EXECUTIVE SUMMARY

The activities conducted for the improvement of municipal solid waste (MSW) management in Hargeisa City, Somaliland capital city, are described hereafter. CeTAmb has been carrying on a study for the improvement of collection, recycling and disposal of MSW in Northern Somalia since 2005. The study was initially performed in collaboration with UNA Consortium within “Somalia Urban Development Programme (SUDP)” from 2005 to September 2008 and then continued together with Cesvi NGO in the “Support to improved service delivery in Somali cities (SISDISC)” project.

At the beginning of the project, solid waste management in the city was largely inadequate; so, several actions were planned in order to improve the service, with positive consequences also for public health and well-being.

According to data provided by the municipality, 223 t/d waste are produced by 650,000 inhabitants in Hargeisa. Two local NGOs are charged of waste collection.

The two NGOs are working in two different areas of the town, performing door to door primary collection by means of donkey carts or trucks, where streets dimensions allow this second practice. The construction of transfer stations where wastes are temporarily stored, waiting for the transportation to the two Hargeisa dumpsites, has started since July 2008. Nowadays, eight out of the twenty foreseen transfer stations have been built, but they were often constructed not according to the original project, that aimed at guaranteeing their technical sustainability and acceptability by local population. Even so, only some areas of the city are currently covered by solid waste collection service and less than 15% of produced wastes are collected.

Moreover, plastic and paper waste recycling were taken into consideration for their possible implementation in Hargeisa City. These fractions are relevant in Hargeisa waste composition, respectively representing 16% and 20% of the total waste, as established by conducted composition analyses. Moreover, the set up of recycling activities could provide many opportunities for employment, for example thanks to the involvement of local NGOs, and reduce environmental problems, such as the spread of plastic bags.

As mentioned above, collected wastes are transported to two municipal dumpsites. Northern dumpsite is located 17 km far from the city and used by one LNGO, whereas Southern dumpsite is located 7 km far from the city and used by the other one. Designs for the shifting of these two
dumpsites to sanitary landfills were elaborated and works for the upgrade of Southern landfill started in February 2009 and are on-going at the moment of writing. Trainings for sanitary landfill operation were also worked out and are going to be held in July 2009. Sanitary landfills are effective in minimizing pollution and nuisance and can significantly contribute to improve population health.

Finally, a great consideration was given to the problem of health-care wastes collection and disposal. The two LNGOs waste collectors, as well as hospitals personnel, were trained on safe practices for health-care waste collection and disposal. Moreover, three incinerators for health-care waste burning were constructed in TB Hospital, General Group Hospital and in a private clinic and a training on the correct use of this facility was delivered.

All carried out and on-going activities were widely discussed with local stakeholders, trying to individuate solutions appropriate for the specific context and characterized by sustainability from technical, economical and social point of view.

INTRODUCTION

In urban areas, especially in the rapid urbanizing cities of the developing world, problems and issues of municipal solid waste management (MSWM) are of immediate importance (Zurbrügg, 2008). Systems for transfer, recycling and disposal of solid waste are almost always unsatisfactory from the environmental, economic and financial points of view. Unfortunately, this situation leads to heavy consequences for public health and well-being, and for the quality and sustainability of the urban environment (Diaz et al., 1999).

In April 2005 the Somalia Urban Development Programme (SUDP), an umbrella framework programme funded by the European Commission and UNDP and led by UN-Habitat, was started. The global objective of the programme was to support the development of urban areas through strengthening urban institutions. Within the SUDP, UNA Consortium and CeTAmb carried out interventions to improve the MSW services in the main cities of Somaliland and Puntland. After the ending of SUDP in September 2008, MSWM related activities were not stopped, but continued under SISDISC (Support To Improved Service Delivery In Somali Cities) programme, lead by Cesvi NGO in collaboration with CeTAmb.

The present paper briefly illustrates interventions carried out for the improvement of MSWM in Hargeisa City, Somaliland capital city.

STUDY AREA

Somalia is a coastal nation in East Africa. It is bordered by Djibouti to the North-West, Kenya on its South-West, the Gulf of Aden with Yemen on its North, the Indian Ocean at its East, and Ethiopia to the West.

Somalia has been without a central government since January 1991. Whereas Southern and Central Somalia still remains a zone of civil war, Northern Somalia developed differently: in the North-West the Republic of Somaliland was established in May 1991 (see Figure 1) and Puntland was founded in the North-East as autonomous regional state in August 1998 (Hoehne, 2008). Activities presented in this paper have been taking place in Hargeisa, Somaliland capital city, where currently about 650,000 people live.
WASTE PRODUCTION
According to the municipality, 223 t/d waste are produced by 650,000 inhabitants in Hargeisa; therefore, per-capita production results equal to 0.35 kg/d.
A waste composition analysis was conducted on Hargeisa urban solid waste since data referring to waste composition were not available. On the whole, 129.1 kg of waste were collected and analyzed. They were characterized by an average density equal to 172 kg/m³. This low value can be justified considering that analyses were carried out during the dry season; density would surely have been higher during the rainy season.
The following Table 1 reports identified waste fractions and their percentages on the whole waste.

<table>
<thead>
<tr>
<th>Waste Fraction</th>
<th>Weight (kg)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic</td>
<td>20.70</td>
<td>16.0%</td>
</tr>
<tr>
<td>Organic matter</td>
<td>27.40</td>
<td>21.2%</td>
</tr>
<tr>
<td>Paper/Cardboard</td>
<td>25.70</td>
<td>19.9%</td>
</tr>
<tr>
<td>Glass/Inerts</td>
<td>6.75</td>
<td>5.2%</td>
</tr>
<tr>
<td>Metals</td>
<td>3.20</td>
<td>2.5%</td>
</tr>
<tr>
<td>Textiles</td>
<td>5.50</td>
<td>4.3%</td>
</tr>
<tr>
<td>Wood/Charcoal</td>
<td>1.65</td>
<td>1.3%</td>
</tr>
<tr>
<td>Other</td>
<td>0.90</td>
<td>0.7%</td>
</tr>
<tr>
<td>&lt; 2.5 cm</td>
<td>37.30</td>
<td>28.9%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>129.1</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

It is possible to observe that the highest percentage is represented by the less than 2.5 cm fraction (28.9%). Organic matter percentage is not very high (21.2%) compared with usual values registered in Developing Countries (up to 50%; Cointreau, 1982); probably because it is commonly eaten by animals and it was dry at the moment of the analysis. Paper and cardboard reach a significant percentage, equal to 19.9%, but within ranges reported by Cointreau (1982), from 15 to 40%. On
the contrary, plastic percentage (16%) is significantly higher than data usually reported for Developing Countries, varying between 2 and 10%.
Moreover, PET and other kinds of plastic were weighed separately. In the whole waste, PET fraction is equal to 3.1%, whereas other plastics fraction reaches 12.9%.

WASTE COLLECTION
As highlighted by Zurbrügg (2008), waste collection in Low-Income Countries is typically organized in two phases: primary collection (from households to collection points) and secondary collection (from collection points to disposal sites). In Hargeisa, two local NGOs were charged of these two phases by the municipality. The two NGOs, DHIS Public Works and Services NGO and Sabowanaag Services NGO, are working in two different areas of the town.

Primary Waste Collection
DHIS NGO carries out door to door collection in the residential area of each district three times a week, passing in the streets with donkey carts or directly with trucks from 9 a.m. up to 6 p.m.. Garbage are collected and loaded daily in each market area and from restaurants. Schools, administrative offices and health centres (including the main hospital) are included in the collection system.

In the districts served by Sabowanaag NGO, each area is served door to door by two teams composed by 20 cleaners and a foreman that manages the group and organizes the activities. The first team works from 6:00 a.m. to 2:00 p.m., the second from 8-9 a.m. to 4-5 p.m.. Moreover, a truck is used for the door to door collection.

Garbage are then taken to commonly recognized collection points or to transfer stations built during the project. Fees are collected by specific operators; their amount depends on supposed waste volume produced by each user, without an univocal and clear criterion: often institutions or international NGOs compounds are overtaxed out of proportion to the actual waste production.

Secondary Waste Collection
As already mentioned, secondary collection deals with transferring wastes from collection points to dumpsites. Two dumpsites are located in Hargeisa (see following paragraphs). The Northern one is used by DHIS NGO, carrying 14 loads per day by means of seven trucks to this site, whereas the Southern dumpsite is used by Sabowanaag NGO, transferring there 12 loads per day by means of five trucks. On the whole, around 15% of produced solid waste is taken to the two dumpsites.

Solid waste transfer stations (SWTSs) were designed and built within the project. It was proposed to locate 20 SWTSs in the city area (10 in the Southern area and 10 in the Northern area). At the moment of writing (June 2009) only eight TSs have been constructed; Figure 2 shows the TS located at Group General Hospital, the main hospital of Hargeisa City.

TSs were designed considering the criteria presented hereafter, aiming at guaranteeing their technical sustainability and acceptability by local population. First of all, their location was agreed with the municipality and with the two NGOs involved in waste collection; the importance of placing TSs close to already existing waste collection points and to draining canals was stressed, in order to make their identification easier for people and to reduce the quantity of waste thrown in canals.

TSs were designed 3 m wide, 4 m long and 1.2 m high, so that their useful volume can be considered equal to 10.5 m³. They are made up of a concrete slab surrounded by walls and between 0.7 and 1 m high. This feature allows to reduce up-and down-loading operations time and facilitates waste transportation to trucks. Two openings were designed in the walls: one for trucks, located on one side of the slab, and the other one for donkey carts, placed on the opposite wall. Since the height of a truck is commonly 1.20 m and the slab is located at an inferior height, a little slope was foreseen on that side of the TS. Finally, the slab is provided with a ramp in order to facilitate wheelbarrows to download collected wastes. The slope of the ramp should be 8° (anyway no more than 12°), favouring wheelbarrows pushing on. So, the height of the slab was chosen considering
the height of trucks and donkey carts (1 m high) and the slope of the ramp for wheelbarrows. Walls surrounding the slab are also provided with some holes, facilitating rainwater discharge. A guardian was encharged of keeping the collection point clean and controlling waste up-and down-loading operations.

Actually, TSs were built not according to the original project, described above. From data collected during the surveys conducted in August 2008 and February 2009, it was possible to highlight some common issues: TSs slabs were often higher than 1 m and slopes of ramp for wheelbarrows were frequently major than 12°. So, problems during up- and down-loading operations were registered. Moreover, some TSs were not provided with openings for donkey carts or these openings were too high.

Also managerial problems were identified: LNGOs were irregularly serving TSs and guardians were seldom present. Moreover, animals and children were often present inside TSs; ramps for wheelbarrows were sometimes dirty and impracticable and the presence of health-care waste inside TSs or in their immediate neighborhood was highlighted. Even so, it was possible to deduce the acceptance by local population of the new collection system and an easy use of TSs also by weaker users, such as women and children in the areas where transfer stations were correctly built.

Figure 2 – Transfer station located at General Group Hospital

**WASTE RECYCLING**

Two kinds of waste recycling were taken into consideration for their possible implementation in Hargeisa City: plastic and paper recycling. These two categories, as well as organic matter, make up a significant percentage of total waste, as shown in Table 1. Composting projects could difficulty be successful in Hargeisa, where agriculture is not a widespread practice and so compost could not find a direct use.

**Paper Recycling**

As concerns paper recycling, tests were performed at the University of Brescia in order to evaluate compaction degree of briquettes produced at different pressure with dry and wet paper. Paper and cardboard were manually shredded and then a part was macerated for 5 days. Different tests were conducted: briquettes were manually or mechanically produced by using dry and wet (macerated) paper and cardboard.

Briquettes obtained from dry paper, cardboard and mixture of paper and cardboard were not characterized by a good compaction degree: briquettes were no more handy or only very carefully handy. It has also to be highlighted that high levels of pressure (10 MPa), not suitable for the Somali context, were adopted to produce these briquettes. So, the production of briquettes from dry material can be considered unfeasible, according to obtained results.

On the other hand, for what concerns briquettes obtained by wet (i.e. macerated) materials, registered compaction degree was good. Moreover, from collected data it was possible to observe
that briquettes compaction degree slightly changed by comparing the results obtained before and after drying, usually increasing after briquette drying. It is also interesting to note that compaction degree for the three materials did not increase as much as pressure did. Best results (highest compaction degree) were registered for 0.5 MPa pressure, value easily reachable also by manual compaction. All the briquettes produced by 0.5 MPa pressing were compact and easily transportable: no relevant differences were observed by comparing the behaviour of the three tested materials.

After these tests, a manual press was built in Hargeisa City (see Figure 3). It is able to produce easily transportable briquettes, that could be used as domestic fuel. It was verified that paper maceration phase takes about one week, whereas drying phase is completed in two days. An economic study concerning this process feasibility should also be conducted.

![Figure 3 – Manual press for paper briquettes production](image)

**Plastic Recycling**

In Hargeisa two small-scale projects for plastic recycling are already performed by local women NGOs: Daryel Umbrella and Daryel NGO (this last one is supported by DHIS company). Plastic bags are collected and reused as material to create buckets and other handmade articles, then sold to support the NGOs activity. These projects cannot be enlarged: market of finished products is limited and also the organization of medium-scale projects could be difficult.

A plastic factory is placed in Hargeisa City, producing plastic bags from already pelletized plastic material (LDPE and HDPE) bought abroad. The willingness of the factory owners to use recovered plastic as raw material seems very small. So, it is now under evaluation the possibility of implementing a process purchasing finished products from collected plastic waste. Also IDPs (Internally Displaced Persons) could be involved in this project as plastic waste collectors.

**WASTE DISPOSAL**

As already mentioned, two dumpsites were located in Hargeisa at the beginning of the project. The upgrade of these two dumpsites is currently on-going.

Northern dumpsite is located 17 km far from the city and, as already reported, is used by DHIS LNGO, whereas Southern dumpsite is located 7 km far from the city and is used by Sabowanaag LNGO. During a survey carried out in August 2008, some important common problems were identified. First of all, access roads were in bad conditions: in particular the way to the Northern dumpsite was nearly impracticable, especially after rainy days. Then, animals and waste pickers (collecting metal sheets) were present inside both the dumpsites. For what concerns dumpsites management, it was limited in both the dumpsites to the use of a bulldozer sometimes a year, in order to push garbage next to the embankments. Wastes were collocated in a lot of opened waste faces. Moreover, garbage were spread also in the dumpsites neighbours, due the strong wind blowing from NE to SW.
So, the upgrade of the two dumpsites was foreseen. In Middle- and Lower- Income countries small incremental improvements in landfill design and operation over several years are more likely to succeed than attempts to make a single, large leap in engineering expectations (UNEP, 2004; Zurbrügg and Schertenleib, 1998). So, simple interventions were foreseen and carried out, on the basis of hydrogeological and topographical surveys conducted between July and August 2008. According to Department of water affairs and forestry (1998), leachate and biogas management systems were not adopted. In fact, in arid climates, where Climatic Water Balance is negative, provided the landfill is correctly designed and operated, only sporadic leachate will be generated. It can be assumed that Climatic Water Balance is negative in Hargeisa: in fact, monthly rainfall is always lower than potential evapotranspiration (PET), as it is possible to observe by data reported in SWALIM (2008). Moreover, in small landfills, i.e. landfills receiving from 25 to 150 tons of general waste per day, biogas collection and treatment is unnecessary (Department of water affairs and forestry, 1998). Furthermore, the hydrogeological study conducted in August 2008 stated that soils by the two landfills in Hargeisa city are characterized by low permeability.

So, interventions are still on-going at the moment of writing in both the dumpsites (Figure 4 shows works conducted in Hargeisa Northern dumpsite). First of all, access roads were levelled by means of a bulldozer, in order to limit trucks breakdowns and save time necessary for solid waste transportation. Then, the construction of draining canals is currently going to be carried out in order to define preferential drainage directions for leachate and rainwater. Two draining canals began to be built in Northern landfill and three in Southern landfill. Draining canals will be filled with gravel, in order to avoid their clogging. Moreover, in Northern landfill the enlargement of the natural drainage area (from 1094 m² to 1835 m²) was conducted aiming at favouring leachate evaporation, whereas in Southern landfill a drainage area (30 m long, 30 m wide and 3 m high) is going to be built inside the dumpsite and surrounded on three sides by embankments. Then, regularization of dumpsite bed and embankments was performed in both the landfills and cleaning of external areas will be carried out.

Moreover, already disposed solid waste will be grouped next to the embankments and covered with a 10 cm-thick layer of earth. A building for the guardian was realized in order to guarantee the permanent presence of a person responsible for dumpsites security. In fact, access to landfills should be controlled by the organisation managing wastes disposal and limited to authorized people. This building was located next to the dumpsites entrance. A concrete basement was realized and a building, provided with a latrine, was placed over it.

Finally, specific trainings are under elaboration in order to illustrate proper landfill management to technicians operating in both the landfills. The most appropriate landfill management is individuated on the basis of available means and workers, in order to define operations to be daily carried out aiming at reducing risks for human health and environment and extend landfills lifetime (Rushbrook and Pugh, 1999; Jaramillo, 2003). After these trainings to be held in July 2009, local technicians will be able to guarantee a technically, environmentally and hygienically sustainable management for both the landfills located in Hargeisa City.
HEALTH-CARE WASTE MANAGEMENT

During SISDISC project, a great consideration was also given to the problem of health-care wastes collection and disposal. In Hargeisa two main hospitals (TB Hospital and General Group Hospital) and a big number of clinics are located.

First of all, DHIS and Sabowanaag LNGOs waste collectors, as well as hospitals personnel, were trained on safe practices for health-care waste collection and disposal.

Moreover, three incinerators for health-care waste burning (De Montfort incinerators) were constructed in TB Hospital, General Group Hospital and Edna Adan maternity hospital, according to the design provided by WHO (2004), then adapted to locally available materials and specific conditions. Trainings on the correct use of this facility were held and their maintenance seems good at the moment of writing. These incinerators were mainly provided for infectious waste and sharps (e.g. syringes safety boxes) burning.

CONCLUSIONS

This paper sums up activities conducted for the improvement of MSWM in Hargeisa, Somaliland capital city. Presented interventions were performed, thanks also to CeTAmb technical collaboration, during two different projects: Somalia Urban Development Programme (SUDP; from 2005 to September 2008) and Support To Improved Service Delivery In Somali Cities (SISDISC; from October 2008 and currently on-going).

They concerned all the phases of waste management: from production to disposal of.

As regards waste production, a study was conducted in order to define waste composition. Hypothesis for the improvement of solid waste collection were elaborated and agreed with the municipality and the two LNGOs involved in this activity. The construction of appropriate transfer stations was then carried out. Also interventions for the upgrade of already existing dumpsites were individuated and performed. They were studied basing on local climatic conditions and available means. Moreover, trainings to define operations to be daily carried out inside the landfills are going to be held. Finally, for what concerns waste recycling, a very simple method for paper briquettes production was identified, whereas alternatives for plastic recycling are under evaluation at the moment of writing.

Also issues about health-care waste management were considered. A partial improvement was obtained thanks to the construction of three incinerators for infectious waste and sharps and the delivering of trainings about safe practices for health-care waste management and the use of De Montfort incinerator.

All carried out and on-going activities were widely discussed with local stakeholders, trying to individuate solutions appropriate for the specific context and characterized by sustainability from technical, economical and social point of view.

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