, 4 (80%) metropolitan cities imposed fines/punishments to the violators of their rules and laws. These corresponding figures were comparatively low 5 (45.5%) among the sub-metropolitan cities and only 26 (11.1%) among municipalities (Table 2.49). The survey revealed that lack of effective rules and their enforcement as the fundamental issue among the municipalities for the poor waste management. The municipalities impose fines to households, institutions and business house/commercial complex. The numbers of violators included 41 households, 8 institutions, 64 business house/ commercial complex and 9 others (Table 2.49).

2.11.4 Expectations from Federal and Provincial Governments

Waste management is largely the responsibility of the local governments. For the proper delivery of the responsibility, it requires adequate resources, including human and financial resources. The survey revealed, 257 (94.8%) municipalities were expecting funds from the federal and provincial governments indicating resource constraint situation with them (Table 2.50; Table

Table 2.50: Number of Municipalities Reporting First to Sixth Priority Support from Federal Government

Categories	% of Municipalities Reporting							Total Reporting (N)
	Policy Formulation	Technical Expert	Need Assessment on Waste Management and Basic Monitoring	Infrastructure Development	Budget	Coordination	Other	
First Priority	25.0	16.3	11.9	28.2	51.2	9.9	2.4	252
Second Priority	6.0	19.8	8.3	42.4	21.2	2.8	0.5	217
Third Priority	13.9	26.7	15.4	17.3	15.4	11.4	0.5	202

Categories	% of Municipalities Reporting							Total Reporting (N)
	Policy Formulation	Technical Expert	Need Assessment on Waste Management and Basic Monitoring	Infrastructure Development	Budget	Coordination	Other	
Fourth Priority	20.4	20.4	16.0	17.7	6.1	18.8	0.6	181
Fifth Priority	18.2	18.9	27.0	6.3	6.9	22.6		159
Sixth Priority	22.0	5.0	24.1	2.8	3.6	42.6		141

2.51). It implies that in absence of funds from the federal and provincial governments, the municipalities would be facing difficulty in bringing desirable improvement in waste management. The municipalities expecting funds from the federal and provincial governments included all the metropolitan and sub-metropolitan cities and 94.5% of the municipalities.

The survey showed that the municipalities have placed their priorities for different supports from the federal government. The majority (51.2%) of the municipalities reported their first priority on budget support from the federal government, 42.4% of the municipalities showed their priority on infrastructure development and 26.7% expressed their priority on technical expertise services (policy formulation, need assessment, coordination, etc.).

Regarding the priorities for supports from the provincial government, 52.5% of the municipalities expressed their first priority on budget support from the provincial government, followed by infrastructural development from provincial government (Table 2.51).

In terms of establishing collaboration, only 84 (31%) municipalities were coordinating with other agencies for waste management (Table 2.52). The higher (59.5%) of the municipalities were coordinating with other agencies for waste collection and management. Other areas of municipal coordination were policy formulation, need assessment, financial support and infrastructure development. The municipalities reported that thought coordination has been established; they were not as effective as expected.

Table 2.51: Number of Municipalities Reporting First to Sixth Priority Support from Provincial Government

Categories	% of Municipalities Reporting							Total Reporting (N)
	Policy Formulation	Technical Expert	Need Assessment on Waste Management and Basic Monitoring	Infrastructure Development	Budget	Coordination	Other	
First Priority	24.2	17.9	13.8	24.2	52.5	12.1	2.1	240
Second Priority	5.8	15.9	6.8	42.5	21.7	7.7		207
Third Priority	12.4	23.2	21.1	17.8	14.6	11.4		185
Fourth Priority	14.4	25.3	17.8	17.8	10.3	14.9	0.6	174

Categories	% of Municipalities Reporting							Total Reporting (N)
	Policy Formulation	Technical Expert	Need Assessment on Waste Management and Basic Monitoring	Infrastructure Development	Budget	Coordination	Other	
Fifth Priority	18.4	21.5	26.0	5.1	5.1	24.7		158
Sixth Priority	29.5	5.8	18.7	5.0	1.4	39.6		139

Table 2.52: Number of Municipalities Reporting Various Coordinating Activities for Waste Management

Categories	% of Municipalities Reporting								Total Reporting (N)
	Waste Collection and Management	Policy Formulation	Technical Expert	Need Assessment on Waste Management and Basic Monitoring	Financial Support	Infrastructure Development	Capital Equipment	Other	
Metropolitan City	50.0		50.0		50.0	50.0	50.0		2
Sub-Metropolitan City	62.5	12.5	62.5	12.5	25.0	50.0	37.5	12.5	8
Municipality	59.5	28.4	41.9	32.4	29.7	28.4	17.6	18.9	74
Overall	59.5	26.2	44.1	29.8	29.8	31.0	20.2	17.9	84

III. CHALLENGES AND NEEDS

3.1 CHALLENGES OF THE WASTE MANAGEMENT

Urban areas of Nepal are facing several challenges in waste management. Currently, only 45% municipalities have sewerage services and 9.4% households are connected with the underground drainage systems indicating limited sanitation facilities. The present increasing pace of urbanization and urban population growth are putting immense pressure on utility services like water and sanitation services. In the context of increasing challenges in waste management, the initiatives made addressing these issues are, however, limited. Issues related to municipal waste management need further improvement under the present federal structure in which the roles and responsibilities of waste management and sanitation lies with the municipalities. Apart from these, lack of adequate institutional structures and legislative measures along with inadequate coordinating mechanism among the three levels of governments (federal, provincial and local) yet remains as a major issue.

The survey provided crucial data that the municipalities have considered waste management as a major challenge. Among the 247 municipalities who reported the challenges, 147 (59.5%) municipalities reported municipal waste management as a major challenge, 122 (49.4%) municipalities reported low level of awareness and 113 (45.8%) municipalities regarded lack of landfill sites as the major challenge of waste management (Table 3.1).

3.2 NEEDS OF THE MUNICIPALITIES

The survey revealed various needs and supports expected by the municipalities. The higher number (121) of municipalities expressed the need of

Table 3.1: Number of Municipalities Reporting Challenges in Waste Management

Categories	Metropolitan City	Sub-Metropolitan City	Municipality	Overall
Low Awareness	2 (40.0)	7 (63.6)	113 (48.9)	122 (49.4)
Insufficient Budget		1 (9.1)	61 (26.4)	62 (25.1)
Lack of Resources	2 (40.0)	4 (36.4)	51 (22.1)	57 (23.1)
Landfill Site Problem	3 (60.0)	3 (27.3)	107 (46.3)	113 (45.8)
Human Resources Shortages			55 (23.8)	55 (22.3)
Planning			11 (4.8)	11 (4.5)
Waste Management	4 (80.0)	5 (45.5)	138 (59.7)	147 (59.5)
Appropriate Technology		1 (9.1)	6 (2.6)	7 (2.8)
Inadequate Infrastructure		1 (9.1)	25 (10.8)	26 (10.5)
Law/ Regulations		1 (9.1)	1 (0.4)	2 (0.8)
Geographical Difficulties/ Scattered Settlements	1 (20.0)	2 (18.2)	31 (13.4)	34 (13.8)
Policies and Guidelines			30 (13.0)	30 (12.2)
Collaboration with Private Organizations/CBOs		1 (9.1)	15 (6.5)	16 (6.5)
Coordination Among 3 Level of Governments			12 (5.2)	12 (4.9)
Reporting at Least One	5 (100.0)	11 (100.0)	231 (90.6)	247 (91.1)

trained human resource and 120 municipalities reported need of constructing landfill sites (Table 3.2). Likewise, 105 (43.4%) municipalities reported need of sufficient budget for waste management. The municipalities expressed further needs for the MSW (Table 3.2).

Table 3.2: Number of Municipalities Reporting the Current Need in Waste Management Sector

Categories	Metropolitan City	Sub-Metropolitan City	Municipality	Overall
Allocate Enough Budget		4 (36.4)	101 (44.7)	105 (43.4)
Build Landfill Site (Quality/ Sufficiency)	3 (60.0)	5 (45.5)	112 (49.6)	120 (49.6)
Increase Awareness	4 (80.0)	2 (18.2)	76 (33.6)	82 (33.9)
Increase/Train Human Resources	2 (40.0)	4 (36.4)	115 (50.9)	121 (50.0)
Increase Machines/ Tools/Other Resources	1 (20.0)	8 (72.7)	93 (41.2)	102 (42.2)
Infrastructure (Build/Improve Quality)		3 (27.3)	41 (18.1)	44 (18.2)
Prepare Plan for Waste Management			8 (3.5)	8 (3.3)
Formulate Law/ Policies and Implement		2 (18.2)	37 (16.4)	39 (16.1)
Sort/ Dispose/ Recycle Waste	4 (80.0)	6(54.6)	48 (21.2)	58 (24.0)
Beneficiary (People) Mobilization			1 (0.4)	1 (0.4)
Coordination Among 3 Level of Governments			23 (10.2)	23 (9.5)
Increase Private Public Partnership		2 (18.2)	12 (5.3)	14 (5.8)
Apply Fine/ Punishment	1 (20.0)		4 (1.8)	5 (2.1)
Other			1 (0.4)	1 (0.4)
Reporting at Least One	5 (100.0)	11 (100.0)	226 (88.6)	242 (89.3)

IV. WASTE SECTOR BASELINE WITH NATIONAL SDG INDICATORS

4.1 SDGS FRAMEWORK ON WASTE MANAGEMENT

The SDGs framework provides a broader guideline on the targets and potential areas of interventions to attain the set goals in specific areas of development. The SDG-11 articulates about the municipal and other wastes management and also outlines interventions that contribute to effective waste management and attain SDGs goals both globally and country levels. The SDG-11, target 6 proclaims that "By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management". In consistent with the SDG-11, target 6, Nepal has set two targets and indicators in the municipal waste management (Table 4.1).

Currently, about 45% municipalities have sewerage services and almost all (98%) hospitals segregate their waste. The SDGs aspires to attain 100% in municipal sewerage services by 2022. Similarly, it also envisions achieving 100% hospital waste segregation by 2022.

4.2 SURVEY FINDINGS VIS A VIS SDGS GOALS AND TARGETS

The survey has generated some important facts on the waste generation and waste management in different categories of municipalities. These data not only provide baseline status for the many parameters related to different types of waste in the municipalities, but also give adequate insights for future planning and strategies for the municipal waste management. The key findings in relation to future waste management and the attainment of SDG goals and targets have been analyzed briefly hereunder.

Waste collection: Nepal has limited literatures on the waste collection and management sector. The waste generation of Kathmandu City was estimated to be 0.23 kg/capita/day and was compared with the figures of other cities of the neighbouring countries. The figures for some of the cities were: Gazipur city of Bangladesh - 0.25 kg/capita/day, Thimpu of Bhutan - 0.54 kg/capita/day, Lahore of Pakistan - 0.84 kg/capita/day and Doddaballapura of India - 0.28 kg/capita/day (Rijal & Adhikari, 2015).

Based on the waste generation and waste collection data, Table 4.2 presents the SDG indicator 11.6.1 "proportion of municipal solid waste collected and managed in controlled facilities out of total municipal waste generated, by cities" for the municipalities. The overall value of the indicator was 0.50. The highest value (0.60) was observed for the metropolitan cities and lowest value (0.48) for the municipalities (Table 4.2). The indicator was however, not considered for wastes collected and managed in controlled facilities, as most of the municipalities do not have such arrangements.

Table 4.1: SDG Targets and Indicators on Municipalities' Waste and Sanitation

S.N.	Target and Indicators	2014	2017	2020	2022	2025	2030
1	Municipalities with sewerage services (%)	45	72	100	100	100	100
2	Private hospitals segregating waste (%)	98	100	100	100	100	100

Source: NPC (2015)

Table 4.2: Annual Waste Collection to Generation Ratio in the Municipalities

Year 2075/76	Metropolitan Cities (mt)	Sub-Metropolitan Cities (mt)	Municipalities (mt)	Average (mt Municipality)
SDG Indicator 11.6.1	0.60	0.68	0.48	0.50

Hazardous waste: The inorganic and toxic waste generated in the cities is likely to cause adverse impacts to the environment and the people. Inorganic waste generated by the metropolitan cities amounted to 7100 mt in 2075/76 with lower figures (1526 mt) for the sub-metropolitan cities and 552 mt for the municipalities.

The overall average quantity of other waste comprising hospital waste, e-waste, toxic and others amounted to 380 mt in 2074/75, 283 mt in 2075/76 and 283 mt in 2076/77. The quantity of waste collected by metropolitan cities was about 20 times higher than the quantity collected by the municipalities. Managing these wastes, although small, pose further challenge to the respective municipalities as these wastes are riskier and hazardous for people and the surrounding environment. The limited institutional experience and capacity of the municipalities, as most of which are established after state restructuring in federal structure, further add challenges in the municipal waste management.

Waste generated from the health care facilities (hospitals, clinics, medical research centres, and laboratories) is known as the healthcare waste. About 80% of such waste is normally non-hazardous in nature, about 20% of them are hazardous (infectious waste, pathological waste, chemical waste and sharps). It is important to think that although only about 20% of the healthcare waste is hazardous, if all the fractions of the wastes are mixed together, all of the waste becomes hazardous.

Intermediate facilities: The municipalities possessed very limited waste handling facilities which constrained them to manage the waste efficiently. Among the surveyed municipalities, only few (15) municipalities were using different facilities to manage the waste in the transfer station and 5 municipalities were having compaction facilities, 4 were having segregation facilities, 3 were having sorting facilities and 2 were having other facilities to reduce the volume of wastes. The limited facility is an indication of inadequate waste management practices of the municipalities. Thus, concerned government agencies should emphasize in making the basic facilities available to the municipalities to handle the waste efficiently.

Waste treatment plants: Waste treatment facilities are available in limited municipalities which is an underlying factor for poor waste management. Among the surveyed municipalities, only 8 municipalities responded about the management of treatment plants with no further details. There is an urgent need to set up treatment facilities in the municipalities.

Leachate treatment facility: Out of the total 97 landfill sites under operation, only 7 sites reported as least one or other type of leachate treatment system. Among the landfill sites, 6 sites had leachate control system, 5 had leachate drainage system and 3 had leachate treatment system. The existence of few landfill sites with leachate treatment facilities confirms poor treatment facilities among the many municipalities.

Waste recycling: the survey showed 30 (14.2%) municipalities were recycling the waste indicating the poor waste management in the urban areas. These included 30 municipalities (2 metropolitan cities, 5 sub-metropolitan cities and 23 municipalities). Similarly, only 9.9% municipalities were using waste to produce manure. Thus, additional efforts need to be paid for recycling/ reusing the municipal waste.

Low level of awareness: Awareness raising among the stakeholders is key to make municipal waste management efficient and functional. However, the low level of awareness was found in the present conditions.

Revenue generation: Revenue generation of the municipalities was very low in most cases. Among the surveyed municipality, only 83 (30.6%) municipalities were collecting fees for waste management. The large shares of the municipalities' resources were generated from the federal government. Among the municipalities, 129 (51.2%) municipalities showed their expectation of budget from the federal government which clearly indicates weak financial position of the municipalities for investing in the municipal waste management.

V. CONCLUSIONS

Waste collection and management is an integral part for the sustainable development of the municipalities. The first step of scientific and effective waste management starts from the categorization and collection of waste from the primary sources where they are generated. However, this remains as a major issue for most of the municipalities as many of them are newly established with limited institutional experience and capacity. The limited waste handling, collection, transport, resource recovery and safe disposal capacity of the many municipalities appear as the major constraints for the municipalities. The specific waste management issues of the municipalities include- limited waste handling equipment, lack of adequate internal revenue, high dependency on the federal government for budget, very few waste transfer stations, lack of adequate and appropriate landfill sites, etc. In addition, lack of long term and holistic waste management plans of the municipalities and their effective implementation further elevates the challenges of the waste management.

It is expected that waste generation is likely to increase further in the years to come. The increasing consumption and production activities in all the subsectors of economy along with the population growth, settlements, urbanization, industrialization, etc. will contribute increased waste generation. In the context of increasing waste generation, effective measures to respond the challenges have to be planned. Among all, the local governments have to play vital role in planning and implementation specific activities for waste management, remaining within the national framework of waste management plans and policies. The holistic and integrated waste management plan needs to be developed for the municipal waste management. This plan should especially focus in strengthening in-house capacity in handling waste through human resource development, database management and effective training and skill enhancement of the municipalities' staff. The survey also necessitates the need of developing waste treatment plants, locating effective landfill sites, including waste transfer stations with adequate space and capacity to handle and manage the waste for the medium and long runs. Procurement and operation of efficient intermediate facilities for waste transportation, sorting/grading, compaction and management also helps in SWM. The municipalities can also develop efficient measures to convert waste to energy including recycling, reusing of waste and production of manure for use in farming. More scientific and inclusive basis of tariff collection can be initiated against waste collection and management to increase internal resource generation of the municipalities.

Increased programs on public participation and awareness raising among the citizens, and roles and responsibilities of other agencies (private and public sectors) are crucial in the management of solid wastes. Effective coordination with concerned local level stakeholders helps in managing the wastes efficiently. Similarly, strengthening data management systems, developing effective waste handling procedures and establishing strong institutional mechanisms help to respond solid waste management challenges.

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Health Care Waste Management Guideline

Government of Nepal

Ministry of Health and Population

Department of Health Services

2014

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2014

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Hon'ble Khaga Raj Adhikari

Minister for Health and Population

Date : ....

Message

It is my great pleasure to present the Health Care Waste Management Guideline 2014. In Nepal health-care waste typically generates from different sources: health-care facilities, health campaigns and emergency relief assistance. Health-care services in a clean environment always aim to reduce health problems and to prevent potential health hazards. In doing so, however, waste is often generated that is potentially harmful to public health and the environment. Some categories of waste are very hazardous in nature and can impose risk on health-care workers, waste transport staff, patients and their attendants too, if they are not managed properly. Poor waste management and poor sanitation in health-care facilities can promote other unforeseen health risks such as hospital-acquired infections, sharp injuries to anybody or even further spread of communicable diseases in the communities. Hence proper management of health-care waste poses a great challenge in the health sector, especially health care providing facilitities.

In developing countries like Nepal, where many health concerns often compete for very limited resources, the management of health-care waste must be given priority. Although some of the national level hospitals in this country have started very encouraging initiatives towards the safe management of health-care wastes, in majority of health-care facilities hazardous wastes are still being dumped haphazardly. In this scenario, I hope this health care waste management guideline will help to raise awareness among the all stakeholders about the importance of safe management of health care waste. This guideline will be very useful to understand the various types of health care wastes and practical ways to assess and improve health care waste management at every step from generation to disposal in a variety of settings.

Lastly, I would like to extend my sincere thanks to Dr. Senendra Raj Uprety, Director General, Department of Health Services for his dynamic leadership during the preparation of this guideline. I would also like to thank all those involved in preparing this guideline.

Khaga Raj Adhikari
Minister
30 July 2014

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Foreword

Health care waste management is the responsibility of all health care facilities or the ones who produce waste. Various fatal infections such as HIV/AIDS, hepatitis B can spread as the result of the mismanagement of health care waste. Health care institutions in Nepal are lacking organized and systematic health care waste management practices. Many of these facilities have not adopted proper segregation, collection, transportation, treatment and disposal of health care waste till date. Currently, it is the common phenomena that the general wastes are being mixed with the highly infectious waste and are being disposed at municipality containers.

It is my immense pleasure to know that the present painstaking initiative has focused on the health care waste management issues in our country. I envisage that the present guideline for health care waste management will definitely bring some positive vibes towards the proper and scientific management of health care waste. I believe that this guideline will beacon the strategies to adopt the best available technique and the best environmental practice in terms of available resources for the proper management of health care waste

I would like to thank most sincerely Ms. Shrijana Shrestha, Senior. Public Health Administrator (DoHS), Mr. Terrence Thompson, Senior Environmental Health Advisor (WHO) and Dr. Sudan Raj Panthi, NPO (WHO) for their untiring efforts in bringing out this guideline. I also thank all those personnel who contributed to the guideline. This guideline will encourage the use of appropriate, safe and cost-effective methods and techniques for the segregation, collection, transportation, storage, treatment and final disposal of health care wastes.

Finally, I wish to request all the concerned stakeholders to be united in ensuring consistent and persistent support for the successful implementation of this guideline in all health care facilities in our country.

....
Dr. Praveen Mishra
Secretary

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Foreword

Health care waste management is one of the major public health problems and burning issues in the present context. Health care sector is expanding and generating large quantities of health care wastes and there is lack of proper health care waste management system in these health care facilities. Health care wastes are either dumped alor.g with household wastes in the landfill site or burned openly.

Health care wastes are hazardous in nature and therefore requires special precautions and arrangements for the proper management which is different from other household wastes. Systematic and coordinated approach is important for the proper and safe segregation, collection, storage, treatment and final disposal of health care wastes.

Solid Waste Management Act 2011, indicates that it is the prime responsibility of the waste producers to manage wastes properly. The present health care waste management guideline is remarkable step for the proper management of health care wastes. This guideline provides practical information regarding safe, efficient and environment-friendly waste management options in the context of Nepal.

I offer special thanks to Ms. Shrijana Shrestha, Senior Public Health Administrator (DoHS), Mr. Terrence Thompson, Senior Environmental Health Advisor (WHO) and Dr. Sudan Raj Panthi, NPO (WHO) for their hard work and dedication in bringing out this guideline. I express my sincere thanks to all the contributors including Civil Service Hospital HCWM team and other organizations involved in the preparation of this guideline. I am particularly grateful for the support provided by WHO Nepal.

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(Dr. Senendra Raj Upreti)
Director General
22 July 2014

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Acknowledgement

Government of Nepal, Ministry of Health and Population has been providing different health services; preventive, curative, promotive and rehabilitative services to people of Nepal. It is Government's commitment to provide quality health services. Recent Health Policy 2014 of Nepal focuses on good quality health services. As we know, infection prevention is one of the important aspects of quality health services and it is important at all levels; primary, secondary and tertiary levels of health facilities. Proper management of health care wastes can contribute to reduce infection prevention.

Management of health care wastes in different health care facilities is still seen as a big challenge in resource constraint setting like Nepal. Different diseases are being transmitted in health care facilities due to improper management of health care wastes. Health care facilities are emerging and expanding day by day and generating huge quantities of wastes including hazardous wastes. The majority of health care facilities dispose wastes in a haphazard way causing human and environment in danger. Therefore, health care wastes should be managed properly. I am hopeful that this guideline will help users to practice general and hazardous wastes in a proper and safe way, which is need of the country.

I would like to offer my sincere appreciation to Ms. Shrijana Shrestha, Senior Public Health Administrator (DoHS), Mr. Terrence Thompson, Senior Environmental Health Advisor (WHO) and Mr. Sudan Raj Panthi, NPO (WHO) for their tireless efforts in bringing out this guideline. I would also like to extend my sincere appreciation to all the contributors from Government and non Government organizations including Civil Service Hospital and Bir Hospital who helped to bring this guideline.

Finally, I hope this guideline will be helpful in the proper management of health care wastes in health care facilities and will improve the current situation in Nepal.

Dr. Bhim Acharya
Director
26 July 2014

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Abbreviation

AIDS	:	Acquired Immune Deficiency Syndrome
BAT	:	Best Available Technique
BEP	:	Best Enviromental Practice
CEPHED	:	Center for Public Health and Environmental Development
COMAT	:	Communication and Management Institute
CSH	:	Civil Service Hospital
CTF	:	Central Treatment Facility
DDT	:	Dichlorodiphenyltrichloroethane
DoHS	:	Department of Health Services
DHO	:	District Health Office
DPHO	:	District Public Health Office
EDCD	:	Epidemiology and Desease Control Division
EIA	:	Environmental Impact Assessment
ESM	:	Environmentally Sound Management
GEF	:	Global Environment Facility
gTEQ	:	Gram Toxic Equivalent
HBV	:	Hepatitis B Virus
HCB	:	Hexachlorobenzene
HCF	:	Health Care Facility
HCV	:	Hepatitis C Virus
HCW	:	Health Care Waste
HCWM	:	Health Care Waste Management
HCWMC	:	Health Care Waste Management Committee
HCRW	:	Health Care Risk Waste
HECAF	:	Health Care Foundation
HIV	:	Human Immunodeficiency Virus
IEC	:	Information, Education and Communication
IEE	:	Initial Environment Examination
MD	:	Management Division
MoE	:	Ministry of Environment
MoHP	:	Ministry of Health and Population
MoSTE	:	Ministry of Science, Technology and Environment
MoUD	:	Ministry of Urban Development
NHTC	:	National Health Training Center

NCASC	:	National Center for AIDS and STD Control
NHRC	:	Nepal Health Research Council
NSI	:	Needle Stick Injury
PCBs	:	Polyclorinated
PEP	:	Post Exposure Prophylaxis
PHCORC	:	Primary Health Care Outreach Clinic
PPP	:	Public Private Partnership
PTMI	:	Provisional Tolerable Monthly Intake
POPs	:	Presistent Organic Pollutants
PVC	:	Polyvinyl Chloride
SBC	:	Secretariat of Basel Convention
SGNHC	:	Sahid Gangalal National Heart Center
SOP	:	Standard Operating Procedure
SPHA	:	Seminor Public Health Administrator
SWM	:	Solid Waste Management
SWMTSC	:	Solid Waste Management Technical Support Center
TB	:	Tuberculosis
UNDP	:	United Nations Development Programme
UNEP	:	United Nations Enironmentment Programme
WB	:	World Bank
WHO	:	World Health Organization

1. Introduction

1.1 Background

The goal of 'Health for all' through primary health care approach was set by World Health Assembly. The Interim Constitution of Nepal 2063 has given emphasis that every citizen has right to a clean environment and right to basic health care. Government of Nepal has a major concern in providing good quality of health services to all the people in the country. Different types of diseases and problems that the country is facing are being solved through different programs by governmental and non-governmental organizations. One of the major problems the country is facing is proper management of health care waste (HCW). Poor management of HCW causes high risk of infection and environmental pollution. Health care wastes not only affect the waste generators but also the waste handlers and general public. One of the manifested impacts of mismanagement of HCW is the alarming incidence of hospital acquired infection.

HCW includes all the wastes generated by health-care establishments, research facilities, and laboratories (WHO, 1999). According to Solid Waste Management Act 2011, medical waste means the hazardous waste produced and discharged from hospitals, clinics, pharmacies, dispensaries, blood banks, pathology laboratories, veterinary institutions and health research centers. Health care facilities (HCF) generate large amount of diverse wastes, which require proper treatment and disposal to protect the persons handling it and the environment. Accroding to UNEP/SBC/WHO, 2004 waste from the HCFs includes following categories of wastes:

- Non-risk HCW
- HCW requiring special attention
- Infectious and highly infectious waste
- Other hazardous waste
- Radioactive waste

Wastes in HCFs are around 20% hazardous and 80% general wastes (WHO, 1999). Improper management of HCWs in the HCFs is mainly responsible for producing a high volume of hazardous wastes. Thus, proper management i.e. proper minimization, segregation, storage, transportation, treatment and disposal of infectious and hazardous wastes will greatly reduce the risks to public health. Early recovery of the patient and health of clinical staff directly depends on infection prevention practices used in HCFs. Health care waste management (HCWM) is considered as one of the essential components of good infection prevention practices.

1.2 Objective of the Guideline

This guideline provides HCFs a minimum standard for safe and efficient HCWM in Nepal. HCF has the prime responsibility of ensuring that there are no adverse health and environmental consequences on handling, storage, treatment and disposal of HCWs. Though this guideline does not provide any details about the proper management of liquid and gaseous waste, through this guideline, HCFs will be able to install appropriate waste management system that can provide other benefits such as:

- Protection of public health by reducing the exposure of employees, patients, attendents, and entire community to hazardous HCWs in the work environment
- Facilitate compliance with regulatory requirements
- Enhance community relation by demonstrating a commitment to environmental protection
- Reduce waste handling and disposal volumes along with costs without compromising the quality of health care
- Increase employee morale resulting from a healthier and safer working environment

1.3 Health care waste and its management in Nepal

Ministry of Health (MoH) report (2003) revealed that the HCW generation is 1.7 Kg/person/day. Out of the generated waste of HCFs, 26 % of the waste is hazardous. Table 1 shows the amount of health care waste generated by the HCFs with bed and corresponding waste generation.

Table 1. Total health care facilities with bed and corresponding waste generation

Hospital with beds (Public+ Private+ Mission+Teaching)	No. of Hospitals	Total Bed	HCW (Tons/Year)	HCRW (Tons/ Year)
Government Hospital including Teaching under MoHP)	92	6601		
Government Hospital including under other Ministry	3	1036		
Government Total	95	7637	3080.19	905.94
Private Hospitals	157	9207		
Private Teaching Hospitals	14	8626		
Private Total	171	17833	7192.49	2115.44
Mission Hospitals	8	612	246.83	72.60
Country Hospital	274	26082	10519.51	3093.98

Source: MoHP Poster Presentation in first HCWM International Workshop, Nepal; 2012

Recent publication revealed that the total health care waste from Nepal is estimated at 0.533 kg/bed-day. Out of which 0.256 kg/bed-day is general, non-hazardous, and non-biodegradable waste, 0.147 kg/bed-day is biodegradable waste, 0.120 kg/bed-day is infectious waste including sharps and 0.009 kg/bed-day is hazardous chemical/pharmaceutical waste. (UNEP, 2012)

Average HCW generation rate per bed in Pokhara city is estimated at 1.22 kg and per patient waste generation in outdoor facility is estimated at 0.34 kg per day (Enayetullah et al., 2011). All hospitals and outdoor facilities in Pokhara city are generating 2.8 ton waste per day. Out of the total waste generated, 22% HCWs is hazardous and infectious and the rest (78%) is harmless general waste. The study also revealed that different categories of waste remain un-segregated due to lack of proper in-house waste segregation activity inside the HCFs. These wastes remain untreated and later disposed as such. Table 2 shows the HCWs generated at different hospitals of Pokhara city.

Assessment study at Civil Service Hospital in Minbhawan, Kathmandu shows that waste generation of the hospital is 64.58 kg per day with an occupancy rate of 55.86% with waste generation rate of 1.73 kg per bed per day. The report has compared the waste generated from the hospital as risk and non-risk waste in cases of pre-separation and post-separation conditions. Pre-separation scenario showed that 71% of the waste is risk waste and 29% of the waste is non-risk. Post-separation scenario shows that the risk HCW is around 25% and non-risk health care waste is around 75% (CSH, 2011).

Table 2. Average waste generation per bed in different hospitals of Pokhara

Name of the Hospital	Total no of beds	Average Waste Generation Per Bed (kg)
Manipal Teaching Hospital	858	1.22
Kaski Model Hospital	25	
Western Regional Hospital	450	
Padma Nursing Home	51	

Source: Enayetullah et al, 2011

A study by Bhatta, 2013 revealed that almost all of the study that covered HCFs was focussing only on solid waste management mostly by method of incineration. Seventy percent of the incinerators were found not working properly as planned due to the lack of skilled manpower, spare parts, high fuel consumption, cultural and public objection and lack of management commitment. Secondly, most of the HCFs mainly district and below level, are managing their solid waste by adopting very poor method of waste disposal such as drum incinerator, pit burning, earthen pit disposal and open burning. Further many institutions are dumping or throwing waste on the back yard, ditches, rivers, open field, corners of hospital buildings, nearby ponds or anywhere around the premises. The third scenario is use of municipal waste container. About 60% of the big hospitals in different parts of the country are using municipal waste disposal system for final disposal of the HCW.

The study conducted at hospitals of Nepal by MoHP with support from WHO (MoHP, 2012) concluded that the waste management system is poor and 38.7% hospitals adopted correct segregation of HCWs. In Kathmandu, municipal vehicles collect waste and the collected waste including medical waste is disposed at Okharpauwa dumping site without any pre-treatment. Most of the rag pickers are often seen collecting plastic bottles, plastic bags, syringes, needles, and iron materials in and around hospital areas and at the waste disposal sites. These are the common practices, which put rag pickers and the community people at the greatest risk of infection and injury. According to a study conducted in Western region of Nepal (DoHS, 2013), 70% of clinical staff and 63% of non-clinical staff reported a needle stick injury (NSI) or other sharps injury at some time.

A study (CEPHED, 2012) showed that 90.32% hospitals do not practise environment sound waste treatment system at all, 61.29% hospitals have very poor source separation including complete absence of such practices in 6.45% hospitals. Among them, 80.65% hospitals do not practise appropriate and separate waste collection; 67.42% hospitals have very poor transportation, however, the criteria for determining the presented data are not so clear.

Above scenario shows the very poor management of HCWs and need to be taken seriously. Liquid wastes including hazardous chemicals and laboratory wastes have not been addressed in almost all institutions. Recently some HCFs in Nepal such as Western Regional Hospital, Bir Hospital, Civil Service Hospital, Manipal Teaching Hospital, Shahid Gangalal National Heart Centre and some other HCFs are practising HCWM systems, which are very encouraging initiatives towards the proper management of HCWs.

2. Policy, Legal Provisions and Commitments

2.1 International Agreements and Underlying Legislative and Regulatory Principles

International agreements have been reached on a number of underlying principles, which govern either public health or safe management of hazardous waste. Nepal is signatory on number of international conventions. Some of the conventions and guiding principles outlined here should be taken into consideration while making plans for the HCWM.

2.1.1 Basel convention 1989

The Basel Convention on the control of trans-boundary movements of hazardous wastes and their disposal was adopted in 1989 and entered into force in 1992. This convention is a global agreement, ratified by 178 member countries to address the problems and challenges posed by hazardous waste. The central goal of the Basel Convention is "environmentally sound management" (ESM), the aim of which is to protect human health and the environment by minimizing hazardous waste production whenever possible. ESM means addressing the issue through an "integrated life-cycle approach", which involves strong controls from the generation of a hazardous waste to its storage, transport, treatment, reuse, recycling, recovery and final disposal. HCW is one of the categories of hazardous wastes covered by the convention.

2.1.2 The stockholm convention on persistent organic pollutants 2001

This Convention is a global treaty to protect human health and the environment from persistent organic pollutants (POPs). POPs are chemicals that remain intact in the environment for long periods, become widely distributed geographically and accumulate in the fatty tissue of living organisms. POPs are toxic to humans and wild life and have adverse effects on human health and the environment. Exposure to POPs can lead serious health effects including cancers, birth defects, dysfunctional immune and reproductive systems, increased susceptibility to disease and even diminished intelligence. POPs circulate globally and can cause damage wherever they travel. To response these problems, the Stockholm Convention, was adopted in 2001 and entered into force in 2004. The convention requires the concerned parties to take measures to eliminate or reduce the release of POPs into the environment. POPs listed under Stockholm Convention are given in the table 3.

2.1.3 Tort law and principles

a. Duty of care principle

This principle stipulates that any organization that generates waste has a duty to dispose the waste safely. Therefore, it is the HCF that has ultimate responsibility for how waste is containerized, handled on-site and off-site and finally treated and disposed of.

b. Polluter pays principle

According to this principle, all waste producers are legally and financially responsible for the safe handling and environmentally sound disposal of the waste they produce. In case of an accidental pollution, the organization is liable for the costs of cleaning it. Therefore, if pollution results from poor management of HCW then the HCF is responsible. However, if the pollution results because of poor standards at the treatment facility then the HCF is likely to be held jointly accountable for the pollution with the treatment facility. Likewise, this could happen with the service provider. The fact that the polluters should pay for the costs they impose on the environment is seen as an efficient incentive to produce less and segregate well.

c. Precautionary principle

This is a key principle governing health and safety protection. When the magnitude of a particular risk is uncertain, it should be assumed that this risk is significant, and the measures to protect health and safety should be designed accordingly. Following this principle one must always assume that waste is hazardous until it is proved to be safe. This means that where it is unknown what the hazard may be, it is important to take all the necessary precautions.

Table 3. POPs listed under Stockholm Convention

Chemical	Stockholm Convention Annex	Use
Aldrin	A	Insecticide
Chlordane	A	Insecticide, termicide
DDT	B	Insecticide
Dieldrin	A	Insecticide
Endrin	A	Insecticide, rodenticide
Heptachlor	A	Insecticide, termicide
Hexachlorobenzene	A	Fungicide
Mirex,	A	Insecticide, termicide
Toxaphene	A	Insecticide
Polychlorinated Biphenyls	A	Industry manufacture; co-planar PCBs are by-product of combustion
Hexachlorobenzene	A	By-product of manufacture (chlorinated solvents, pesticides), application of pesticides, incineration of HCB containing wastes
Dioxins	C	By product
Furans	C	By product
Alpha hexachlorocyclohexane	A	By product
Beta hexachlorocyclohexane	A	By product, pesticides
Chlordecone	A	By product, pesticides
Hexabromobiphenyl	A	Industrial chemical
Hexabromodiphenyl ether, Heptabromodiphenyl ether	A	Industrial chemical
Pentachlorobenzene	A and C	Pesticide, Industrial chemical, By-product
Lindane	A	Pesticide
Tetrabromodiphenyl ether and pentabromodiphenyl ether	A	Industrial chemical
Perfluorooctane sulfonic acid, its salts and perfluorooctane sulfonyl fluoride	B	Industrial chemical
Endosulfan	A	Pesticides

Note : A = Parties must take measure to eliminate the production in use
B = Parties must take measure to restrict the production in use.
C = Parties must take measure to reduce the unintentional releases.

d. Proximity principle

This principle recommends that treatment and disposal of hazardous waste take place at the closest possible location to its source to minimize the risks involved in its transport. According to a similar principle, any community should recycle or dispose of the waste it produces, inside its own territorial limits.

2.2 Existing National Acts, Rules and Regulation related to HCWM

Considering that waste producers, HCFs have a legal and financial responsibility ("polluter pays principle") for managing HCW safely ("duty of care principle"), taking all necessary measures to minimize risks ("precautionary principle"). Nepal has endorsed policy, acts, rules and regulations, some of them which help to achieve these goals in the most cost-effective and sustainable way as possible are described below.

2.2.1 Solid waste management Act 2011

Solid Waste Management (SWM) Act 2011- provides legal basis and regulation for HCWM. The main objectives of the acts are:

- To make arrangement for the systematic and effective management of solid waste by minimizing the solid waste at source, re-using, processing or disposing of the solid waste, and
- To maintain the clean and healthy environment by minimizing the adverse effects of the solid waste in the public health and environment.

Section 2 of the act has defined medical waste and hazardous waste. According to this act, "medical waste" means the hazardous waste produced and discharged from hospitals, clinics, pharmacies, dispensaries, blood banks, pathology labs, veterinary institutions and health research centers and "hazardous waste" means the goods, substances and radioactive rays discharged in different forms which cause to degrade the natural environment and harm human health and the life of other animals.

Section 4 sub-section 1, 2 and 3 has made provisions for the responsibility of the management of the solid waste as given below:

1. The responsibility to manage or cause to manage solid waste shall rest with the local body.
2. Notwithstanding anything contained in sub-section 1, the responsibility for processing and management of hazardous waste, medical waste, chemical waste or industrial waste under the prescribed standards shall rest with the person or institution that has generated the solid waste.
3. If any industry or medical institution requests for the management of solid waste

remained after processing of hazardous waste, medical waste, chemical waste and industrial waste or other solid waste, or for using a sanitary landfill site constructed by the local body, the local body may manage the solid waste or allow the institution to use the sanitary landfill site by levying fees as determined by the local body.

Section 5 of the act has spelled the reduction in production of solid waste and states that it shall be the duty of every person, institution or entity to reduce the quantum of the solid waste by making arrangements to dispose the disposable solid waste within their own area or making arrangement for the reuse and discharging the remaining solid waste thereafter.

Section 6 of the act on segregation of the solid waste states that:

(1) The local body shall have to prescribe for segregation of solid waste at source by dividing the solid waste into different categories including at least organic and inorganic.

(2) The responsibility to segregate solid waste at source as prescribed by the local body pursuant to sub-section 1 and carrying them into the collection center shall rest with the person, institution or entity who produces the solid waste, and for this purpose the local body may provide necessary technology, goods, equipment, containers, etc. to them.

Section 7 sub-section 2 and 3 of the act on discharge of solid waste states that the person, organization and entity that produce hazardous waste or chemical waste shall have to manage such solid waste as prescribed; and the hazardous waste and chemical waste shall not be discharged in the solid waste collection center or transfer station.

Section 39 sub-section 8 of the act on punishment states the local body may impose a fine from fifty thousand to one hundred thousand rupees on anyone who commits offence as mentioned below:

- To throw, keep, discharge or cause to discharge chemical waste, industrial waste, medical waste or hazardous waste haphazardly;

- To throw, keep, discharge or cause to discharge hazardous waste produced by any industrial enterprise or health institution haphazardly; And if the same offence is committed again, it may also punish with a double fine as was imposed earlier and recommend to the concerned authority for cancellation of the license.

Section 43 sub-section 1 and 2 of the act on Management of Medical Waste states that the authority that grants license to establish a health institution as per the prevalent law shall, before granting license for establishment and operation of the health institution, confirm whether appropriate management has been made for solid waste management or not and it shall have to grant license only if appropriate arrangement is made. While granting license pursuant to sub-section 1, the special conditions to be abided by or the standards to be maintained by the health institution regarding solid waste management may also be prescribed.

2.2.2 The town development act 1989

The Town Development Act 1989 was promulgated in order to provide necessary services and facilities to the residents of the town by reconstructing, expanding and to develop existing towns and by constructing new towns and to maintain health, convenience and economic interest of general public. Section 9 of this act empowers the Town Development Committee to regulate, control or prohibit to do any act and activity which causes adverse effect on natural beauty, tourism site and public health or which causes environmental pollution.

2.2.3 The local self-governance act 1999

The Local Self-Governance Act 1999 has empowered the local body to fine anyone up to Rs.15,000 for haphazard dumping of solid waste. The act has made provisions for managing domestic solid waste; however, the act does not require the local governments to manage hazardous waste. According to the act, municipalities are supposed to preserve water bodies such as lakes and rivers and assist in controlling water, air and noise pollution.

2.2.4 The environmental protection act 1997 and environmental protection rules 1997

The Environmental Protection Act 1997 and Environmental Protection Rules 1997 were formulated to reduce adverse impacts on the environment likely to be caused from environmental degradation on human beings and ensure the proper use of natural resources for environmental conservation. Section 2 and sub-section (h) of the act defined waste as the liquid, solid, gas, slurry, smoke, dust, radiated element or substance or similar other materials disposed in a manner to degrade the environment. The act and the rule have made compulsory provisions for Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA), depnding upon the size of the project. Chapter 2 of the rule states that a proponent shall be required to carry out the IEE of the proposals for final disposal management of biological lethal substances emitted from health center, hospital, or nursing home with at least twenty five beds (The schedule 2 subsection H point 4 (c) of the rule and for operation of hospitals or nursing homes with more than twenty five beds (The schedule 2 subsection J point 1). Amendment of the rule has made provisions for the EIA for operation of Health Care Facility with more than hundred beds. Section 7 and sub-section 1 of act states that "Nobody shall create pollution in such a manner as to cause significant adverse impacts on the environment or likely to be hazardous to public life and people's health, or dispose or cause to be disposed sound, heat radioactive rays and wastes from any mechanical devices, industrial enterprises, or other places contrary to the prescribed standards." It is important to note that IEE for the health-care facilities has been administrated by MoHP whereas EIA has been administrated by Ministry of Science, Technology and Environment (MoSTE).

2.2.5 Solid waste management policy 1996

Solid Waste Management Policy is formulated relating to the management of solid wastes. The objectives of this policy are:

- To make management work of the solid wastes simple and effective.
- To minimize environmental pollution caused by the solid wastes and adverse effect thereof to the public health.
- To mobilize the solid wastes as resources.
- To privatize the management work of the solid wastes.
- To obtain public support by increasing public awareness in the sanitation works.

The policy has made a provision for the establishment of a separate unit concerning sanitation works in each municipal corporation, sub-municipal corporations, municipality and town-oriented village development committees where the management works of solid wastes has become a problem and such unit shall operate its works in close co-ordination with the national level institution concerning solid wastes management. The responsibilities of such an institution shall be as follows:

- To carry out collection, preservation, movement, site management, transportation and final disposal works of solid wastes by the local bodies having involved the private sector also, if necessary.
- To mobilize the human resources and other means available in the local body at the maximum.
- To introduce the concept and criteria of sanitation accepted by Government of Nepal.
- To involve non-governmental social organization in the sanitation works.
- To collect service charges from the person or organization generating solid wastes on the basis of volume and nature of the solid wastes.
- To punish or impose fine to a person who generates solid wastes in an unmanageable way and to use such amount in the sanitation works.

2.2.6 The industrial enterprises act 1992

The Industrial Enterprises Act 1992 was promulgated to facilitate the employment opportunities by creating an environment of industrial investment. The act states that for the establishment of a industy affecting safety, public health and environment permission from the concerned department is required. The act also has provisions to make arrangements for controlling environment by establishment of the industrial promotion board. The act gives priority to industries which manufacture pollution control devices. The act has also empowered the concerned authority to punish those who do not comply with the conditions mentioned in the license or registration certificate.

2.2.7 The labour act 1992

The Labour Act 1992, administrated by the Ministry of Labor, is the main regulation governing the working environment by making provisions for the rights, interests, facilities and safety of workers and employees working in enterprises of various sectors. Chapter 5 Section 27 of the act is related with the health and safety and some of the points included on this section are as follows:

- To make arrangements of removal and disposal of solid waste during production process.

- To make arrangements of prevention of accumulation of dust, fume, vapor and other impure materials in working rooms which would adversely affect the health.
- To make arrangements of necessary preventive personal devices for protection of health from adverse effects from any other source, and make provisions that this would produce less noise during the work process.
- To cause to conduct compulsory health check-ups of the workers or employees once every year in the enterprises where the nature of works is likely to affect the health adversely.

Section 28 sub-section 1 and 2 have the provisions of necessary protective devices for the protection of the eyes of the workers and employees from injuries likely to be caused by dust or pieces of glass, mercury, magnet, lime, stone, explosive substances and harmful rays. Section 29 has made provisions from chemical substance. The proprietor shall have to make provisions for necessary personal protective devices for the protection of workers or employees.

2.2.8 Guideline for health institutions establishment, operation and upgrade standard 2070

This guideline contains the code of conducts required for the operation of health institution. This guideline deals with the infrastructure and standards required for the operation of health institutions like emergency services, OPD and in-patient services, pharmacy, emergency preparedness, waste disposal and management and all other prerequisites.

In addition to the above mentioned national and international legislations and commitments, there are also other legal provisions and commitments, some of them are as follows:

- UN Minamata Convention on Mercury, adopted on October 2013 in Japan
- Second Long Term Health Plan 1997-2017
- Nepal Health Sector Program Implementation Plan 2010-2015
- National Guidelines on Clinical Trials with the use of Pharmaceutical Products 2005
- Standards for medical college and hospital as per the Ministry of Health and Population (MoHP) and Medical Council
- Standards of Medical College as per the university to be affiliated

Certain standards have also been endorsed which also need to be maintained for managing the sound environmental conditions of HCFs. Some of the standards are as follows:

- Waste water/effluent standards 2060
- National Drinking Water Quality Standard 2062
- National air quality standard 2069

3. Categorization

3.1 Definition

Actually HCW embraces all the wastes generated through all the medical activities. Medical activities include the activities of:

- Diagnosis, preventive, curative and palliative treatments for human beings
- Research pertaining to the above activities and
- Production or testing of biologicals

Some examples of sources of HCWs are:

- Hospitals
- Primary health care centers, health post, sub-health posts, immunization (EPI clinic), primary health care outreach clinics (PHC ORC)
- Clinics (medical, primary health care, alternative medicines, dental, maternity homes, dialysis centers, physician offices)
- Laboratories and research centers (medical and biomedical laboratories, medical research centers and institutions, blood banks and blood collection centers, biotechnology laboratories, pathological laboratories, microbiological laboratories)
- Pharmacy and medical store
- Institutions (medical, nursing home, dental, nursing, paramedics, drug rehabilitation centers)
- Mortuary and autopsy centers
- Ambulance and emergency care

3.2 Categorization based on the UNEP/SBC/WHO

Health care wastes have been classified into different categories by different organizations. Below provided HCW categorization is based on the Technical Guidelines on Environmentally Sound Management of Biomedical and Health care waste provided by the Conference of the Parties to the Basel Convention on the Control of Trans-boundary Movements of Hazardous Waste and their Disposal. (UNEP/SBC/WHO, 2004) According to this, HCW is basically divided into five categories.

3.2.1 Non-risk health care waste

Non-risk HCWs are those wastes generated from the HCFs which have not been infected. This type of waste does not pose any problem or hazard to human health or to the environment and are comparable to the domestic waste. It is usually generated from the administrative and house-keeping services of HCFs. Examples of such wastes includes: general office waste, garden/yard waste, packaging or left over food. These wastes can be composted to make manure or can be recycled or can be managed by the municipal waste services. Researches have shown that non-risk HCWs constitute about 75% to 90% of the total amount of HCWs generated by HCFs. Non-risk HCWs are again classified as follows:

i. Recyclable HCW

It includes paper, card board, non-contaminated plastic or metal, cans or glass which can be recycled. These can be sold to the recycling company to generate money.

ii. Biodegradable HCW

This category of waste consists of the waste that can be composted. Examples are left over food scraps or gardens. Food scraps can provide most of the nitrogen while bulking agents such as wooden chips could provide carbon. The composting techniques range from the simple anaerobic to vermin-composting. The resulting rich compost can be used as manure by the community people or it can be used for plants around the HCF.

iii. Other non-risk HCW

This category of non-risk waste includes all the non-risk waste that does not belong to categories of recyclable HCW and biodegradable HCW.

3.2.2 Health care waste requiring special attention

This category of HCW constitutes the biomedical HCW which needs special attention for disposal and it includes five types of wastes namely; human anatomical waste, sharp waste, pharmaceutical waste, cytotoxic pharmaceutical waste and blood and body fluids, as described below:

i. Human anatomical waste

Human anatomical waste consists of human body parts, organs and tissues. Examples of such wastes are: tissue waste, removed organs, amputated body parts, placentas, blood, body fluids, human fetus, animal and carcasses obtained through medical procedures.

ii. Sharp Waste

Sharps are all objects and materials capable of cutting or penetrating skins. These wastes pose a potential risk of injury and infection due to their puncture or cut property. For this reason, sharps are considered as one of the most hazardous waste generated in the HCFs and they must be managed with utmost care. Sharp waste may be contaminated with blood, body fluid, microbiological materials and toxic or cytotoxic substances. Examples of such wastes include: all types of needles, broken glass ware, ampoules, scalpel blades, lancets, cover slips, glass slides, vials without content, various plastic items such as amniotic membrane perforators and broken plastic pipettes.

iii. Pharmaceutical waste

Pharmaceuticals include a multitude of active ingredients and types of preparations. Pharmaceuticals range from heavy metal containing disinfectants to highly specific medicines. This category of waste also comprises pharmaceuticals that have passed their recommended shelf life or pharmaceuticals that are unusable. Pharmaceutical wastes are again divided into three classes.

- **Non-hazardous pharmaceutical waste**

  This class includes pharmaceuticals such as camomile tea, normal saline, dextrin or cough syrup, which pose no hazard during collection, intermediate storage and waste management. They are not considered hazardous wastes and should be managed as non-risk HCW.

- **Potentially hazardous pharmaceutical waste**
  This class of pharmaceutical waste poses a potential hazard when used improperly by un-authorized persons. They are considered as hazardous wastes and their management must take place in an appropriate way.

- **Hazardous pharmaceutical waste**
  This pharmaceutical waste comprises heavy metal containing unidentifiable pharmaceuticals as well as heavy metal containing disinfectants, which owing to their composition require special management. They must be considered as hazardous wastes and their management must take place in an appropriate way.

iv. Cytotoxic pharmaceutical waste

Cytotoxic pharmaceutical wastes are HCWs that can arise by use (administration to patients), manufacture and preparation of pharmaceuticals with a cytotoxic (antineoplastic) effect. These chemical substances can be sub-divided into six main groups: alkylated substances, antimetabolites, antibiotics, plant alkaloids, hormones, and others.

- Alkylating agents cause alkylation of DNA nucleotides, which leads to cross-linking and miscoding of the genetic stock.
- Anti-metabolites inhibit the biosynthesis of nucleic acids in the cell; mitotic inhibitor; prevent cell replication.

Persons who handle cytotoxic pharmaceuticals are exposed to potential health risk from the mutagenic, carcinogenic and teratogenic properties of these substances. Special measures and precaution must be taken to handle such pharmaceuticals for occupational health and safety provisions. Cytotoxic drugs are being increasingly used in HCFs to treat various malignant and non-malignant conditions such as cancer, rheumatoid arthritis, multiple sclerosis, psoriasis, systemic lupus erythematosus (SLE) and some ophthalmic conditions. Examples of such wastes include: discernible liquid residues of cytotoxic concentrates, post-expiration-date cytotoxic pharmaceuticals and contaminated materials from drug preparation and administration such as syringes, needles, gauges, vials; urine, feces and vomit from patients which may contain potentially hazardous amounts of the administered cytotoxic drugs or of their metabolites and these should be considered genotoxic for at least 48 hours and sometimes up to 1 week after drug administration and these must be disposed of as cytotoxic pharmaceutical waste. It is recommended to prepare separate guideline for management of cytotoxic pharmaceuticals by HCFs handling cytotoxic drugs.

v. Blood and body fluids waste

It includes wastes that are not categorized as infectious waste but are contaminated with human or animal blood, secretions and excretions. These wastes might be contaminated with pathogens. Examples of such wastes include: dressing material, swabs, syringes without needle, infusion equipment without spike, bandages.

3.2.3 Infectious and highly infectious waste

These wastes consist of the pathogen and its contamination cause the spread of the diseases. These wastes must be imposed whenever waste is known or expected to be contaminated by causative agents of diseases. This category of waste has been divided into two groups depending on the degree of infectiousness that is expected.

i. Infectious waste

This category of HCW comprises of those kinds of infectious waste, which is known or clinically assessed by a medical practitioner or surgeon to have the potential of transmitting infectious agents to humans or animals. Waste of this kind is typically generated in the following places: isolation wards of hospitals; dialysis wards or centers caring for patients infected with hepatitis viruses (yellow dialysis); pathology departments; operating theatres; medical practices and laboratories which mainly treat patients suffering from the diseases specified above. It includes following wastes:

- Discarded materials or equipment contaminated with blood and its derivatives, other body fluids or excreta from clinically confirmed infected patients or animals with hazardous communicable diseases. Contaminated waste from patients known to have blood-borne infections undergoing hemodialysis (e.g. dialysis equipment such as tubing and filters, disposable sheets, linen, aprons, gloves or laboratory coats contaminated with blood).

- Carcasses as well as litter and animal feces from animal test laboratories, if transmission of the above-mentioned diseases is to be expected.

Blood from patients contaminated with HIV, viral hepatitis, brucellosis, Q fever, feces from patients infected with typhoid fever, enteritis, cholera and respiratory tract secretions from patients infected with TB, anthrax, rabies, poliomyelitis are also considered as infectious waste.

ii. Highly infectious waste

This category of HCW includes:

- All microbiological cultures in which a multiplication of pathogens of any kind has occurred. They are generated in institutes working in the fields of hygiene, microbiology and virology as well as in medical laboratories, medical practices and similar establishments.

- Laboratory waste (cultures and stocks with any viable biological agents artificially cultivated to significantly elevated numbers, including dishes and devices used to transfer, inoculate and mix cultures of infectious agents and infected animals from laboratories). Examples of such wastes: sputum cultures of TB laboratories, contaminated blood clots and glassware material generated in the medical analysis laboratories, highly concentrated microbiological cultures carried out in medical analysis laboratories.

3.2.4 Other hazardous waste

This category of HCW include waste chemicals, waste with high contents of heavy metals such as batteries, pressurized containers, etc. Chemical waste consists of discarded gaseous, liquid and solid chemicals that are generated during diagnostic and experimental work and from disinfecting procedures, cleaning processes and house-keeping. Not all of them are hazardous and chemical waste is considered hazardous if it has at least one of the following properties:

- Toxic,
- Corrosive (acids of pH <2 and bases of pH >12),
- Flammable,
- Reactive, (explosive, water-reactive, shock sensitive)
- Cytotoxic or genotoxic properties.

They must be used and disposed of according to the specifications provided with each type of chemical. Waste with high contents of heavy metals and their derivatives are potentially highly toxic. They are considered as a sub-group of hazardous chemical waste and are usually highly toxic; should be treated specifically. Mercury wastes are usually generated by spillage from broken clinical equipment (thermometer, blood pressure gauges, etc). Residues from dentistry have high mercury content. Cadmium waste comes from the discarded battery. Many types of gases used in HCFs are often stored in pressurized cylinders. Pressurized containers either full or emptied should be handled with care these containers may explode if incinerated or accidently punctured. Examples of such wastes: thermometers, blood-pressure gauges, photographic fixing and developing solutions in X-ray departments, halogenated or non-halogenated solvents, organic and in-organic chemicals, containers or aerosol cans with pressurized liquids, gas or powdered materials.

3.2.5 Radioactive waste

Radioactive wastes include materials contaminated with radio-nuclides, which arise from the medical or research use of radio-nuclides. It includes disused sealed radiation source, liquid and gaseous material contaminated with radionuclide, excreta of patients who underwent radionuclide diagnostic and therapeutic applications, paper cups, straws, needles syringes, test tubes and tap water washing of such paraphernalia. These wastes are generated from in-vitro analysis of body tissue and fluid, in-vivo body organ imaging and tumor localization, and investigative and therapeutic procedures. These wastes with ionizing radiations have genotoxic effects. It is produced during nuclear medicine, radio-immuno assay (RIA) and bacteriological procedures. The ionizing radiations in medicine include X-rays and γ-rays as well as α- particles and β- particles. It concerns mainly therapeutic and imaging investigation activities where Cobalt (60Co), Technetium (99mTc), Iodine (131I) and Iridium (192Ir) are most commonly used. Certain radionuclide e.g. C-14 contaminated wastes have much longer half-life more than a thousand years, this needs special management, if possible in a centralized treatment facility (CTF) for radioactive wastes. Similar treatment is recommended for the management of disused radiation sources used for cancer treatment. In case of unavailability of CTF, it should be stored safely till it decays.

3.3 Categorization at nepalese context

At the present context, HCFs in Nepal are still at infancy in the HCWM practices. Proper management of above categorized HCWs is a big challenge for Nepal. Wherever possible, the above classification by UNEP/SBC/WHO is recommended for the segregation of HCWs. Considering the geographic and climatic variation of the country, the categorization should entirely depend on the nature of the HCFs generating wastes and the available techniques of their treatment and disposal. Based on the amount and categories of generated HCWs, the number and types of HCWs can be decreased or increased. However, it is recommended that the non-risk HCW should not be mixed with other types of HCWs. Non-risk HCW should at least be separated into:

- Bio-degradable
- Non-biodegradable

Risk health care wastes should at least be separated into six categories as mentioned below:

- Pathological Waste
- Infectious waste
- Sharp waste
- Cytotoxic waste
- Pharmaceutical waste
- Other hazardous waste

4. Possible Environmental and Health Impacts

In Nepal, health care sector is expanding enormously and this has resulted in generation of large quantities of HCWs. HCWs are either being dumped by the river bank or go to the landfill site along with domestic waste. In many cases HCWs are burned in metal drums or just openly. This results in the emissions of by-products and toxic substances into the environment. Improper disposal of HCWs pollute environment either due to the contamination of ground water, soil or by releasing several toxic gases like dioxin and furan along with the heavy toxic metals like lead, mercury and cadmium. All individuals exposed to HCWs are potentially at risk of being injured or infected specially due to infectious and sharp waste.

4.1 Occupational and public health risks

All individuals, who are exposed to hazardous HCWs are potentially at risk of being injured or infected. They include:

- Medical staff: doctors, pharmacists, laboratory technologists, nurses, paramedics, sanitary staff and hospital maintenance personnel
- In and out patients: receiving treatment in HCFs as well as their visitors
- Workers in support services: linked to HCFs such as laundries, waste handling and transportation services
- Workers in waste disposal facilities: including scavengers
- The general public: mostly the children playing with the items they can find in the waste outside the HCFs when it is directly accessible to them.

During handling of wastes (especially infectious and sharps), the medical and auxiliary staff as well as the sanitary staffs can be infected and injured if the waste has not been packed safely. Many injuries occur because syringes, needles or other sharps have not been collected in safety boxes or because these have been over filled. The unsafe disposal of HCWs (for example, contaminated syringes and needles) poses health risks to medical personnel or the public. One cross-sectional study carried out in Gandaki Medical College Teaching Hospital showed that 70.79% health care workers had experienced Niddle Stick Injury (NSI) among them 52.5% suffered from NSI with unused needles and 47.5% health care workers suffered NSI from used needles; 68.42% of NSI sufferer of used needles reported the incident. (Gurung, et al, 2010)

Contaminated needles and syringes creat a big threat if we failure to dispose them safely. Contaminated injections and equipments may be scavenged from waste areas and dump sites and are either reused or sold keeping the public at risks. Experts working on health care and solid waste management expressed that the recycling practices, particularly the reuse of syringes, is certainly the most serious problem in Nepal. WHO estimates that over 20 million infections of hepatitis B, C and HIV occur yearly due to unsafe injection practices (reuse of syringes and needles in the absence of sterilization) and transmits via HCWs. Generally, these viruses are transmitted through injuries from syringe needles contaminated by human blood. WHO estimated that, in 2000, contaminated injections with contaminated syringes caused:

- 21 million hepatitis B virus (HBV) infections (32% of all new infections);
- 2 million hepatitis C virus (HCV) infections (40% of all new infections); and
- at least 260000 HIV infections (5% of all new infections).

Sharps not only cause cuts and punctures but may also infect these wounds if they are contaminated with pathogens. Because of this double risk of injury and disease transmission, sharps are considered as one of the most dangerous categories of HCWs. The general public can be infected by HCWs either directly or indirectly through several routes of contamination.

Infectious waste may contain variety of pathogenic microorganisms. Pathogens in infectious waste may enter the human body through a puncture, abrasion, cut in the skin; mucous membranes; inhalation or by ingestion and can have major adverse effects to the community. Examples of infection caused by the HCWs are given in 4.

Table 4. Infection caused by the HCWs

Type of infection	Examples of causative organisms	Transmission vehicles
Gastroenteric infections	Enterobacteria (Salmonella, Shigella spp.); Vibrio cholerae; helminthes	Feces and/or vomit
Respiratory infections	Mycobacterium tuberculosis; measles virus; Streptococcus pneumoniae	Inhaled secretions; saliva
Ocular infection	Herpes virus	Eye secretions
Genital infections	Neisseria gonorrheae; herpes virus	Genital secretions
Skin infections	Streptococcus spp.	Pus
Anthrax	Bacillus anthracis	Skin secretions
Meningitis	Neisseria meningitides	Cerebrospinal fluid (CSF)
HIV/AIDS	Human immunodeficiency virus (HIV)	Blood, sexual secretions
Hemorrhagic fevers	Junin, Lassa, Ebola, Marburg viruses	All bloody products and secretions
Bacteremia	Coagulase-negative Staphylococcus spp.; Staphylococcus aureus; Enterobacter, Enterococcus, Klebsiella, Streptococcus spp.	
Candidemia	Candida albicans	Blood
Viral hepatitis A	Hepatitis A virus	Feces
Viral hepatitis B and C	Hepatitis B and C viruses	Blood and body fluids

Source: WHO, 1999

In addition, the existence of bacteria resistant to antibiotics and chemical disinfectants in HCFs may also contribute to the hazards created by poor management of HCWs. It has been demonstrated that plasmids from laboratory strains contained in HCWs were transferred to indigenous bacteria via the waste disposal system. (WHO, 1999) Moreover, antibiotic-resistant Escherichia coli survive in an activated sludge plant, although there is no significant transfer of this organism under normal conditions of waste water disposal and treatment.

4.2 Indirect risks via the environment

Besides patients and health care personnel, consideration must be given to the impact of HCWs to the general public and environment. Care must also be paid to the possible pollution of air, water and soil including the aesthetic beauty. The dumping of HCWs in uncontrolled areas can have a direct environmental effect by contaminating the surroundings including the ground water. Obsolete pesticides (especially DDT used for the treatment of malaria in HCF), stored in leaking drums or torn bags, can directly or indirectly affect the health of anyone who comes into contact with them. Poisoning can occur through direct contact with the product, inhalation of vapors, drinking of contaminated water, or consuming of contaminated food. Other hazards may include the possibility of fire as a result of inefficient disposal such as burning. Pharmaceutical residues, which may include antibiotics and other drugs, heavy metals such as mercury, phenols and derivatives, and disinfectants and antiseptics may have toxic effects on the natural ecosystems.

Mercury has been used over centuries in the HCFs. The mercury exposed to the environment due to broken thermometers, sphygmomanometer, due to accidental spills and emissions from the incineration of HCWs increase the risk of various hazards resulting due to acute and chronic exposures. The most common potential mode of occupational exposure to mercury is via inhalation of metallic liquid mercury vapors. Mercury, due to its potent neurotoxic nature, can affect brain, spinal cord, kidneys and the development of children. Due to the growing awareness on mercury related hazards on the public health and environment, Nepal has recently banned the purchase and use of mercury containing devices in all the HCFs. Mercury based medical devices are being slowly replaced with mercury-free alternative devices in the HCFs.

Inefficient incineration and open burning of HCWs are the main sources of dioxins, furans, and are major sources of mercury pollution in HCFs. In the last few years, there has been growing controversy over the incineration of HCWs. Under some circumstances, including when wastes are incinerated at low temperatures or when plastics that contain polyvinyl chloride (some plastics, some blood bags and fluid bags) are incinerated, dioxins, furans and other toxic air pollutants may be produced as emissions and/or in bottom or fly ash. Dioxins, furans and co-planar polychlorobiphenyls (PCBs) are persistent organic substances that do not readily break down in the environment and bio-accumulate in the food chain. Most human exposure to dioxins, furans and co-planar PCBs is through the intake of food. Long-term, low-level exposure of humans to dioxins and furans may lead to the impairment of the immune system, nervous system, endocrine system and reproductive functions. Short-term, high-level exposure may result in skin lesions and altered liver function. WHO has established a Provisional Tolerable Monthly Intake (PTMI) for dioxins, furans, and polychlorinated biphenyls (PCBs) of 70 picograms (10-12 g) per kilogram of body weight. The PTMI is an estimate of the amount of chemical per month that can be ingested over a life time without appreciable health risk. (WHO, 1999)

National Implementation Plan for Stockholm Convention on POPs has estimated the annual release of dioxin and furan at about 335.97 gTEQ. Out of which 12 gTEQ is coming from medical waste incinerators and 159 gTEQ is coming from uncontrolled burning of biomass including waste. (MoEST, 2007)

Thus, dioxins, furan and mercury emissions from HCFs are a major environmental and health challenges. Substantive steps need to be taken to reduce these emissions by waste minimization, environmentally safe alternatives and in-house management of waste in the HCFs.

5. Organizational Issues

Government of Nepal has been conducting various programs and activities on HCWM including awareness raising, orientation, training to health care workers; however, HCWM is not so effective due to following reasons:

- Lack of specific policy and legislation on HCWM
- Weak implementation of existing policy, acts, rules and guidelines
- Inadequate coordination with the concerned stake holders
- Low priority to HCWM.
- Inadequate awareness regarding the impacts of HCWs to the public health and environment
- Inadequate monitoring and evaluation
- Lengthy procurement procedure

Experts' opinion and experiences show that installation of individual treatment facilities by small HCFs requires comparatively high capital investment. Furthermore, it requires separate human resource and infrastructure development for proper operation and maintenance. Thus concept of Central Treatment Facility (CTF) for HCWs addresses such problems. This concept of CTF can be one of the options for the proper HCWM. In such a scenario, individual HCFs should manage their HCWs on their own efforts. Some HCFs such as Civil Service Hospital and Bir Hospital are managing their HCWs by applying 'zero waste concept' for HCWs generated from wards and operation theater and are the encouraging model of the HCWM practices in Nepal.

Whether the generated HCWs are treated and disposed in CTF or in the hospital premises or in the municipal landfill site, HCF shall be responsible for the proper treatment and disposal of the generated HCWs. In this context, HCF itself can manage the HCWs or can contract the civil society organization/private organization for the proper management of HCWs. Each HCF shall be responsible for the development of waste management plan for their HCF, outlining the accountabilities and responsibilities of managers, employees and staffs. The HCF shall comply with guidelines, to ensure proper HCWM i.e. proper classification, segregation, collection, transportation, treatment, and disposal. Options for HCWM plan depend entirely on the local context. Additionally, locally available technology and maintenance is an important consideration while making HCWM plan. Generally, a HCWM plan should be implemented from the onset of planning a HCF. So, every HCF must develop its HCWM Plan. Certain basic steps are needed for the development of proper HCWM plan, which are discussed in the next heading.

5.1 Planning and organization

Efficient and appropriate HCWM practices depend entirely on the administration and management of the organization. This requires adequate legislative and financial support along with the active participation by trained, skilled and dedicated staff. The entire organizational structure and service of HCF must be responsible for the proper management of HCW; however, certain units and individual have more responsibility. Thus, particular services/units within the HCF must be identified to have major role on HCWM. The functions of the administrations are provided in the paragraph below.

5.1.1 Function of the administration office

- Form a health care waste management committee (HCWMC) to develop a written waste management plan for the HCF.
- Designate a waste management officer to supervise and coordinate the waste management plan.
- Keep an up-to-date waste management plan.
- Ensure that monitoring procedure is incorporated in the plan. The efficiency and effectiveness of the waste management system should be monitored in such a way that the system can be updated and revised whenever necessary.
- Ensure adequate training for the key staff members and designate the staff responsible for coordinating and implementing the training course.
- Establish good working relationship with related organizations concerning HCWM.
- Establish good community relationship through the awareness raising activities to the community people.

5.1.2 Health care waste management committee (HCWMC)

As mentioned above, every HCF should have HCWMC and the committee should constitute at least following members:

- Chief/Director of the HCF
- Department Heads
- Matron
- Waste Management Officer
- Representative from support staff (sweeper)

For other smaller HCF, the waste management committee must have the following members:

- Chief of the HCF
- Technical staff
- Support staff (sweepers/worker)

The functions of HCWMC will be as follows:

- Promulgate a strategy formalizing the commitment of HCF to proper HCWM with the prime goal of protecting health and environment.
- Establish baseline data and develop the HCWM plan which must include, training and written guidelines on waste management from waste generation to waste treatment and final disposal.
- Implement the HCWM plan and review and update the plans and guidelines in an annual basis.
- Ensure adequate financial and human resources for the implementation of HCWM plan

(to support this, the authorized body can recommend the formulation of strategy to allocate certain percentage of total budget for HCWM).

- Assign responsibility to each member of the committee.

5.1.3 Health care waste management plan

A comprehensive waste management plan is essential for safe and efficient waste management in a HCF. While developing the waste management plan, first step is the assessment of the generation of waste within the facility. The assessment begins with establishing a baseline of how much and what kind of waste is being generated by whom in each department/ward. This involves gathering data regarding the waste streams, processes and operations, types of practices, information on input materials and economic information. Waste audit is an important tool for the assessment phase, providing data on the source of waste, compositions, generation rates and waste flow within the HCF. Data can be collected in-house using self-audit forms and questionnaires. Data collected for few days provides a snapshot of the waste flow and data collected for continuous seven days provides a clear picture of waste generation, as the waste generation pattern differs from day to day. Through this data the HCF can establish the flow of waste and generation rates from every unit/department of the HCF. Waste composition data can be used to determine segregation practice. Data from the waste generation survey should form the basis while developing HCWM plan. Following procedures should be taken into consideration while developing HCWM plan:

- Existing policies, laws, regulations and guidelines related to HCWM
- Review and assess the current waste management stream within HCF before drafting or revising HCWM plan, some of the issues to be addressed are:

  - Where waste is generated
  - What types of wastes are being generated
  - How the waste are being categorized
  - How the waste are being segregated
  - How and where the waste are being collected, stored and transported
  - How the waste are being treated and disposed
  - The cost effectiveness of the current handling process
  - Personal safety of the waste handlers.

- Design the plan taking in consideration the existing and future needs of the HCF. Care must be taken such that the plan is capable of handling the current waste stream properly and efficiently.
- Comprehensive training and orientation on how the plan is to be implemented and each of the staff should know their individual roles and responsibility.
- The plan should be regularly reviewed and updated based on the recommendations of the implementation and monitoring and evaluation teams.

5.2 Implementation

Implementation of the HCWM plan includes the following activities:

- Interim measures to be introduced to complete implementation of the new waste management system according to the HCWM plan.
- Appoint personnel responsible for waste management.
- Organize and supervise training program to all staffs.
- Launch educational and communication program.
- Install necessary new equipment and ensure that the waste management operation is put in place as per waste management plan.
- HCWMC should review the plan annually and initiate change to upgrade the system, interim revisions may also be made if and when necessary.
- Prepare an annual report for the disposal of HCW, providing data on waste generation, equipment requirement and costs.

5.3 Monitoring and Evaluation

Regular monitoring and evaluation of the plan in each HCF should be performed. It helps to find out the loop holes, bottle necks and reveal the new issues which have come in managing the HCWs. It helps to have recommendations and shortcoming of the programs and also provides an opportunity to educate staff and reinforce good practices. Three types of monitoring mechanism need to be enforced for the progressive improvement and sustainability of the HCWM system. They are:

- Baseline monitoring
- Compliance monitoring
- Impact monitoring

Baseline and compliance monitoring should be performed by the person(s)/authority designated by existing HCWMC. Impact monitoring and evaluation should be conducted through a third party i.e. externally. A comprehensive list of indicators for compliance and impact monitoring must be developed for effective implementation of HCWM plan.

Baseline monitoring identifies the changes in basic environmental conditions whereas compliance monitoring identifies whether the concerned parties follow the rules and guidelines or not. Compliance monitoring should be done at two stages, one during construction of treatment unit/facility and another during the operation of entire plan. At the construction phase, it is important to check out whether the appropriate equipment is being installed properly. During operation, it has to be ensured that infectious and hazardous wastes are being handled properly and the equipment is being operated as per the Sanderd Operating Procedure (SOP). The monitoring should be in compliance with EIA and IEE requirements along with the HCF requirements.

Impact monitoring pinpoints the positive and negative changes that have been brought about by the establishment of HCWM system. Impact evaluation should thoroughly analyze:

- Impact
- Relevance
- Effectiveness and efficiency
- Sustainability

- Replicability

During impact evaluation, the recommendation and major lesson learnt should also be provided through opinion survey, consultation and secondary data analysis.

6. Waste Management

Health care waste includes a large component of general waste and a smaller proportion of hazardous waste. According to the WHO estimation, among the total amount of HCW generated, 80% is general HCW, 15% is pathological waste and infectious waste, 1% is sharp waste, 3% is chemical or pharmaceutical waste and less than 1% special waste such as radioactive or cytotoxic waste, pressurized container or broken thermometer and used batteries. Thus, very less amount of HCWs is hazardous if it is properly managed.

Solid Waste Management Act 2011 has clearly indicated that processing and management of hazardous waste, medical waste, chemical waste or industrial waste under the prescribed standards shall rest with the person or institution that has generated the waste. The Stockholm Convention is related with the reduction and total elimination of unintentional production of persistent organic pollutants (POPs) and has given priority for Best Available Technique (BAT) and Best Environmental Practice (BEP). In our context, following basic steps are considered essential for the proper waste management:

- Waste minimization
- Waste segregation
- Waste collection and storage
- Waste transportation
- Waste treatment and disposal

6.1 Waste Minimization

Waste minimization is defined as the prevention of waste production and/or its reduction. Waste minimization usually benefits the waste producer by reducing the costs for the purchase of goods. It involves specific strategies of changes in management and behavioral change. At the top of the waste minimization options is waste avoidance strategy. Achieving this goal means changing work practices. How we choose to go about our work often dictates how much waste we generate, for example what is our behavior? do we use disposable or reusable equipment? do we send paper memos or e-mails? do we bring our own cup or use a disposable one? Thus, methods of waste reduction include modification of purchasing procedures, control of inventory, and production of less toxic materials when discarded as wastes. However, no actions should be taken that would impact on the quality and limit the access to health care. Waste minimization can be achieved through:

- Waste reduction at source (product substitution, product change, procedural change)
- Giving preference to recyclable and reusable items

6.1.1 Waste reduction at source

Reduction involves measures that either completely eliminate use of a material or generate less waste. Examples are improving house-keeping, reviewing purchasing policies without compromising work standards or environmental outcomes. Reduction can also be achieved through product substitutions, and modifications. While purchasing the product, it should be carefully assessed in terms of its potential to generate problematic waste, result in toxic emissions, or be detrimental to the operation and maintenance of treatment facilities in the long turn. Some of the examples are: mercury thermometer should be replaced with electronic/ digital thermometer, work with supplier to reduce packaging of the products. Simple changes to patient care procedures can also be made to minimize the wastes generated. Some of the examples are as follows:

- When preparing for dressing, cleaning and sterile procedures, practitioners should critically assess material required. Unwanted extra materials should be removed for re-sterilization or reuse. This should occur prior to the commencement of the procedure, which minimize the potential of contamination.
- Review frequency of waste collection, size and location of containers and bags.

Some of the reduction policies include:

- Purchasing reductions: selection of supplies, which are less wasteful or less hazardous
- Use of physical rather than chemical cleaning methods (e.g. steam disinfection instead of chemical disinfection)
- Prevention of wastage of products, e.g. in nursing and cleaning activities.

6.1.2 Giving preference to reusable and recyclable items

Product recycling and reuse can minimize the volume of HCWs, though a high standard of patient care and worker safety may preclude reuse of some items. Plastic syringe, catheters and waste contaminated with radioactive substances such as plastic, disposable gloves, syringes and needles can not be recycled or reused. Medical and other equipments used in HCF may be reused provided that it is designed for the purpose and will withstand the sterilization process; some examples are scalpels, glass bottles and containers. After use, reusable items should be collected separately from non-reusable items, carefully washed and sterilized by one of the available processes; however, infectious waste should not be washed before sterilization. Instead, washing is recommended after sterilization before sending it into recycling. HCFs should critically examine current waste streams and determine what product can be separated out at the point of generation to be effectively recycled. Some of the materials which can be recycled are given below:

- Glass
- Plastics
- Aluminium cans
- Paper and card board
- Iron

Before beginning any reclamation/recycling program, it is recommended to review the possible uses for these products.

6.2 Waste Segregation

Waste segregation refers to the process of separation of waste at the point of generation and keeping them apart during handling, collection, interim storage and transportation. Segregation of the waste at source is the key principle of successful and safe waste minimization and is the most important step for a successful management of HCW. In fact, it reduces the quantity of that wastes, which are hazardous and require special attention and treatment. It is highly recommended that segregation of HCW occurs on-site at the time the waste is generated, for example, when an injection is given, needle and syringe are placed in a different waste container, or when packaging is removed from supplies and equipment and kept separately. Thus, segregation must take place at the bed site, at the operation theater, at ward, at laboratory, wherever it is generated. Non-risk waste (e.g. paper, glass, plastic, iron) can be recycled. Non-risk biodegradable organic wastes (i.e. food waste, garden waste) can be composted. Infectious waste must never be mixed with non-infectious waste to keep the volume of infectious waste as low as possible.

Segregation of waste (Source, MD-DoHS)

Given the fact that only about 10-25% of the HCW is hazardous, treatment and disposal costs can be greatly reduced if a proper segregation is performed. Segregating risk wastes from non-risk waste greatly reduces the risks of infecting workers handling HCWs. Based on the hazardous properties of the waste, the type of treatment and disposal practices that are applied to the waste generated. A recommended way of identifying HCW categories is by sorting the waste into color-coded and well-labeled bags or containers. Sturdy (rigid walled) containers should be used and container should be selected according to the following criteria:

- The opening must be wide enough to allow disposable materials to be dropped into the container by a single hand operation. Depending on the bulk of the disposable material for which the particular container is designed, the aperture should, under normal conditions of use, inhibit removal of the contents.
- If retractable lids are incorporated, they should be designed or long forceps should be provided so that there is never need to push material into the container by hand.
- Container should be designed to minimize the possibility of external surface being contaminated when disposing of a used item.
- The container wall must be impermeable to fluids and non-readily penetrable. Hance, card board containers are never acceptable for this purpose.

- After being sealed, all types of containers must be leak-proof.
- The container must be capable of being securely sealed and remaining sealed during transport.
- The container must be safe and easy to handle.

All the specific procedures of HCW segregation, packaging and labeling should be explained to the medical and auxiliary staff and displayed in each department/ward on charts located on the walls nearby the HCW containers that should be specifically suited for each category of waste. Segregation should:

- Always take place at the source, i.e. at the ward, bed side, operation theater, medical laboratory, pharmacy or any other room or ward in the HCF, where the waste is generated.
- Be simple to implement for the medical and auxiliary staff and applied uniformly.
- Be safe and guarantee the absence of infectious HCWs in the domestic waste flow.
- Be well understood and well known by the medical and ancillary staff of the HCFs.
- Be regularly monitored to ensure that the procedures are followed strictly.

Apart from these, following should also be followed:

- All sharps should be collected together, regardless of whether they are contaminated or not. Container should be puncture proof made of either metal or high density plastic and fitted with covers. It should be rigid and impermeable to contain not only sharps but any residual liquids from syringes. To discourage abuse, containers should be tamper proof and needles and syringes should be rendered unusable.
- Bags and containers for infectious and highly infectious waste should be marked with the internationally approved symbol for infectious waste.
- Waste with high content of heavy metals (e.g. cadmium or mercury) should be collected separately.

The recommended color-coding of the containers for different categories of the wastes is provided in Table 5.

Table 5. Recommended color-code for the container, labeling and international signs for segregation of HCW

Waste Category, symbol and labeling		Color Code for Container	Examples of wastes
Non-risk HCW	Non-risk waste Biodegradables	Green	Left over stuff foods, gardens, fruits peels, flowers etc.
	Non-risk waste Recyclable 	Dark Blue	Non-biodegradable, which can be recycled: plastic bottles, cans, metals, glass, plastics, papers, rubber etc.
	Other non-risk HCW	Light Blue	Other HCW, that do not belong to bio-degradable and recyclable.

HCW requiring special attention	Pathological waste  Danger! Pathological waste	Red	Human body parts, organs, human tissues, removed organs, amputated parts, bone marrow.
	Hazardous Sharps  Danger! contaminated sharps Do not open	Red	Needles, glass syringes with fixed needles, scalpels, blades, glass, etc. which may cause puncture and cuts.
	Pharmaceuticals	Red	Unused and date expired drugs
	Cytotoxic pharmaceutical waste  Danger! Hazardous Infectious waste	Red	Waste with anti-neoplastic effect such as: alkylated substances, anti-metabolites, antibiotics, plant alkaloids, hormones, etc.
Infectious and Highly infectious waste	Danger! Hazardous Infectious waste 	Brown	Discarded items contaminated with blood and body fluids from clinically confirmed infected patients including cotton, dressings materials, soiled plaster, linen, bedding, swabs, gloves, syringes without needle, infusion equipment without spike, bandages, other materials contaminated with blood, dialysis equipment, blood from patients infected with HIV, viral hepatitis, brucellosis, respiratory tract secretion from patients infected with TB, anthrax, rabies.
	Danger! Highly infectious waste . 	Brown	Waste generated from the microbiological cultures, laboratory waste, such as sputum cultures of TB laboratories, highly concentrated microbiological cultures

Other hazardous waste	Danger! To be discarded by authorized staff only  	Yellow	Waste with high content of heavy metals, such as batteries, pressurized container, organic and inorganic chemicals
Radioactive Waste	Danger! Radioactive waste  or 	Black	Waste includes solid, liquid and gaseous waste contaminated with radionuclides such as Cobalt, Technetium, Iodine, Iridium, generated from in-vitro analysis of body tissue and fluid, in-vivo body organ imaging and tumor localization

Note: If the container with the recommended color is not available, any colored container can be used to segregate wastes with proper labeling and hazardous sign as shown in the above table.

Since categorization of the waste entirely depends on the types of the waste generated, available technology for the treatment and disposal, and the local environmental conditions of HCFs. If possible, HCFs should categorize and segregate the HCWs as mentioned above. However, it is recommended that HCFs should at least categorize and segregate the HCWs into non-risk HCW and risk HCW as mentioned in section 3.3.

6.3 Waste Collection and Storage

In order to avoid accumulation of the waste, it must be collected and transported to a central storage area within the HCF on a regular basis before being treated or removed. All the collected HCWs should be stored in waste storage area until transported to a designated off-site treatment facility. This area must be marked with warning sign. Storage facilities for waste should be suitably established within the HCF; however, these areas should be located away from patient rooms, laboratories, hospital function/operation rooms or any public access area. The storage facility should be lockable, hygienic and appropriately sign-posted. They must be kept secured at all the times. HCFs are responsible for providing:

- Designated storage areas with adequate lighting, ventilation and provision for the containment of spills within the storage area.
- Water supply for cleaning purposes.
- Waste security and restriction of access to authorized persons.
- Easy access for waste collection vehicle.
- Protection from sun, rain, strong winds and floods.
- Storage areas designed so that routine cleaning, maintenance to hygienic standards and post-spill decontamination are all easy to undertake.
- Supply of cleaning equipment, protective clothing and waste bags or container should be located conveniently close to the storage area.

- Bio-degradable general and hazardous waste should not be stored longer and should be removed within 24 hours to minimize microbial growth, putrefaction and odors.
- Segregation should be well maintained in the storage area.

For small waste generators, the requirement for a designated storage area may be achieved by the use of suitable rigid-walled container. The container should be kept in secure area and measures should be taken to prevent obnoxious odors or nuisance. Appropriate labeling for any forms of waste stored in the area should be included.

6.4 Waste Transportation

Health care waste collection and transportation practices should be designed to achieve an efficient movement of waste from point of generation to storage or treatment. A program for collection of HCW should be established as part of the HCWM plan. Certain recommendations should be followed by the auxiliary worker in-charge of waste collection:

- Suggested collection frequency on room to room basis is once every shift. Time of collection regardless of category should be at the start of every shift. In case of difficulty in the collection of waste in every shift, waste should be collected on daily basis (or as frequently as required) and transported to the designated central storage site of HCF.
- No bags should be removed unless they are labeled with their point of production (hospital and ward or department) and contents.
- The bags or containers should be replaced immediately with new ones of the same type.
- A supply of fresh collection bags or containers should be readily available at all locations where waste is produced.

Transport of infectious waste (Source: Katy Thompson, 2012)

6.4.1 On-site transport

The waste disposal plan of HCF should include procedures for on-site and off-site transport of wastes. During movement of wastes segregation must be maintained and the batch of waste should be managed according to the component with the highest level of risks. On-site transport of waste from the point of generation to an assembly storage or treatment area should be carried by wheeled trolleys, containers or carts. Wherever possible, the transport of clinical waste should be separate from general traffic. Hazardous/infectious HCW and non-risk HCW should be transported on separate trolleys. The transportation must follow specific routes through the HCF to reduce the passage of loaded carts through wards and other clean areas. The carts or trolleys should be:

- Easy to load and unload.
- Have no sharp edges that could damage waste bags or containers during loading and unloading.
- Easy to clean.

The on-site collection vehicle must be cleaned and disinfected daily using chlorine solution, phenolic compounds and persons transporting the waste should be equipped with appropriate protective equipment.

6.4.2 Off-site transport

The HCW producer is responsible for safe packaging and appropriate labeling to the waste to be transported off-site and for authorization of its destination i.e. either at the CTF or at the landfill site. Vehicles used for transporting clinical and related waste should be reserved for this purpose wherever possible. They must be easy to load, unload and clean, and should be equipped with spillage collection sumps or other suitable spill controls. The vehicle should be marked with the name and address of the waste carrier. The hazardous/infectious sign should be displayed on the vehicle container.

HCFs are responsible for small clinical and related waste spills that may accidently occur both on-site and off-site transportation areas. HCF must include a spill management plan with well defined procedures for handling spills safely in its HCWM plan. Personnel responsible for spill management must receive education and training in emergency procedures and handling requirements and should be fully aware of how, when and which emergency service should be called for advice and assistance. Spill kits should be made easily accessible and should contain absorbents, disinfectants, buckets, shovel, broom, gloves, disposable overalls, facemasks/shield, torch, disposable containers, plastic waste bags with appropriate labeling.

6.5 Waste Treatment and Disposal

The methods for treatment and disposal of HCWs depend on specific factors applicable to the HCF, relevant legislation and environmental aspects affecting the public. The bulk of HCW falls into the category of non-risk HCW, much of which can be recycled or reused. With correct segregation, low amount of waste can be categorized as risk HCW requiring specific attention and are hazardous waste. The hazardous waste and infectious waste must be managed by approved treatment methods. Once treated, the waste may be re-classified accordingly for disposal. Currently available waste treatment options have various capabilities and limitations. As technology changes, HCFs should evaluate treatment alternatives for their safety, effectiveness, environmental impacts, costs and compliance with country requirements. Any treatment option for HCWs should:

- Render sharps incapable of causing penetration injury.
- Achieve a significant volume reduction with no hazardous by-products.
- Result in residues being suitable for approved landfill disposal without harmful leaching to the environment.
- Result in minimum levels of hazardous or toxic by-products including POPs such as polychloro biphenyls.
- Reduce the potential for the transmission of infection.
- Be verifiable for the treated wastes.
- Have automatic controls and built-in safe mechanism.
- Have continuous automatic monitoring and recording.
- Ensure that the waste cannot bypass the treatment process.
- Meet occupational health and safety standard.
- Have safe alternative treatment and disposal in case of emergency.
- In case of autoclave, be tested at least annually to ensure that optimal performance is maintained.

HCW can be treated and disposed through the following techniques:

a. Biological procedure
b. Autoclave
c. Chemical disinfection
d. Encapsulation
e. Sanitary landfill
f. Burial
g. Septic/concrete vault
h. Incineration
i. Inertization

a. Biological Procedure

Biological process uses an enzyme mixture to decontaminate HCW and the resulting by-product is put through an extruder to remove water for sewage disposal. The technology requires regulation of temperature, pH, enzyme level and other variables. Presently, biological procedure is getting popularity for the disposal of non-risk HCW. Composting (aerobic and anerobic composting) of the biodegradable waste is one of the options for the disposal of HCWs.

i. Composting

Composting technique is recommended for non-risk HCWs. Composting is the natural, biological decomposition of organic matter by fungi, bacteria, insects, worms and other organisms. Successful composting entails the management of the decomposition process so that it is relatively quick, safe and clean. Poorly managed composting may produce offensive odors, encourage pests and vermin, spread plant and animal pathogens, cause environmental contamination and generate a product of inferior quality through extended processing times that will be inefficient and inappropriate in a commercial composting operation. Organisms that decompose organic matter require the following basic inputs and conditions to maximize their processes and efficiency:

- A suitable food source;
- A suitable temperature;
- Water; and
- Oxygen (if decomposing aerobically)

b. Autoclave

Autoclave is a process of steam sterilization under pressure. It is a low heat process in which steam is brought into direct contact with the waste material for duration sufficient to disinfect the material. Typically, autoclaves are used in hospitals for the sterilization of medical equipments to render waste harmless. This technique has been used for long time in HCFs for sterilization of reusable medical equipment. Autoclaves are commonly used for the treatment of highly infectious waste, such as microbial cultures or sharps. It has been reported that the effective inactivation of all vegetative micro-organisms and most bacterial spores in a small amount of waste (about 5–8kg) requires a 60 minute cycle at 121°C (minimum) and 1 bar (100kPa); this allows for full steam penetration of the waste material (WHO, 1999); however, the effective penetration of steam and moist heat depends on many factors including time, temperature, pressure, load size, stacking, configuration and packing density, types and integrity of bags or containers used, physical properties of the materials in the waste (such as bulk density, heat capacity and thermal conductivity), amount of residual air and the moisture content in the waste. (UNEP, 2012) Validation of the autoclave should be conducted and standard operating

Autoclave (Source: Katy Thompson, 2012)

procedure (SOP) should be followed while operation of the autoclave. The microbial inactivation efficacy of autoclaves should be checked periodically. For autoclaves that do not shred waste during steam disinfection, color-changing indicator strips may be inserted inside the yellow bag in the middle of each load and that the strip shall be checked to ensure that steam penetration has occurred. In addition, a microbiological test (using commercially available validation kits containing Bacillus stearothermophilus spore strips, vials or packs) shall be conducted periodically or as per the requirements. It is recommended that all general hospitals, even those with limited resources, be equipped with autoclaves.

c. Chemical disinfection

Chemical disinfections are usually applied for the treatment of infectious and highly infectious HCW. Aldehydes, chlorine compounds, phenolic compounds are added to HCW to kill or inactivate pathogens. It is the preferred treatment for liquid infectious wastes, but can also be used in treating solid waste too. This technique is most suitable in treating blood, urine, stools and sewage. Some chemical systems use heated alkali to destroy tissues, organs, body parts and other anatomical waste. Chemotherapy waste (including bulk cytotoxic agents) can be treated by chemical decomposition. Examples are: reaction with 5% sodium hypochlorite; acid hydrolysis followed by alkaline hydrolysis; reduction using zinc powder, degradation using 30% hydrogen peroxide; and destruction using heated alkali. Micro-organism types, degree of contamination, type of disinfectant, contact time; and other relevant factors such as temperature, pH, mixing requirements and the biology of the micro-organism should be considered when using chemical disinfections. Occupational health and safety should be taken in consideration while using chemical disinfection. Ultimate disposal of chemically treated waste should be in accordance with national and local requirements.

d. Encapsulation

Encapsulation involves the filling of the containers with waste, adding an immobilizing material and sealing the container. The process uses either cubic boxes made of high-density polyethylene or metallic drums. When containers are three quarters filled with sharps, pharmaceuticals and chemical waste, an immobilizing agent such as plastic foam, bituminous sand, cement mortar or clay is poured into it. Material is allowed to be dried and the container is sealed and disposed safely. Encapsulation is effective in reducing the risk of scavengers gaining access to the hazardous waste. It is particularly suitable for sharps and pharmaceutical waste.

e. Sanitary landfill

Sanitary landfill is an engineered method, designed and constructed to keep the waste isolated from the environment. So, it shuuldn't contaminate the soil, surface, and ground water and should limit air pollution, smells and direct contact with public. Disposing of certain types of HCW (infectious waste and small quantities of pharmaceutical waste) in sanitary landfills is acceptable. Some essential features of sanitary landfills are:

- Easy access to the site and working areas for waste delivery.
- Personnel should be available on-site for effectively controlling the daily operation.
- The site should be planned appropriately and divided into manageable phases, before starting the landfill.

- Lining of the base and sides of the sites must be adequately sealed to minimize the movement of waste water. Landfill site should be at least 50 meter away from water sources.
- There must be landfill gas control measures, environmental monitoring points and bore holes (for monitoring air and ground water quality).
- There must be adequate and efficient mechanism of leachate collection and treatment.
- The site must be well organized in a small area, i.e. proper spreading, compaction, and daily covering the waste with soil.
- The landfill site must be protected with wire bar/fence to prevent from unauthorized persons, animals and birds.
- Final cover must be constructed to prevent/minimize rain water infiltration when each phase of the landfill is completed.

f. Burial

Hazardous waste can be buried in a special pit. Burial is recommended in those HCFs that have minimal programs for HCWM, especially in remote locations, in temporary refugee encampments, or in areas experiencing exceptional hardship and in those cases where the safe burial of waste on hospital premises may be the only feasible option available at the time. For the purpose, the pit should be 2-5 m deep and 1-2 m wide. The bottom of the pit should be at least 2 m above the water table. After each waste load, it should be covered with a 10–30 cm thik soil layer. If coverage with soil is not possible, lime may be deposited over the waste. In case of outbreak of an especially virulent infection (such as Ebola virus), both lime and soil cover may be added. When the level of the waste reaches 30 to 50 cm to the surface of the ground, fill the pit with dirt, seal with concrete and dig another pit. Certain rules need to be established for proper HCWM in burial pit, as follows:

- Access to this dedicated disposal area should be restricted to authorized person only.
- The use of a pit would make supervision by landfill staff and thus prevent scavenging. The water deposition around the burial pit should be prevented.
- The burial site should be lined with a material of low permeability, such as clay, to prevent pollution of ground water.
- Large quantities (higher than 1 kg) of chemical/pharmaceutical wastes should not be buried.
- The burial site should be managed as a landfill, with each layer of waste covered with a layer of earth to prevent from rodents and insects and odor as well.
- Burial site should not be located in flood prone areas.
- The burial site should be fenced with warning signs.
- The location of waste burial pit should be down-hill or down-gradient from any nearby wells and about 50 meters away from any water body such as rivers or lakes.
- HCF should keep a record of the size and location of the existing burial pits to prevent construction works.

g. Septic/concrete vault

This method can be used for the disposal of used sharps and syringes. In this technique, the following process is applied.

- Dig a pit (1m x 1m x 1.8m depth), enough to accommodate sharps and syringes for certain period without reaching the ground water level. The site must be isolated and at least 500 feet away from the ground water sources and dwelling units.
- Construct concrete walls and slabs of the pit. Provide slab with opening or manhole for easy deposition of collected sharps and syringes. The manhole should be extended a few centimeters above the soil surface to overcome infiltration of the surface water.
- Deposit the collected safety boxes filled with used sharps and needles inside the septic/concrete vault.
- Install a security fence around the site.

h. Incineration

Incineration converts combustible materials into non-combustible residue or ash. Incinerators can be oil-fired or electrically powered or a combination of both. Broadly, three types of incinerators are used for treatment of HCWs: multiple hearth, rotary kiln and controlled air type. All the three types can have primary and secondary combustion chambers to ensure optimal combustion. Gases are ventilated through the incinerator stacks, and the residue or ash is disposed in a sanitary landfill. Wastes containing mercury or cadmium should never be burned or incinerated because of the risk of atmospheric pollution with toxic vapors. When wastes are incinerated at low temperatures or when plastics that contain polyvinyl chloride (PVC) are incinerated, dioxins, furans and other toxic gases may be produced as emissions and/or in bottom or fly ash (ash that is carried by air and exhaust gases up the incinerator stack). This happens particularly when wastes are incinerated at temperatures lower than 800°C or when the wastes are not completely incinerated. Even in high temperature incinerators (>800°C), temperatures are not uniform and dioxins and furans can form in cooler pockets or during start-up or shut-down periods.

Where incineration is used, two chambered incinerator should be used and must follow the standard operating procedure (SOP). HCF must utilize emission limits and other requirements to ensure effective waste treatment, minimize emissions and decrease exposure and risks to workers and the community. This should include the use of approved incinerator designs that can achieve appropriate combustion conditions (e.g., proper temperature, required chimney heights); appropriate location (e.g., away from populated areas or where food is grown); adequate training to the operator (including both class room and practical training); appropriate waste segregation, storage and ash disposal facilities; adequate equipment maintenance; managerial support, supervision; and sufficient budgeting. The temperature must be at least of 850°C to ensure minimal emission of toxic gases at the primary chamber. High chimney is also required (higher than nearby roofs) and following wastes should never be incinerated:

- Pressurized gas containers
- Large amounts of reactive chemical waste
- Radioactive waste
- Silver salts or radiographic wastes
- Halogenated plastics (e.g. PVC)
- Mercury or cadmium
- Ampoules of heavy metals

i. Inertization

Inertization is usually suitable disposal method for the pharmaceuticals and incinerated ash with heavy metal content. (WHO, 1999) In this technique, the HCW is mixed with cement and other substances in a composition of 65% waste, 15% lime, 15% cement and 5% water. The formed mixture is allowed to set into cubes or pellets and then these are transported to suitable storage site. For proper setting of the mixtures into cubes and pellets, the waste must be grinded. In an alternative procedure, the formed homogeneous mixture in liquid state can be transported to a landfill and poured safely. This technique helps to minimize the risk of contamination of toxic substances migrating to surface water or ground water and prevent scavenging.

7. Health and Safety Practices

Management of HCW is an integral part of hospital hygiene and infection control. HCW should be considered as a reservoir of pathogenic micro-organisms, which can cause contamination and give rise to infection. If waste is inadequately managed, these micro-organisms can be transmitted by direct contact, in the air, or by a variety of vectors. Infectious waste may lead to the risk of nosocomial infections, putting the health of hospital personnel and patients at risk. It has to be emphasized here that other environmental health considerations, such as adequate water supply and sanitation facilities for patients, visitors, and health care staff are of prime importance. HCWM plans should include provision for the continuous monitoring of workers' health and safety to ensure that correct handling, treatment, storage and disposal procedures are being followed. Essential occupational health and safety measures include the following basic measures:

- Proper training of workers (no training/no hiring policy should be instituted; immunization at the first day of the work).
- Provision of equipment and clothing for personal protection.
- Establishment of an effective occupational health program that includes immunization, post-exposure prophylaxis (PEP) treatment and continuous medical surveillance.
- Information, Education and Communication (IEC) activities.

Training on health and safety should ensure that workers know and understand the potential risks associated with HCW, value of immunization against viral hepatitis B and the importance of consistent use of personal protection equipment (PPE). Workers at risk include health care providers, hospital cleaners, maintenance workers, operators of waste treatment equipment, and all operators involved in waste handling and disposal within and outside health care establishments.

7.1 Infection Prevention

Everyone who works at, receives care at or visits a HCF is at risk of infections. Thus, infection prevention is the responsibility of everyone. As a result of being at a HCF, staff, clients and visitors may be exposed to infectious diseases that others at the facility have. We can, however, prevent transmission of infections in many cases. The only way to prevent infections is to stop the transmission of micro-organisms that cause infections. The best way to prevent infection is by following standard precautions, which include the following:

- Wash hands.
- Wear PPE such as gloves, eye protection, face-shields, and gowns.
- Follow appropriate respiratory hygiene/cough etiquette.
- Prevent injuries with sharps.
- Correctly process instruments and client-care equipment.
- Maintain correct environmental cleanliness and waste-disposal practices.
- Handle, transport and process used/soiled linens correctly.

7.2 Personal hygiene and hand hygiene

Basic personal hygiene is important for reducing the risks from handling HCW, and convenient washing facilities (with warm water and soap) should be available for personnel involved in the task. As the hands of health care workers are the most frequent vehicle of nosocomial infections; hand hygiene including both hand washing and hand disinfection is the primary preventive measure. An antimicrobial soap will reduce the transient flora, only if the standard procedure for hand washing is applied. Hand washing with non-medicated soap is essential when hands are dirty and should be routine after physical contact with a patient. Killing all transient flora with all contaminants within a short time (few seconds) necessitates hygienic hand disinfection: only alcohol or alcoholic preparations act sufficiently fast. Hands should be disinfected with alcohol when an infected tissue or body fluid is touched without gloves.

7.3 Workers' protection

The generation, segregation, collection, transportation, treatment, and disposal of HCWs involve the handling of potentially hazardous and infectious material. Protection against personal injury is, therefore, essential for all workers who are directly involved in handling potentially hazardous and infectious HCWs. The individuals responsible for management of HCW should ensure that all risks are identified and that suitable protection from those risks is provided. A comprehensive risk assessment of all activities involved in HCWM should be carried out during preparation of the HCWM plan, which will allow the identification of necessary protection measures. These measures should be designed to prevent exposure to hazardous materials or other risks, or at least to keep exposure within safe limits. (WHO, 1999) Suitable training should be provided to the related personnel on this aspect.

7.4 Protective clothing

The type of protective clothing usage will depend to an extent upon the risk associated with the HCW, but the following should be made available to all personnel who are directly involved to collect and handle HCWs:

- Helmets/cap with or without visors: depending on the operation
- Face masks: depending on operation
- Disposable gloves (medical staff) or utility gloves or heavy-duty gloves (waste workers): obligatory
- Eye protectors (safety goggles): depending on operation
- Overalls (coveralls): obligatory
- Aprons: obligatory
- Leg protectors and/or boots: obligatory

Boots and heavy-duty gloves are particularly important for waste workers. The thick soles of the boots offer protection in the storage area, as a precaution from spilled sharps, and where floors are slippery. If segregation is inadequate, needles or other sharp items may have been placed in plastic bags; such items may also pierce thin-walled or weak plastic containers. If it is likely that HCW bags will come into contact with workers' legs during handling, leg protectors may also need to be worn.

7.5 Immunization

Viral hepatitis B infections have been reported among health care personnel and waste handlers, and immunization against the disease is; therefore, recommended. Tetanus immunization is also recommended for all personnel handling waste.

7.6 Injection Safety

Medical professionals and health care workers must be made aware on the injection safety. Injections are most commonly used among health care procedure worldwide. In developing and transitional countries alone, some 16 thousand million injections are administered each year. Most injections, more than 90%, are given for therapeutic purposes while 5 to 10% are given for preventive services, including immunization and family planning. (WHO, Guiding principle to ensure injection safety devices) A safe injection does not harm the recipient, does not expose the health care worker to any avoidable risk and does not result in waste that is dangerous for the community. Unsafe injection practices (reuse of syringes and needles in the absence of sterilization) have to be discouraged. The disposable needle and syringe should be rendered useless after use. The needle from the syringe should be cut/crushed and disposed safely.

7.7 Response to injury and exposure

Health care facility should establish program that prescribes the actions to be taken in the event of injury or exposure to a hazardous substance. All staffs who handle HCW should be trained to deal with injuries and exposures. The program should include the following elements:

- Immediate first-aid measures, such as cleansing of wounds and skin, and irrigation (splashing) of eyes with clean water.
- An immediate report of the incident to a designated responsible person.
- Retention, if possible, of the item involved in the incident; details of its source for identification of possible infection.
- Additional medical attention in an accident and emergency or occupational health department, as soon as possible; such as availability of post-exposure prophylaxis (PEP).
- Medical surveillance
- Blood or other tests if indicated.
- Recording of the incident;
- Investigation of the incident, and identification and implementation of remedial action to prevent similar incidents in the future.

The purpose of incident reporting should not be seen as punitive; active support by managers should encourage prompt and accurate reporting.

7.8 Special precautions for clearing up spillages of potentially hazardous substances

Spillage usually requires clean-up of the only contaminated area. For clearing up spillages of body fluids or other potentially hazardous substances, particularly if there is any risk of splashing, eye protectors and masks should be worn, in addition to gloves and overalls. Respirators (gas masks) are also needed if an activity is particularly dangerous, for e.g., if it involves toxic dusts, the clearance of incinerator residues, or the cleaning of contaminated equipment. Residues should be recovered as completely as possible using hand tools (e.g. a shovel), and then packed safely. It is especially important to recover spilled droplets of metallic mercury. If a leakage or spillage involves infectious material, the floor should be cleaned and disinfected after most of the waste has been recovered.

7.9 Safe Use of Cytotoxic Drugs and Radioactive Materials

Health care facilities, which use cytotoxic products and radioactive materials, should develop specific guidelines on their safe handling for the protection of personnel and the environment. It is difficult to ensure safe use of cytotoxic and radioactive material, it is recommended that the use of these substances be limited to specialized (e.g., oncological) HCFs, which are better able to implement safety measures. The guidelines handling cytotoxic products should include rules on the following waste handling procedures:

- Separate collection of waste in leak proof bags or containers, and labeling for identification
- Return of date expired drugs to suppliers. Take back policy should be applied for these kinds of materials. Agreement should be signed while purchasing the cytotoxic and radioactive materials and these materials should be collected back by the suppliers after usage.
- Safe storage separately from other HCW
- Provisions for the disposal of contaminated material, for the decontamination of reusable equipment, and for the treatment of spillages.
- Provisions for the treatment of infectious waste contaminated with cytotoxic products, including excreta from patients and disposable linen used for patients.

Hospital staffs should ensure that the families of patients undergoing chemotherapy are aware of the risks and know how they can be minimized or avoided. Minimal protective measures for all waste workers who handle cytotoxic waste should include protective clothing, gloves, goggles and masks.

7.10 Emergency Response in case of spillage

Spillage is the most common type of emergency involving infectious and other hazardous materials. Spills are inadvertent discharges that occur at different place of HCF. Spills include accidental tipping over containers, dropping and breaking of containers. It may also occur during manual transfer, overfilling and leaks in the process. The response process for the spillage includes:

- Contaminated area cleaned and disinfected.
- Exposure of workers is limited as much as possible during the cleaning process.
- Impacts have to be limited on patients, medical, other personnel and environment.
- Spillage of mercury should be properly handled.
- Procedures for dealing with spillage should specify safe handling operation and appropriate protective clothing.
- In case of skin and eye contact with hazardous substance, there should be immediate decontamination and in case of eye contact with corrosive chemicals, the eye should be irrigated

continuously with clean water for 10-30 minutes; the entire face should be in basin with eyes being continuously opened and closed.

7.11 Management practices

Many of the management practices recommended in Chapters 6 contribute to a reduction in risk for personnel who handle health care waste; these are summarized as follows:

- Waste segregation: careful separation of different types of waste into different distinct containers or bags, which defines the risk linked to each waste package.
- Appropriate packaging: prevents spillage of waste and protects workers from contact with waste.
- Waste identification (through distinct packaging and labeling): allows for easy recognition of the class of waste and of its source.
- Appropriate waste storage: limits the access to authorized individuals only, protects against infestation by insects and rodents, and prevents contamination of surrounding areas.
- Appropriate transportation: reduces risks of workers being exposed to.

8. Methods of Health Care Waste Management at Different Levels of Health Care Facilities

According to Solid Waste Management Act 2011, the responsibility for processing and management of hazardous waste, medical waste, chemical waste and industrial waste under the prescribed standards goes to the person or institution that has generated the waste. Thus, the responsibility of management of HCWs of the HCF is the responsibility of chief of a HCF is of the facility itself. This chapter provides the basic guidance for the management of HCWs at different levels of HCF; however, HCFs can plan for the classification, segregation and management of the HCWs based on the local context and environment. The following tables (Table 6 to 13) show the HCWM at different levels of HCFs:

Table 6. Health Care Waste Management at Hospitals

<table>
<tr><th colspan="2">Types and Categories of HCW</th><th>Methods of management</th><th>Responsibility</th></tr>
<tr><td rowspan="3">Non-risk HCW</td><td>Bio-degradable (Compostable)</td><td>The waste can be composted to produce compost manure and can also be used for production of bio-gas.</td><td rowspan="6">Chief of HCF, concerned health workers and the authorized person</td></tr>
<tr><td>Recyclable (Non-biodegradable)</td><td>Recyclable items should be recycled and reused.</td></tr>
<tr><td>Other non-risk waste</td><td>If waste cannot be composted or recycled, contact the local authority for disposal.</td></tr>
<tr><td rowspan="3">HCW requiring special attention</td><td>Human anatomical wastes such as placenta, human tissue</td><td>Dispose in placenta pit/safe burial/controlled incineration as per standard operating procedure (SOP).</td></tr>
<tr><td>Sharps such as injections, blades</td><td>Mutilate/cut the tip of the syringe and the needle with needle and hub cutter, then autoclave and dispose properly.
OR
Wastes are first disinfected with 0.5% chlorine solution and then subjected to deep burial/ encapsulation/septic vault.</td></tr>
<tr><td>Pharmaceutical waste such as waste comprising of date expired, contaminated and discarded medicines</td><td>Apply return back policy; return the waste to the store and from the store to the supplier.
OR
Dispose in secured landfill after encapsulation.</td></tr>
</table>

Types and Categories of HCW		Methods of management	Responsibility
	Cytotoxic pharmaceutical waste such as post- expiration date cytotoxic pharmaceuticals, discernable liquid residues of cytotoxic concentrates etc.	Apply return back policy; return the waste to the store and from the store to the supplier. **OR** Sanitary landfill with encapsulation	Chief of HCF, concerned health workers and the au-thorized person
Infectious and highly infectious waste	Infectious wastes such as blood bags, gloves, syringe etc.	Sterilization with autoclave/ steam sterilization and dispose safely. Always mutilate/cut before disposal/ recycling. **OR** Mutilate/cut gloves, syringes, blood bags and then disinfect with 0.5% chlorine solution and dispose it properly (e.g. deep burial).	Chief of HCF, concerned health workers and the au-thorized person
	Infectious waste such as bandage, cotton etc.	Autoclave and then dispose properly. **OR** These wastes are first disinfected with 0.5% chorine solution and safe disposal through burial/ sanitary landfill.	
Radioactive waste	Sealed radiation source, liquid and gaseous, material contaminated with radionuclide, such as paper cups, straws, needles syringes, test tubes etc.	Apply return back policy; return the waste to the store and from the store to the supplier; it should be agreed at the purchasing phase. **OR** Radioactive isotope should be collected, packaged, inventoried and securely stored for time period suitable for complete radioactive decay. In case of mixed radioactive and infectious waste, the radioactive component is addressed first and later suitable treatment for the infectious component should be carried out.	
Other hazardous waste	Heavy metal such as mer-cury .	Should be collected and stored separately in glass bottle with water and well labeled and stored in secured place.	
	Chemical waste (chemicals used in production of biological toxins, chemicals used in disinfection, insecticides)	Chemical treatment and discharge into drains after massive dilution with plain water	

Table 7. Health Care Waste Management at Primary Health Care Centre

Types and Categories of HCW		Methods of management	Responsibility
Non-risk HCW	Bio-degradable (Compostable)	The waste can be composted to produce compost manure and can also be used for production of bio-gas.	Chief of primary health care centre, concerned health workers and the authorized person
	Recyclable (Non-biodegradable)	Recyclable items should be recycled and reused.	
	Other non-risk waste	If waste cannot be composted or recycled, contact the local authority for disposal.	
HCW requiring special attention	Human anatomical wastes such as placenta, human tissue	Dispose in placenta pit/safe burial/controlled incineration as per standard operating procedure (SOP).	
	Sharps such as injections, blades	Mutilate/cut the tip of the syringe and the needle with needle and hub cutter, then autoclave and dispose properly. **OR** Wastes are at first disinfected with 0.5% chlorine solution and deep burial/encapsulation/septic vault.	
	Pharmaceutical waste such as waste comprising of date expired, contaminated and discarded medicines	Apply return back policy; return the waste to the store and from the store to the supplier. **OR** Dispose in secured landfill after encapsulation.	
	Cytotoxic pharmaceutical waste such as post-expiration date cytotoxic pharmaceuticals, discernable liquid residues of cytotoxic concentrates	Apply return back policy; return the waste to the store and from the store to the supplier. **OR** Sanitary landfill after encapsulation.	
Infectious and highly infectious waste	Infectious wastes such as blood bags, gloves, syringe	Sterilization with autoclave/ steam sterilization and dispose properly. Mutilate before disposal. **OR** Mutilate/cut gloves, syringes and blood bags and disinfect wastes with 0.5% chlorine solution and dispose it properly.	
	Infectious waste such as bandage, cotton	Autoclave and dispose properly. **OR** These wastes are first disinfected with 0.5% chorine solution and safe disposal through burial/ sanitary landfill.	

Other hazardous waste	Heavy metal such as mercury	Should be collected and stored separately in glass bottle with water and well labeled and stored in secured place.	Chief of primary health care centre, concerned health workers and the authorized person
	Chemical waste (chemicals used in disinfection, insecticides)	Chemical treatment and discharge into drains after massive dilution with plain water	

Table 8. Health Care Waste Management at Health Post

Types and Categories of HCW		Methods of management	Responsibility
Non-risk HCW	Bio-degradable (Compostable)	The waste can be composted to produce compost manure and can also be used for production of bio-gas.	Chief of Health post, concerned health workers and the authorized person
	Recyclable (Non-biodegradable)	Recyclable items should be recycled and reused.	
	Other non-risk waste	If waste cannot be composted or recycled, contact the local authority for disposal.	
HCW requiring special attention	Human anatomical wastes such as placenta, human tissue	Dispose in placenta pit/safe burial.	
	Sharps such as injections, blades	Mutilate/cut and autoclave then dispose properly. **OR** Wastes are at first disinfected with 0.5% chlorine solution and deep burial/encapsulation/septic vault.	
	Pharmaceutical waste such as waste comprising of date expired, contaminated and discarded medicines	Apply return back policy; return the waste to the store and from the store to the supplier. **OR** Dispose in secured landfill after encapsulation.	
Infectious and highly infectious waste	Infectious wastes such as gloves, syringe	Sterilization with autoclave/ steam sterilization. Always mutilate/cut before disposal/ recycling. **OR** Mutilate/cut gloves syringes, blood bags and then disinfect with 0.5% chlorine solution and dispose safely.	
	Infectious waste such as bandage, cotton	Autoclave and dispose properly. **OR** These wastes are first disinfected with 0.5% chorine solution and safe disposal through burial/ sanitary landfill.	

Other hazardous	Heavy metal such as mercury	Should be collected and stored separately in glass bottle with water and well labeled and stored in secured place.	Chief of Health post, concerned health workers and the authorized person
	Chemical waste (chemicals used in disinfection, insecticides)	Chemical treatment and discharge into drains after massive dilution with plain water	

Table 9. Health Care Waste Management at Sub Health Post

Types and Categories of HCW		Methods of management	Responsibility
Non-risk HCW	Bio-degradable (Compostable)	The waste can be composted to produce compost manure and can also be used for production of bio-gas.	Chief of Sub-Health post, concerned health workers and the authorized person
	Recyclable (Non-biodegradable)	Recyclable items should be recycled and reused.	
	Other non-risk waste	If waste cannot be composted or recycled, contact the local authority for disposal.	
HCW requiring special attention	Human anatomical wastes such as placenta, human tissue	Dispose in placenta pit/safe burial.	
	Sharps such as injections, blades	Mutilate/cut and autoclave then dispose properly. **OR** Wastes are at first disinfected with 0.5% chlorine solution and deep burial/encapsulation/septic vault.	
	Pharmaceutical waste such as waste comprising of date expired, contaminated and discarded medicines	Apply return back policy; return the waste to the store and from the store to the supplier. **OR** Dispose in secured landfill or burial pit/ after encapsulation.	
Infectious and highly infectious waste	Infectious wastes such as, gloves, syringe	Sterilization with autoclave/ steam sterilization and dispose safely. Always mutilate/cut before disposal. **OR** Mutilate/cut gloves, syringes, blood bags and disinfect wastes with 0.5% chlorine solution and dispose safely (deep burial).	
	Infectious waste such as bandage, cotton	Autoclave and dispose properly. OR These wastes are first disinfected with 0.5% chorine solution and safe disposal through burial/ sanitary landfill.	

Other hazardous waste	Heavy metal such as mercury	Should be collected and stored separately in glass bottle with water and well labeled and stored in secured place.	Chief of Sub-Health post, concerned health workers and the authorized person
	Chemical waste (chemicals used in disinfection, insecticides)	Chemical treatment and discharge into drains, after massive dilution with plain water.	

Table 10. Health Care Waste Management at Primary Health Care Out-reach Clinic (PHCORC)/Out-reach Immunization Post/Session

Types and Categories of HCW		Methods of management	Responsibility
Non-risk HCW	Bio-degradable (Compostable)	These wastes can be put in pit for Composting. (Discuss with the local authority for disposal).	Concerned health workers
	Recyclable (Non-biodegradable)	Recyclable items can be disposed by contacting the local authority. **OR** Bring back to the health care facility for proper disposal.	
	Other non-risk waste	If waste cannot be composted or recycled, contact the local authority for disposal. **OR** Bring back to the health care facility and dispose properly.	
HCW requiring special attention	Sharps such as needles	Mutilate/cut and Dispose in safety Box. The box can be carried to the nearby HCFs and dispose (Autoclave and dispose). **OR** These wastes are at first disinfected with 0.5% chlorine solution and deep burial/ encapsulation/septic vault. (Discuss with local authority before disposal whether it is possible in the local area or not.)	
Infectious waste	Wastes such as cotton swabs	It can be carried to the nearby HCFs, autoclave and dispose properly. **OR** First disinfect with 0.5% chlorine solution and safe disposal through deep burial.	

Table 11. Health Care Waste Management at Private/Public Teaching Hospitals and Nursing Homes/Research Institute

<table>
<tr><th colspan="2">Types and Categories of HCW</th><th>Methods of management</th><th>Responsibility</th></tr>
<tr><td rowspan="3">Non-risk HCW</td><td>Bio-degradable (Compostable)</td><td>The waste can be composted to produce compost manure and can also be used for production of bio-gas.</td><td rowspan="10">Director, concerned health workers and the authority assigned person</td></tr>
<tr><td>Recyclable (Non-biodegradable)</td><td>Recyclable items should be recycled and reused.</td></tr>
<tr><td>Other non-risk waste</td><td>If the waste cannot be composted or recycled, contact the local authority for disposal.</td></tr>
<tr><td rowspan="4">HCW requiring special attention</td><td>Human anatomical wastes such as placenta, human tissue</td><td>Dispose in placenta pit/safe burial/ controlled incineration as per standard operating procedure (SOP).</td></tr>
<tr><td>Sharps such as injections, blades</td><td>Mutilate/cut the tip of the syringe and the needle with needle and hub cutter, then autoclave and dispose properly.
OR
Wastes are at first disinfected with chlorine solution and deep burial/ encapsulation/septic vault.</td></tr>
<tr><td>Pharmaceutical waste such as waste comprising of date expired, contaminated and discarded medicines</td><td>Apply return back policy; return the waste to the store and from the store to the supplier.
OR
Dispose in secured landfill after encapsulation.</td></tr>
<tr><td>Cytotoxic pharmaceutical waste such as post-expiration date cytotoxic pharmaceuticals, discernable liquid residues of cytotoxic concentrates</td><td>Apply return back policy; return the waste to the store and from the store to the supplier.
OR
Sanitary landfill after encapsulation.</td></tr>
<tr><td rowspan="2">Infectious and highly infectious waste</td><td>Infectious wastes such as blood bags, gloves, syringe</td><td>Sterilization with autoclave and dispose safely. Always mutilate/ cut before disposal/recycling.
OR
Mutilate/cut gloves, syringe, blood bags and then disinfect with 0.5% chlorine solution and dispose safely.</td></tr>
<tr><td>Infectious waste such as bandage, cotton</td><td>Autoclave and then dispose properly.
OR
These wastes are first disinfected with 0.5% chorine solution and safe disposal through burial/ sanitary landfill.</td></tr>
</table>

Radioactive waste	Sealed radiation source, liquid and gaseous, material contaminated with radionuclide, such as paper cups, straws, needles syringes, test tubes	Apply return back policy; return the waste to the store and from the store to the supplier; it should be agreed at the purchasing phase. **OR** Radioactive isotope should be collected, packaged, inventoried and securely stored for time period suitable for complete radioactive decay. In the case of mixed radioactive and infectious waste, the radioactive component is addressed first and later suitable treatment for the infectious component should be carried out.	Director, concerned health workers and the authority assigned person
Other hazardous waste	Heavy metal such as mercury	Should be collected and stored separately in glass bottle with water and well labeled and stored in secured place.	
	Chemical waste (chemicals used in production of biological toxins, chemicals used in disinfection, insecticides)	Chemical treatment and discharge into drains after massive dilution with plain water.	

Table 12. Health Care Waste Management at Clinic/Pathology lab clinic

Types and Categories of HCW		Methods of management	Responsibility
Non-risk HCW	Bio-degradable (Compostable)	The waste can be composted to produce compost manure and can also be used for production of bio-gas.	Chief of the clinic and the authorized person
	Recyclable (Non-biodegradable)	Recyclable items should be recycled and reused.	
	Other non-risk waste	If the waste cannot be composted or recycled, contact the local authority for disposal.	
HCW requiring special attention	Human anatomical wastes such as placenta, human tissue	Dispose in placenta pit/safe burial/ controlled incineration as per standard operating procedure (SOP).	
	Sharps such as injections, blades	Mutilate/cut the tip of the syringe and the needle with needle and hub cutter, then autoclave and dispose properly. **OR** Disinfect with 0.5% chlorine solution and dispose safely.	

HCW requiring special attention	Pharmaceutical waste such as waste comprising of date expired, contaminated and discarded medicines	Apply return back policy; return the waste to the store and from the store to the supplier. **OR** Disposal in secured landfill with encapsulation.	Chief of the clinic/ concerned staffs
	Cytotoxic pharmaceutical waste such as post-expiration date cytotoxic pharmaceuticals, discernable liquid residues of cytotoxic concentrates	Apply return back policy; return the waste to the store and from the store to the supplier. **OR** Sanitary landfill with encapsulation.	
Infectious and highly infectious waste	Infectious wastes such as blood bags, gloves, syringe	Autoclave the waste and then dispose properly. Mutilate/cut before disposal. **OR** Mutilate/cut gloves, syringes, blood bags and disinfect with 0.5% chlorine solution and dispose safely (deep burial).	
	Infectious waste such as bandage, cotton	Autoclave the waste and then dispose properly. **OR** Disinfect wastes with 0.5% chlorine solution and dispose safely.	
Radioactive waste	Sealed radiation source, liquid and gaseous, material contaminated with radionuclide, such as paper cups, straws, needles syringes, test tubes	Apply return back policy; return the waste to the store and from the store to the supplier; it should be agreed at the purchasing phase. **OR** Radioactive isotope should be collected, packaged, inventoried and securely stored for time period suitable for complete radioactive decay. In the case of mixed radioactive and infectious waste, the radioactive component is addressed first and later suitable treatment for the infectious component should be carried out.	
Other hazardous waste	Heavy metal such as mercury	Should be collected and stored separately in glass bottle with water and well labeled and stored in secured place.	
	Chemical waste (chemicals used in production of biological toxins, chemicals used in disinfection, insecticides)	Chemical treatment and discharge into drains after massive dilution with plain water	

Table 13. Health Care Waste Management at Pharmacy/Medical Stores

Types and Categories of HCW		Methods of management	Responsibility
Non-risk HCW	Bio-degradable (Compostable)	The waste can be composted to produce compost manure and can also be used for production of bio-gas.	Storekeeper and authorized person
	Recyclable (Non-biodegradable)	Recyclable items should be recycled and reused.	
	Other non-risk waste	If waste cannot be composted or recycled, contact the local authority for disposal.	
HCW requiring special attention	Sharps such as injections, blades	In case of used needles and syringes, wastes are first autoclaved and if autoclave is not available, disinfect with 0.5% chlorine solution and dispose safely.	
	Pharmaceutical waste such as waste comprising of date expired, contaminated and discarded medicines	Apply return back policy; return the waste to the store and from the store to the supplier. **OR** Disposal in secured landfill after encapsulation	
	Cytotoxic pharmaceutical waste such as post-expiration date cytotoxic pharmaceuticals, discernable liquid residues of cytotoxic concentrates	Apply return back policy; return the waste to the store and from the store to the supplier. **OR** Sanitary landfill with encapsulation.	
Other hazardous waste	Heavy metal such as mercury	Should be collected and stored separately in glass bottle with water and well labeled.	
	Chemical waste (chemicals used in production of biological toxins, chemicals used in disinfection, insecticides)	Chemical treatment and discharge into drains after massive dilution with plain water	

Note:

- It is recommended to have central treatment facility (CTF) for the treatment and disposal of HCWs based on the public-private partnership (PPP) approach however, where these facilities are not available, HCF shall have to manage their HCWs using the BAT and BEP techniques so as to have 'zero waste concept' as being practiced in different hospitals of Nepal such as Civil Service Hospital and Bir Hospital.
- Open burning should not be considered as an option because of the risk it creates for staffs, communities and the environment.
- If autoclave is not available in the HCF then disinfect wastes with 0.5% chlorine solution or 1% bleaching powder solution.
- Chemical treatment using at least 0.5% chlorine solution for at least 30 minutes. If it is not available then disinfect wastes with 1% bleaching powder solution for at least one hour.
- Unusable blood and laboratory reagents should be safely disposed after proper chemical treatment.

9. Training and Raising Awareness

Promotion of the appropriate handling and disposal of HCW is important for public health and hence every member of the community has the right of information about the potential health hazards. The objectives of public education on HCWs are as follows:

- To prevent exposure to HCW and related health hazards;
- To create awareness and foster responsibility among hospital patients and visitors to HCFs regarding hygiene and HCWM.
- To inform the public about the risks linked to HCW.

In order to develop proper training modules, training need assessment should be carried out at the first. Training need assessment has been defined as the process to establish a clear understanding of who requires what types of training.

9.1 Employees to be trained

All hospital personnel, including senior medical doctors, should be convinced of the need for a comprehensive HCWM plan and the related training. Separate training activities should be designed for the following personnel:

- Hospital managers and administrative staff responsible for implementing regulations on HCWM.
- Medical doctors
- Nurses and Paramedicals Staff
- Cleaners, porters, staff and waste handlers

9.2 Content

Training programs should include:

- Information on, and justification for, all aspects of the health care waste plan
- Information on the role and responsibilities of each hospital staff member in implementing the plan
- Technical instructions, relevant for the target group, on the application of waste management practices.

These should be periodically reviewed and updated. Periodic repetition of courses will provide refreshment training as well as orientation for new employees and for existing employees with new responsibilities; it will also update knowledge in line with policy changes. In general, the training should include the following information:

- Concept of health care waste and basic steps for health care waste management
- Legal provisions, policies and international commitments

- Impact of HCW on health and environment
- Health care waste management
- Management of mercury spill
- Injection safety
- Health and safety
- Health care waste management at different levels of HCF
- Field visit and action plan

9.3 Training responsibility

The administration/management section should be given responsibility for all training related to HCWM. The section should ensure that staffs at all levels of HCFs are aware of the HCWM plan, their own responsibilities and obligations in this regard. The record of all training sessions and the content of training programs should be documented. The content of the training programs should be periodically reviewed and updated as per requirements.

9.4 Training package

The training package can be developed by the national government responsible for the HCWM. The package should be suitable for various types of HCFs, including government, private, teaching and dental hospitals, polyclinics, health centre, health care research institutions and clinical laboratories. It would also be useful for more general educational establishments and for organizations that provide services for HCW disposal. The package should be liberally illustrated with drawings, diagrams, photographs, slides or overhead transparencies. These should reflect the environments in which trainees work and provide examples of measures that have been (or will be) implemented. Where it is likely that waste handlers and other workers are illiterate, all procedures should be carefully represented in diagrams and photographs.

9.5 Selection of participants

The ideal number of participants in a training course is 15-20. Courses should be aimed at all categories of personnel; discussions may be easier and more useful if the group is composed of trainees from various disciplines (e.g. supervisors, medical and nursing staff, laboratory staff, engineers, auxilliary staff) or at least contains one or two medical assistants and nurses. It may also be valuable to include senior administration staff and heads of departments in certain training groups to demonstrate their commitment to the waste management policy and to show the relevance of the policy to all personnel of health care establishments.

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Annex

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RESEARCH ARTICLE

Sustainable financing for municipal solid waste management in Nepal

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Data Availability Statement: We have used publicly available data from the following sources. 1. The main data set that is used for this study comes from the Asian Development Bank 2013 (https://www.adb.org/sites/default/files/publication/30366/solid-waste-management-nepal.pdf). Appendices of this report has the full data set on waste types, volume etc. generated from 58 municipalities in Nepal. The data is available publicly. 2. Plastic import data for Nepal were obtained from the Department of Customs under 'Plastic and article there-of' (https://www.customs.gov.np/en/tariff_rates.html), which was classified

Abstract

Financing municipal solid waste (MSW) services is one of the key challenges faced by cities in developing countries. This study used plastic waste, a constituent of MSW, to explore the possibility of generating revenue for financing MSW management in the municipalities of Nepal. The results of this study suggest that plastic material recovery could generate revenue, which is equivalent to 1.38 times of the plastic-waste-related management cost when collection efficiency reaches 66.7%. An increase in 1% of recovery rate and collection efficiency could cover an additional 4.64% and 2.06% of the costs of managing plastic waste, respectively. In addition, an increase in tax on imported plastic materials could also motivate recovery of plastic waste for recycle and reuse. An additional 1% tax on plastic imports would be sufficient to cover plastic-related waste management when plastic waste recovery and collection efficiency rates are low. This plastic recovery- revenue exercise could be expanded to other materials such as paper and metal to fully understand the possibility of sustainable financing of MSW management and reducing environmental harm in developing countries like Nepal.

Background

There has been a steady increase in the urban population worldwide over the years. According to a report published by the Department of Economic and Social Affairs of the United Nations, the world's urban population was 55% of the total population in 2018 but is expected to increase up to 68% by 2050 [1]. According to the Report, more than 90% of this growth would take place in Asia and Africa. The increase in urban population, coupled with economic growth and improved living standards, has resulted in the generation of enormous amounts of waste already in cities in developing countries [2]. But municipal solid waste (MSW), if not managed properly, produces negative externalities and contributes to flooding and waterlogging during extreme climatic events such as excessive rainfall [3–6].

under HS code 39 for the years 2010-2016. This data is also available online from the above link.

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Municipal authorities are working to make their cities resilient and smart. Smartness aims to improve the welfare of citizens by making cities liveable [7]. Although MSW management is one of the major components of making cities resilient and smart [8,9], it remains a major challenge for municipal authorities, particularly in developing countries [10]. Unplanned settlements, poor infrastructure, inadequate resources and capacities, and low level of awareness among municipal residents are making MSW management all the more complex [11,12]. For many municipal authorities in developing countries, solid waste management is a high cost activity, which may command up to 50% of the total municipal budget [13,14].

Additional infrastructure, mainly physical, to manage MSW may not seem an attractive option to municipal authorities under severe resource constraints. But there is a growing demand for better solid waste management services by residents who are also ready to pay increased waste collection tariffs for improved services [9,15]. Compounding the problems are the shortening life-spans of landfill sites due to the percentage increase in plastic waste which takes a longer period of time to decay [16]. The demand for more landfill sites is expected to increase in future because of the growing consumption of processed food products that are packaged in plastic (among them, bottles, food wraps, bags, etc.) and the use of electronic appliances which take a long time to decompose. In the absence of a mechanism for proper recycling of plastic and electronic waste (e-waste), the demand for landfills sites is bound to increase steadily, which would only add to conflicts between municipal authorities and communities close to the landfills, as landfill sites generate disamenities to nearby residents [17].

Dumping of plastic waste in rivers and canals, in addition to drainage systems, results in flooding and water logging in low-lying areas. In such situations, structural interventions can provide only a short-term solution in the absence of MSW management [6]. Similarly, imposing a ban on plastic use without strict enforcement may not work properly [18]. Hence, reduction of plastic waste at source is critical for preventing water logging and flooding in cities and low-lying areas. Several cities have, in fact, enforced a levy on the use of plastic bags to reduce its release to the environment [1] and studies show that a levy on disposable plastic bags reduces its use [2]. Some European countries have introduced policies on recyclable packaging standards to increase recyclable waste [4]. While the management of electronic waste is challenging, discussions already are underway in developed countries to implement extended producer responsibilities [5].

In this context, the present study attempts to answer how to make MSW cost-effective and financially sustainable. Although many studies have explored the financial contribution of households, businesses and institutions to MSW management [9,19], they have not been of much use to policy makers and municipal authorities in developing countries who seek information on a national-scale sustainable financing mechanism for managing MSW. Sustainable financing, as understood in the present case, is one where MSW management activities would not require additional funding from other sources but one where material recovery and recycling alone would generate sufficient resources.

This study examines both sides of the financing mechanism–costs and revenues–for properly managing plastic waste. It also estimates the additional tax that needs to be imposed at national level on the import of plastic materials when material recovery and collection efficiency rates are low. This study hypothesizes that the additional revenue could be used for managing plastic waste so that municipalities would not need to overly rely on the voluntary subscriptions of households to carry out solid waste management services. The current practice in Nepal is one where households have the option of subscribing to the MSW collection service by paying a pre-specified tariff. In comparison, the proposed imposition of additional tariffs on the import of plastic materials or the recovery of plastic waste for recycling would be more inclusive while ensuring distributional justice vis-à-vis the poor and vulnerable groups living in urban slums and other areas, who are unable to afford the service charge in the existing pay-as-you-use waste management service.

Methods

Theoretical framework

Since MSW management is a complex process involving a series of steps with multifaceted effects on human life, its improvement requires the participation of diverse stakeholders and treatment of waste as a resource while taking into consideration cross-cutting issues like sustainability, inclusion, gender and governance. This can be achieved through a careful study of the different components and contextualization of standard practices.

An integrated and sustainable solid waste management (ISSWM) approach views solid waste management as a system which engages all stakeholders by adopting the principles of equity, effectiveness, efficiency and sustainability. This approach basically considers three factors–(i) stakeholders, (ii) elements, and (iii) aspects–in order to design the MSW management system focusing on reduce, reuse and recycle [20]. This concept, often called the 3Rs, is predicated upon the belief that solid waste comprises several types of materials with different values and impacts. The analysis in this study mainly focuses on plastic waste, which is considered one of the most challenging categories of waste [18].

As most of the plastic waste could be recycled, the ISSWM promotes a circular economy which would be able to generate enough resources to pay off the management costs [21]. But, in order to be feasible economically and technically, MSW management should factor in social acceptance, cost effectiveness and technical feasibility.

Fig 1 depicts the framework for sustainable financing of MSW management services. The framework indicates that sustainable financing of MSW management has two components: (i) financing and (ii) management of waste. Financing depends on costs of management and revenues from recycling and reusing. Management costs can be minimized by reducing the use of plastics, increasing the reuse of waste materials, and generating lower volumes of waste.

Similarly, management of wast has two aspects: material recovery and collection efficiency. Material recovery is the percentage of total recyclable material recovered from collected solid waste. Collection efficiency which is the percentage of recyclable waste material collected out of the total waste, influences the cost of MSW management while revenue relies on material recovery, collection efficiency, and price of recovered materials. In Nepal, very few households practice separation at source; even if households segregate waste at source, service providers generally do not have a separate pick-up service [9]. Some households practice separation of saleable materials such as metal, plastic and paper from the waste. Generally, materials that are recovered for reuse or for sale by households are not included in total waste estimates in this study. Hence, this study only considers recovered items from the landfill sites.

The financial component (revenue and cost) is market driven. Therefore, in this analysis, revenue and costs are taken from the existing waste management practices in Nepal. As for the management component, government policies in addition to efforts of municipal authorities could improve it. For instance, the quantity of recycled materials depends on the quality of plastic materials used in packaging [22], which highlights the role that the government can play in imposing restrictions on the quality of plastic used in packaging. Similarly, provision of incentives to households to segregate waste at household level would contribute to improving collection efficiency.

The deficit in the cost of plastic waste management could then be made up by imposing an additional tariff on the import of plastic materials that are mainly disposable and thus end up in landfills and drainage systems. The additional tariff would make the use of such plastics

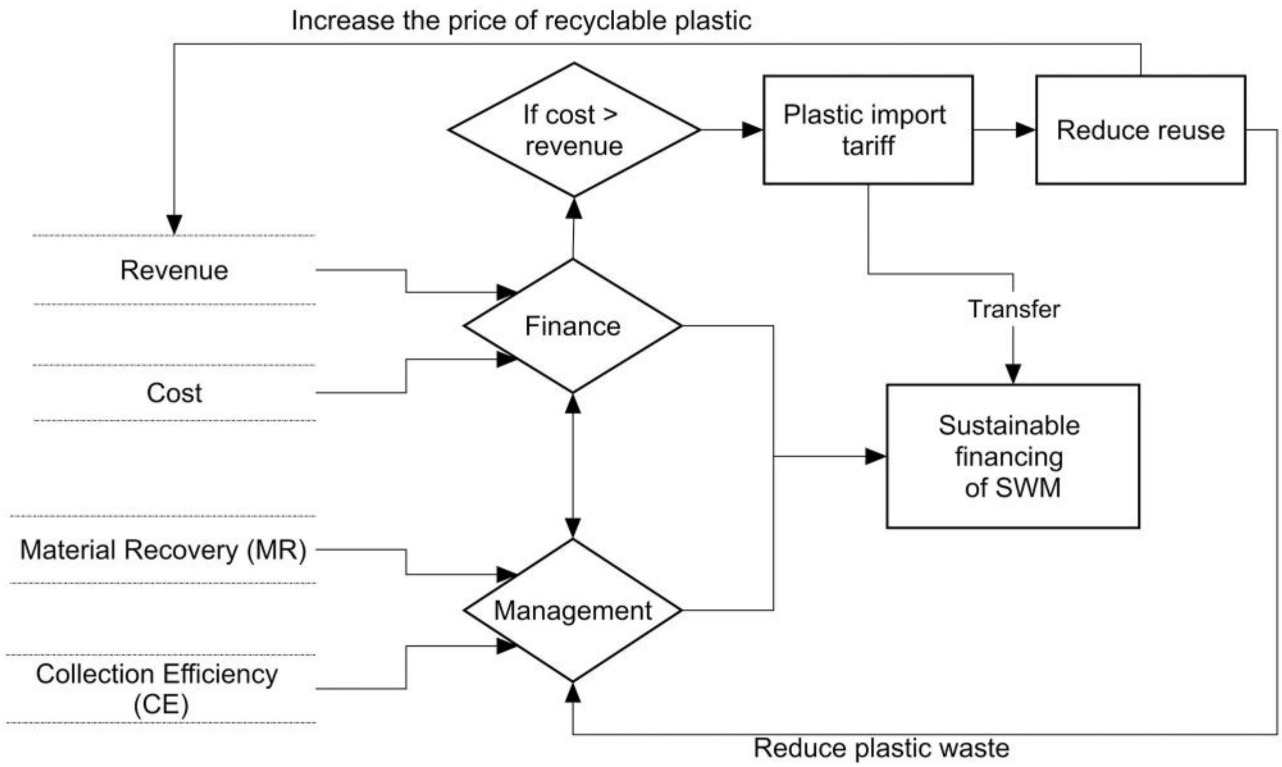

Fig 1.

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relatively expensive, which would help thereby to: a) promote substitutes, b) reduce the use of plastics, and c) increase the price of recycled plastic, which would increase revenues. Since plastic waste will become expensive with the additional tariff, it would help promote recycling as well as reduce the use of plastics.

Data collection

This study used both qualitative and quantitative approaches to collect data. A total of 83 respondents from different stakeholder groups were interviewed to explore existing MSW management and financing. Of them, 20 were collectors of recyclable materials, 23 were local government officials, 15 were environmental activists, and 25 were policy makers. These respondents were chosen using different approaches, based on the category. For example, the collectors of recyclables were surveyed from the selected municipalities. These collectors generally gather in local tea-shops in the morning for tea. The research enumerators approached them and obtained their consent to answer the relevant questions. This process was continued in the different municipalities until 20 respondents were interviewed. Other categories of respondents, such as local government officials, environmental activists and policy makers, were easier to identify. We prepared the list of potential respondents and discussed with them first their availability for an interview as well as interest in providing information voluntarily.

The questionnaire, which is in two parts, has been submitted to the journal for public access. The first part aimed at collecting data on existing MSW management, which was the same for all respondents. The second part sought to collect information on the involvement of particular stakeholders in MSW management and the supply chain of recovered material. The information provided by private companies that collect and dispose of MSW was used to determine the material recovery rate (MRR).

So far, there is no institutional review board or national ethical guidelines for social science research in Nepal. Therefore, the study adhered to established standards in research ethics such as obtaining verbal consent for participation in research, keeping personal informal confidential, and allowing participants to quit the discussion at any point withdrawing their consent if they so desired. Furthermore, no personal information of the key informants or other individuals, who provided information related to solid waste generation and import of plastics or related information, were used in this research. Average values of the collected information were used for developing different scenarios for simulation.

For this research, the material recovery rate is estimated using a series of Eqs (1)–(5) based on the SWM baseline data of municipalities taken from the report published by the Asian Development Bank (ADB) in 2013 to assess the current situation of SWM in municipalities of Nepal [23]. The Tables in Appendix 4–7 were used to estimate the efficiency of waste collection, weight of the solid waste estimates in municipalities, and the contribution of plastic waste in the total waste. The Table in Appendix 9 of the ADB 2013 Report was used to calculate the expenditure incurred by a municipality to manage a ton of solid waste. Missing data were excluded while calculating the average value of the relevant variables across the municipalities. The data collection process with the major findings of the baseline survey can be accessed from the Asian Development Bank's website [3].

$$CW = TW \times ACE \tag{1}$$

where,

CW is weight of waste collected by municipality

TW is total weight of solid waste produced in the municipality

ACE is average collection efficiency

$$MRP = RPM \times CW \tag{2}$$

where,

MRP is weight of the material recovery potential waste

RPM is percentage of recoverable potential material in CW

$$MR = MRP{*}\mathrm{MRR} \tag{3}$$

where,

Material Recovered (MR) = weight of material recovered (for this study plastic) from MRP

MRR is material recovery rate which is the percentage of particular material that can be recovered from the MRP.

$$\mathrm{PTWR} = MR/TW \tag{4}$$

where,

PTWR is proportion of recovered waste to TW

$$\mathrm{TMR} = PTWR{*}PCW{*}UP \tag{5}$$

where,

TMR is total material recovered

PCW is weight of waste produced per capita

UP is population living in municipalities

The amount of solid waste materials was estimated for commercial, institutional and residential waste separately as the material composition varies by source of waste [23]. MRR affects overall calculation of material recovered, and costs and revenue from recycling. Therefore, we cautiously selected the MRR. We first reviewed the material recovery rates for different countries and compared them with local rate. in different municipalities in Nepal. The material recovery rates in some of the municipalities in Nepal were similar to those observed in developed countries. An example would be Dhankuta Municipality, where solid waste management has been practiced for the past several years, the rate of which is comparable to that reported in Australia for 2012 [24].

The cost of and revenue from MSW management were estimated using material recovery information and the results were simulated using two additional items of information: a) average price of recyclable materials and b) MSW management cost. The potential revenue gap was then estimated, which was followed by the estimation of the levy to be imposed on imported plastics to cover the resource gap (cost–revenue).

Plastic import data for Nepal were obtained from the Department of Customs under 'Plastic and article there-of', which was classified under HS code 39 for the years 2010–2016. This information was used to analyse the import values of plastic-related materials and the taxes collected under different headings. The additional levy on plastic imports based on the resource gap was estimated thereafter. In doing so, we expect the top-up levy to increase the price of plastic materials reducing in turn the demand. The price mechanism would provide some incentive for using alternative materials in place of plastics while also reducing the demand for disposable plastics as the price goes up, thus curbing the increasing per capita consumption of disposable plastic items. Already, there have been instances reported in Nepal where large retail stores have stopped providing plastic bags to their customers while some restaurants have started using local materials such as bamboo utensils and dried-leaf plates as substitutes for plastics. With an additional import duty on plastic materials, the trend in using substitutes is bound to increase with time.

Analysis

The analysis determines the different components of sustainable financing (see Table 1). It uses information for 58 municipalities as Nepal had only 58 municipalities till 2013 while the rest were village development committees [23]. After the promulgation of the new Constitution in 2015, there has been a drastic change in the number of local administrative units in Nepal with, currently, more than 750 local administrative units across the country. For our analysis, we considered the earlier administrative structure and have thus included 58 municipalities in the study.

Table 1. Levels of different components of sustainable financing.

Finance		Management	
Revenue	**Cost (per ton of waste collected)**	**Material recovery**	**Collection efficiency**
• R1- NPR 30/kg • R2- NPR 15/kg • R3- NPR 12/kg	• C1- NPR 2,347/ton • C2- NPR 4,673/ton	• Low -12% • Medium -15% • High—30%	• Least efficient—20% • Existing—33.7% • Medium—50% • High—66.7% • Maximum—90%

NPR is Nepalese Rupees; USD1 = NPR 85 in 2012

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In the analysis, two types of MSW management costs were identified: (i) lowest cost (C1) and (ii) average cost (C2). The lowest cost (C1) is the cost of MSW management practiced by Dhankuta Municipality, which has one of the best MSW management practices in Nepal. The average cost (C2) is the average cost of MSW management practiced by the other municipalities in Nepal. Similarly, three revenue scenarios were determined based on the price of recycled/reused plastic materials: (i) average price received by collectors (R1), (ii) price received by segregators in Dhankuta municipality (R2), and (iii) average price received by households (R3). The prices for R1, R2 and R3 were elicited, respectively, from the collectors' survey, a manager of the solid waste management company contracted by Dhankuta Municipality, and the website of Khalisisi–a social enterprise engaged in door-to-door collection of recyclable material [25].

Based on the costs and revenues in Table 1, six scenarios were developed to assess the costs and benefits from solid waste management. These scenarios are R1C1, R1C2, R2C1, R2C2, R3C1 and R3C2. Of these scenarios, R1C1 is the best with the best selling price for recovered plastic materials with the least management cost. In contrast, R3C2 is the worst scenario with regard to the average MSW management cost; it also has the lowest price for recovered plastic.

These scenarios were assessed using different material recovery rates and collection efficiencies as reported in Table 1 (columns 3–4). The estimated collection efficiency for Nepal is 33.7%, which is the weighted average of collection efficiency of the 58 municipalities in 2012. As communicated by the environment officer of the municipality, the plastic recovery rate is between 12% and 15% in Dhankuta municipality minus the segregation of plastics and other waste at source. It is expected that segregation at source will increase the recovery rate up to 30% [26]. Based on these findings, three different scenarios of plastic recovery rates are identified: 12%, 15% and 30%. Similarly, collection efficiency is categorized into five groups: (i) Least efficient–below average, (ii) Existing–equivalent to the average of the disposed waste in landfills, (iii) Medium–the performance of smaller towns with better management, (iv) High–the lower bound of major cities, and (v) Maximum–the higher bound of major cities.

Results

Material recovery potential

In 2012, Nepal imported 0.4 million tons of plastic while the estimated plastic waste generated was 0.23 million tons [27]. On average, the 58 municipalities generally produced 1,281 tons of waste per day of which 769 tons were household waste, 447 tons commercial waste and 65 tons institutional waste [23]. Organic waste exceeded 66% of the total waste volume generated at the household level while it was 40% and 20%, respectively, in the case of commercial and institutional waste [23].

The average MSW collection efficiency of all municipalities is 33.7% in Nepal [28]. Based on the collection efficiency, the daily quantity of materials that can be processed for material recovery is 432 tons. The daily material recovery potential is thus 196 tons, which is around half of the collected waste. Organic material is recoverable or reducible and many households use organic waste as animal feed or, once processed, as compost for their farm or kitchen garden. However, organic waste in big cities is becoming unmanageable since, in big cities like Kathmandu, plot sizes are smaller, kitchen gardens are absent, and many families live in rented apartments, limiting the scope for composting the organic waste in their backyards.

Another recoverable material is paper. On average, 48.7 tons of paper can be recovered on a daily basis from these municipalities. There is a wide variation in the price and quality of paper. Khalisisi, an organization working on waste recycling in Nepal, pays NPR 17/kg for notebooks, NPR 9/kg for cardboard, NPR 11/kg for used books, and NPR 14/kg for

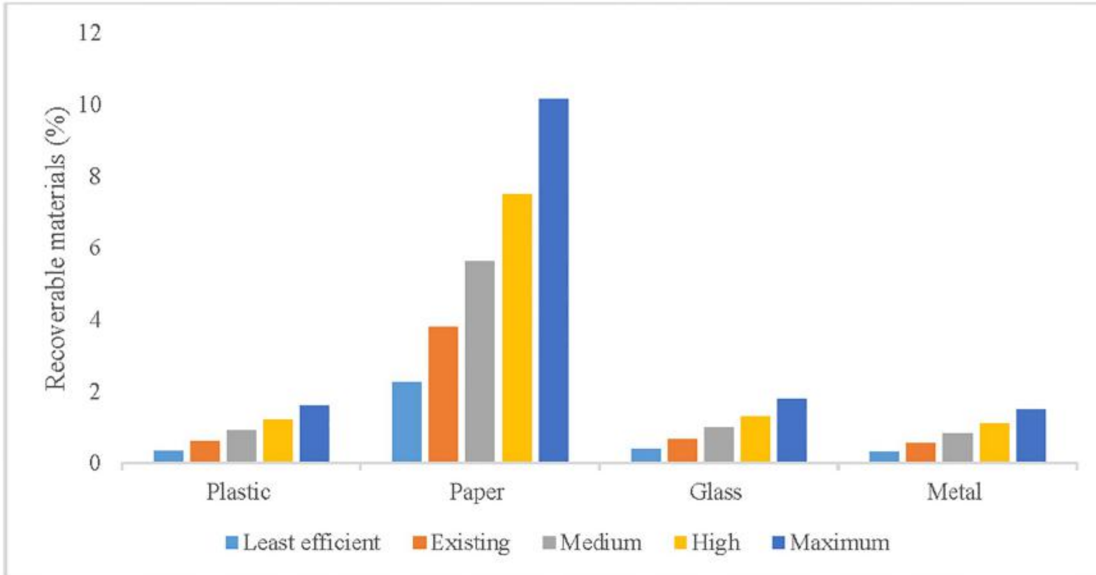

Fig 2.

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newspapers [25]. As there is a chain of collectors, an increased volume of collection can be sold to big collectors which could bring in a better price for the sellers.

Plastic is a dominant material in waste. At present, on average, 6.05 tons of plastic waste can be recovered daily from the 50.4 tons of plastic waste produced each day. According to collectors, the rate of recovery varies with the type of the plastic product. For example, while the recovery rate of plastic bags is 58%, for bottles it is 61% and for utensils it is 62%. These recovery rates can go up higher when waste is managed more efficiently. But there are technological constraints to recycling since some plastic items are not recyclable while many items do not have enough volume. Low volume is not profitable as the marginal cost of recycling exceeds the marginal benefits from recycling.

The quantity of recoverable materials changes with a change in collection efficiency (Fig 2). Based on the existing collection efficiency and the 12% plastic MRR, only 0.61% of the total waste produced can be recovered as plastic. The maximum plastic recovery would thus be 1.62% of the total waste produced at 90% collection efficiency with 12% MRR. Given this data, a 1% increase in plastic MRR would increase recovery by 0.04% of plastic waste and 0.02% of total solid waste.

Financing

Table 2 reports the costs and revenues at 12% MRR in different collection efficiencies for the best and worst case scenarios. The results suggest that, at the existing collection efficiency, the revenue generated from recovered plastic could cover 1.6% and 7.8% of the total solid waste management costs, respectively, in the worst and best case scenarios. Similarly, it could cover 11.2% and 55.7% of the plastic-related MSW management costs in the worst and best case scenarios, respectively. As such, the management would require additional finances to cover the plastic-waste-related cost, which is equivalent to 0.2% and 0.7% of the total plastic import value, in the best and worst case scenarios, respectively.

The results indicate that if collection efficiency increases to 66.7%, then the revenue generated from the recovered plastic at 12% MRR would outweigh the plastic-related MSW

Table 2. Cost and revenue in best case (R1C1) and worst case (R3C2) scenarios at 12% recovery rate.

Criteria	Collection efficiency									
	Least efficient (20%)		Existing (33.7%)		Medium (50%)		High (66.7%)		Maximum (90%)	
	R1C1	R3C2	R1C1	R3C2	R1C1	R3C2	R1C1	R3C2	R1C1	R3C2
% of overall MSW management cost	4.6	0.9	7.8	1.6	11.6	2.3	15.4	3.1	20.8	4.2
% of plastic-related MSW management cost	33.0	6.6	55.7	11.2	82.6	16.5	110.0	22.1	149.0	29.8
Revenue (NPR in million)	30.0	12.0	51.0	20.0	76.0	30.0	102.0	41.0	137.0	55.0
Top-up to cover plastic waste related cost (% of import value)	0.3	0.8	0.2	0.7	0.1	0.7	0.0	0.6	-0.2	0.6

Simulation results using primary and secondary sources of data discussed under data section.

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management costs in the best case scenario while it would cover only 22% of the costs in the worst case scenario. Even if collection efficiency improves to 90% in the worst case scenario, the revenue from the recovered plastic would cover a mere 30% of the plastic-related MSW management cost.

Sensitivity analysis

An optimistic scenario is defined as a case where the plastic MRR is 15% and the collection efficiency is high (at 66.7%). This scenario was set up after a series of discussions with the relevant stakeholders and officials of municipalities assuming that it would be achievable in the Nepalese context. The results of the optimistic scenario for best and worst cases are reported in Table 3. The results suggest that the best case scenario generates 1.38 times more revenue than the plastic-related MSW management cost earning NPR 35 million whereas the revenue generated from recovered plastic in the worst case scenario can cover only 27.6% of the plastic-related MSW management cost. The optimistic condition will prevent 4,220 tons of plastic from entering the environment annually while reducing 1.5% of total waste from the waste stream.

In addition, two analyses were carried out to examine how much the revenue from recovered plastic is sensitive to collection efficiency and recovery rate (see Table 4). The effect of recovery rate on plastic revenue is calculated at existing collection efficiency (33.7%) and the effects of collection efficiency on the 15% recovery rate. The results show that a 1% increase in recovery rate and a 1% increase in collection efficiency would recover an additional 4.64% and

Table 3. Results of optimistic scenario.

Criteria	Unit	Best Case Scenario (R1C1)	Worst Case Scenario (R3C2)
MSW management cost (per year)			
Total cost (A)	NPR Million	659.0	1312.0
Plastic proportionate (B)	NPR Million	92.0	184.0
Plastic revenue (C)	NPR Million	127.0	51.0
Deficit (D) for managing plastic waste = [B-C]	NPR Million	-35.0	133.0
Cost recovered from recovered plastic revenue			
Total MSW management cost (C/A)	percentage	19.3	3.9
Plastic proportionate (C/B)	percentage	138.0	27.7
Top-up (D/total value of import)	ratio	-0.16	No top-up required
Weight of recovered plastic proportionate to total waste	percentage	1.50	

Simulation.

https://doi.org/10.1371/journal.pone.0231933.t003

Table 4. Plastic-related cost recovery for the best case scenario (R1C1).

Existing collection efficiency (33.7%)			15% recovery rate		
Recovery rate (%)	Cost recovery (%)	Plastic recycled (ton)	Collection efficiency (%)	Cost recovery (%)	Plastic recycled (ton)
12	55.7	1,707	20.0	41.3	1,266
13	60.3	1,849	33.7	69.6	2,134
14	65.0	1,991	50.0	103.3	3,165
15	69.6	2,134	66.7	137.7	4,220
30	139.2	4,267	90.0	185.9	5,698

Simulation.

https://doi.org/10.1371/journal.pone.0231933.t004

2.06% of the plastic-related MSW management cost, respectively. Similarly, recycled plastic waste would increase by 142 and 63 tons, respectively, with a 1% increase in both recovery rate and collection efficiency.

The results also suggest that a 30% recovery rate generates 39% more revenue compared to the plastic-related MSW cost when recycling 4,267 tons of plastic per year. Similarly, revenue generated from recovered plastic at collection efficiency more than 50% can cover the plastic-related MSW management cost by reducing at least 3,165 tons of plastic in the waste stream. Table 4 suggests that with a 30% recovery rate under the existing collection efficiency rate, the plastic recycling program would generate enough revenue to finance the costs of plastic waste management. On the other hand, with a 15% recovery rate, a 50% collection efficiency would be needed to generate enough revenue to finance the plastic waste management costs.

Discussion

The volume of MSW is showing an increasing trend in Nepal as the economy undergoes a transition from a farm-based rural economy to an industry- and service-based urban economy [29,30]. With this transition, consumption of processed foods packaged in plastic covers/containers has been on the rise. Furthermore, the use of plastic bags has been rampant as these bags are mainly provided at no additional cost at groceries and shopping centres. In urban Nepal, on average, a household uses over 10 plastic bags per week for groceries which translates into roughly 28,000 tons of plastic bags in the environment per year if not recycled properly [18]. For this estimate, a conservative weight of 1 plastic bag equals 10 grams had been used whereas a plastic bag used in homes could weighbetween 8 and 32 grams.

The local municipal authorities have been facing challenges in managing solid waste effectively because of poor planning, a low level of awareness among residents, and lack of resources. But the increased volume of waste is likely to increase the cost of MSW management. Household waste collection is one of the most expensive MSW management activities in Nepal. Sweeping and waste collection comprise around 60–70% of the total MSW management cost of municipalities [23]. In addition, a challenge arises relating to the management of land-fill sites with increasing waste production. In such a scenario, municipal authorities need to develop a strategy that would minimize the MSW management cost while increasing the longevity of landfill sites.

There has been a growing interest in converting waste to energy, a popular idea in South Asia [31]. Another way to reduce the use of plastics bags is to impose a ban and enforce the ban with significant fines. But without strict enforcement of the ban with sufficient fines, such a ban would fail miserably [18]. The ban would also increase the administrative costs of the cities as strict enforcement of the ban requires constant monitoring. This study discusses an alternative option, i.e., material recovery and recycling of plastic waste with additional tariffs on the import of plastic materials.

Recycling and reusing plastic would contribute to the following: reduce the volume of waste to be collected and disposed of in landfills while generating revenue. However, it requires an integrated approach involving all stakeholders–from members of households who segregate waste at source to collectors and recyclers. Usually, incentives motivate stakeholders to participate in environmental management programs [32,33]. In plastic waste management, a household could earn extra income from plastic waste if they segregate waste at the source. Similarly, waste pickers could also earn more once improved recycling activities are in place [34].

The results suggest that ISSWM not only collects, transfers and disposes of the waste but also minimizes the cost of MSW management by generating revenue from recovered waste material [26]. This could offset some portion of the MSW management cost, which is one of the more expensive activities of municipal authorities. This study suggests that revenue generated from recovered plastic could recover up to 20% of the MSW management cost. But the analysis excludes the indirect benefits of plastic recycling such as reduction in oil usage and carbon dioxide emissions as well as lowering the quantities of plastic waste dumped ensuring thereby the longevity of landfill sites [22]. In addition, recycling can also reduce the demand for virgin raw materials for the production of plastic items, reducing thereby the volume of plastic imports and the trade deficit. Accounting for these indirect benefits will increase the financial as well as the environmental contribution of recovered plastic waste in MSW management.

Even in conservative estimates that include only direct benefits, the generated revenue outweighs the plastic-related solid waste management cost in the given material recovery rate and collection efficiency. This corroborates the findings of another study according to which the financial benefits generated from properly managed construction waste offsets the management cost of the particular waste [21].

The results suggest that improving the material recovery rate would be more effective than increasing collection efficiency. However, both should be improved simultaneously to enhance the efficiency of MSW management. These inputs could be improved through appropriate infrastructure or policy instruments [35,36]. For instance, revenue could be increased through additional collection and recovery of high-value materials [35]. Improvement in the material recovery rate would require the introduction and enforcement of packaging standards and at-source waste segregation strategies [22,37]. Recovery and recycling of material from waste, however, is a complicated process. ISSWM requires several complementary policies and a supportive environment [7]. The experience of MSW management in Japanese municipalities suggests that the cost of MSW management depends on scale, segregation at household level, cooperation of adjacent municipalities in integrated management, and the manner in which the service is being provided [8]. Private sector engagement reduces cost and increases effectiveness [8,9]. An important aspect of increasing recovered material is segregation of waste at household level. It is hard to recover plastic from mixed waste as households pack mixed waste in plastic bags, making it almost impossible to segregate. In such a situation, promoting kitchen gardens or scaling up waste-to-energy-type biogas could consume the organic household waste so that easy-to-segregate waste enters the collection channel [10]. Enforcing recyclable packaging material could help circulate the same material and reduce the release of plastic waste into the environment [4]. However it would only work if segregation-at-source and recycling are practiced [11].

The quality of plastics and packaging materials could also be controlled by setting standards for those importing such materials with proper tax incentives. Additional import tariffs would have three benefits: i) it would immediately discourage the unnecessary use of plastics as plastic-related goods will become relatively expensive; ii) it would provide additional revenue to fill in the revenue gap in managing MSW properly; and iii) it would encourage promotion of substitutes for plastic in the medium to long term, which will help in achieving the goal of reducing plastic waste in the environment. According to the analysis in this paper, less than 1% of additional import duty on the import of plastic-related goods would generate sufficient revenue to bridge the resource gap in managing plastic waste if it were to coincide with the current collection efficiency and recovery rates of plastic waste.

Generally, a change in efficiency in collection and material recovery carries cost implications. However, changing the collection efficiency is difficult in the context of Nepal as municipalities are heterogeneous in terms of population density, waste production and accessibility. This heterogeneity compounds the difficulty of estimating the marginal cost of collection efficiency. For instance, some municipalities are characterized by sparsely populated suburban areas that may result in a high collection cost whereas some other municipalities would be able to improve the collection efficiency through predictable services [9]. Therefore, this study uses the average cost of per ton of MSW with a collection efficiency of up to 94%.

However, accounting for indirect effects of proper MSW management [38] as well as recovery of other waste materials such as paper and metals would assist in the recovery of such costs because segregation of plastic would also result in the segregation of other materials. It is also important to understand how the management cost changes with a change in the per unit marginal recovery rate and collection efficiency. While the expense associated with improving the material recovery rate through improved standards will be borne, in particular, by the consumer of the commodities, the expenditure incurred in improving collection efficiency will be shouldered by the waste management actors.

The financial component of the sustainable financing of MSW management is market-driven. Hence, the price of recovered materials is another determinant of revenue. This price may fluctuate due to volatile scrap market prices as requirements of scrap buyers could change over time [39]. If this were to happen, government interventions would be required to maintain the market price of scrap materials. Otherwise, households would be demotivated from segregating recyclable material at their homes and selling it to collectors; similarly, waste pickers may change occupations. Thus, one way to provide incentives for better recovery of plastic waste is to increase the import duty on plastic raw materials. In the short run, this would, in addition, generate revenue to finance plastic waste management. At the same time, it would encourage users to look for alternatives to plastics. The analysis suggests that less than 1% of import duty on the value of imported plastics materials would help finance the cost of managing plastic waste in Nepal.

Conclusion

Sustainable financing hinges on both the financial and management components of waste management. Promoting a circular economy (i.e., reduce, reuse and recycle) would create opportunities for generating the much-needed resources for MSW management. The recovery of waste materials would produce several direct and indirect benefits. For instance, the estimated revenue generated from recovered plastic waste would come to 1.38 times the cost of managing plastic-related waste. In addition, it would prevent 4,220 tons of plastic waste from entering the environment annually, which would have additional environmental benefits. In low-performing cases where the collection cost is high and revenue is low, i.e., the revenue collected from recovered and recycled material is only 22% of the plastic-related waste management costs, which would require in turn additional resources, the cost could be met by imposing an additional 1% tax on the value of imported plastic-related material.

Nevertheless, sustainable MSW would require an integrated approach to designing and implementing management activities from source to landfill site that would link and engage all stakeholders. This study indicates that the financing of MSW management would depend on the effective management of municipal waste. Increased collection efficiency of waste material and material recovery rate would reduce the financial burden on municipal authorities. For example, collecting half of the MSW and recovering 15% of plastic material from the collected MSW would cover the cost of managing plastic-related waste. However, there is a possibility that the flow of financial resources could fluctuate based on recovery rate, collection efficiency, and price of recovered plastic. Thus, in the long term, additional policy interventions such as standardising of packaging materials and infrastructure development would help in managing MSW better.

This study only covers the financial and management aspects of ISSWM in Nepal. Future studies could focus on other aspects, particularly, stakeholder interests, policy coherence, and household behaviour in developing an ISSWM framework for Nepalese municipalities.

Supporting information

S1 Data.
(DOCX)

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मूल्याङ्कनका औजारहरू

यो फाराम प्रशिक्षण सुरु गर्नु भन्दा पहिले तालिमका सहभागीहरूको फोहोरमैला व्यवस्थापन सम्बन्धी ज्ञानका बारेमा जान्नको लागि नमुना स्वरूप तयार पारिएको हो र यसलाई स्थान विशेष र अवस्था अनुसार थपघट गर्न सकिने छ।

प्रशिक्षण पूर्व-परीक्षण प्रश्नावली

१. प्राकृतिक रूपमा फोहोरमैला कति प्रकारका हुन्छन्?

क) ख)

२. व्यवस्थापनको आधारमा फोहोरमैला कति प्रकारका हुन्छन्?

क) ख) ग)

३. श्रोतको आधारमा फोहोरमैला कति प्रकारका हुन्छन्?

क) ख) ग) घ)

४. नगर बस्तीबाट निस्कने फोहोरमैलाहरू के के हुन्?

क) ख) ग)

५. जैविक फोहोरमैला प्रशोधनका विधिहरू के के छन्?

क) ख) ग) घ)

६. विषादीयुक्त फोहोरमैलाले के के मा असर गर्छ?

क) ख)

७. ठोस फोहोरमैला व्यवस्थापनका उपायहरू के के छन्?

क) ....

ख) ....

ग) ....

घ) ....

८. एकीकृत फोहोरमैला भन्नाले के बुझ्नुहुन्छ?

क) ....

ख) ....

ग) ....

९. नगर फोहोरमैला व्यवस्थापनका सरोकारवालाहरू नाम लेख्नुहोस्?

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१०. फोहोरमैला छुट्टाउन किन आवश्यक छ?

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११. विषाक्त फोहोरमैला कति प्रकारका हुन्छन्?

क) ख) ग)

१२. सार्वजनिक-निजी क्षेत्रको सहभागितामा फोहोरमैला व्यवस्थापन गर्दा साझेदारहरू को को हुन सक्छन्?

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फोहोरमैला व्यवस्थापन तथा वातावरण व्यवस्थापन प्रशिक्षण

दैनिक पृष्ठपोषण फाराम (.........................दिन)

नामः मितिः

१. आजका प्रशिक्षण सत्रहरूबाट के के सिकाइहरू भयो ?

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२. तपाईँती सिकाइहरूलाई कसरी प्रयोग गर्नुहुन्छ ?

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३. प्रशिक्षणलाई अझ प्रभावकारी बनाउन के गर्नुपर्ला ?

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फोहोरमैला व्यवस्थापन तथा वातावरण व्यवस्थापन प्रशिक्षण

प्रशिक्षण अन्तिम मूल्याङ्कन फाराम

प्रशिक्षणको नामः .... **प्रशिक्षण मितिः ....**

कृपया तलका प्रश्नहरूमा आफूलाई उपयुक्त लागेको विकल्पमा चिह्न लगाउनुहोस्।

१. यो प्रशिक्षणलाई तपाईं कसरी मूल्याङ्कन गर्नुहुन्छ ?

(क) उत्कृष्ट (ख) ज्यादै राम्रो (ग) राम्रो (घ) ठिकै (ङ) सुधार गर्नुपर्ने

टिप्पणी/सुझाव..

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२. सहजकर्ताहरूलाई तपाईं कसरी मूल्याङ्कन गर्नुहुन्छ ? (विषयवस्तुको ज्ञान, सञ्चार क्षमता, प्रस्तुतीकरण शैली आदि)

(क) उत्कृष्ट (ख) ज्यादै राम्रो (ग) राम्रो (घ) ठिकै (ङ) सुधार गर्नुपर्ने

टिप्पणी/सुझाव..

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३. प्रशिक्षणको विषयवस्तु तपाईंलाई कस्तो लाग्यो ? (कामसँग सम्बन्धी र उपयोगी, ज्ञानमा वृद्धि, सिप र दक्षताको विकासमा सहयोगी आदि)

(क) उत्कृष्ट (ख) ज्यादै राम्रो (ग) राम्रो (घ) ठिकै (ङ) सुधार गर्नुपर्ने

टिप्पणी/सुझाव..

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४. प्रशिक्षणमा प्रयोग भएको प्रशिक्षण विधि तपाईंलाई कस्तो लाग्यो ? (विषयवस्तु बुझ्नका लागि सहयोगी आदि)

(क) उत्कृष्ट (ख) ज्यादै राम्रो (ग) राम्रो (घ) ठिकै (ङ) सुधार गर्नुपर्ने

टिप्पणी/सुझाव..

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५. प्रशिक्षणमा उपलब्ध गराइएका पाठ्यसामग्री तथा सन्दर्भसामग्रीहरू तपाईंलाई कस्ता लागे ? (विषयवस्तु बुझ्नका लागि सहयोगी, भावी प्रयोजना लागि उपयुक्त आदि)

(क) उत्कृष्ट (ख) ज्यादै राम्रो (ग) राम्रो (घ) ठिकै (ङ) सुधार गर्नुपर्ने

टिप्पणी/सुझाव..

...

स्थानीय तहको क्षमता अभिवृद्धिका लागि तयार पारिएका प्रशिक्षण सामग्री

मोड्युल ११	भवन निर्माण मापदण्ड तथा भवन संहिता
मोड्युल १२	आगलागी र अग्नी नियन्त्रण उपकरण सञ्चालन
मोड्युल १३	फोहोरमैला व्यवस्थापन तथा वातावरण व्यवस्थापन
मोड्युल १४	जग्गा नापजाँच
मोड्युल १५	हरित आवास
मोड्युल १६	सडक ठेगाना र भौगोलिक सूचना प्रणाली
मोड्युल १७	एकीकृत स्थानीय विकास योजना प्रणाली
मोड्युल १८	अर्वन डिजाइन (Urban Design)
मोड्युल १९	सूचना र संचार प्रविधि
मोड्युल २०	पूर्वाधार निर्माण
मोड्युल २१	चट्टयाङ्ग र विद्युतीय निरीक्षण

नेपाल सरकार
सङ्घीय मामिला तथा सामान्य प्रशासन मन्त्रालय

स्थानीय विकास प्रशिक्षण प्रतिष्ठान
(स्थानीय विकास प्रशिक्षण प्रतिष्ठान ऐन, २०४९ द्वारा स्थापित)
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