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**Challenges for the SWM sector in post-natural disaster
and post-conflict scenarios: a comparison**

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This paper describes the solid waste management system in two cities in post emergency/ recovery phase such as Juba, South Sudan, and Port-au-Prince, Haiti, respectively due to the conflict run until 2005 in Sudan and the devastating earthquake happened on 12th January 2010 in Haiti. Thanks to field assessments conducted by the authors, it was possible to highlight common challenges in the sustainable provision of solid waste service delivery for the two cities, such as lack of awareness, instability of institutions, lack of policies, lack of coordination among the different stakeholders and limited human and financial resources. A strategic solid waste management plan should be developed in both cities involving all sustainability factors. In particular, it should have a specific focus on promoting recycling activities and favouring the return of skilled people in Juba, on developing a contingency plan to reduce the impact of future natural disasters in Port-au-Prince.

Study areas

Juba, South Sudan

Sudan, the largest Country in Africa, is located in Northern Africa, bordering the Red Sea, between Egypt and Eritrea. Its territory covers an area of 2,505.813 km² and its population is about 41 million people, with a median age of 18.4 years and a life expectancy at birth equal to 51 years (CIA, 2010). Sudan was embroiled in two prolonged civil wars during most of the remainder of the 20th century. These conflicts were rooted in northern economic, political, and social domination of largely non-Muslim, non-Arab southern Sudanese. The first civil war ended in 1972 but broke out again in 1983. The second war and famine-related effects resulted in more than four million people displaced and, according to rebel estimates, more than two million deaths over a period of two decades. Peace talks gained momentum in 2002-04 and the final North/South Comprehensive Peace Agreement (CPA), signed in January 2005, granted the southern rebels autonomy for six years. A referendum for independence has been held on 9th January 2011. A separate conflict, which broke out in the western region of Darfur in 2003, has displaced nearly two million people and caused an estimated 200,000 to 400,000 deaths. Sudan also has faced large refugee influxes from neighboring countries primarily Ethiopia and Chad (CIA, 2010).

Juba - where the reported study took place - is the regional capital of Southern Sudan and the capital of the Sudanese State of Central Equatoria. City officials estimate that Juba proper occupies a 12 km area in diameter from the centre of town. Greater Juba, including the surrounding rural lands, encompasses roughly 100 km in diameter. It is probably one of the fastest growing cities in the world: in 2005 an estimated 250,000 people were living in Juba, while there are no official figures at present, as the government of South Sudan rejected the 2009 census figures, but experts claim that the numbers have more than doubled in just five years (IDN, 2010).

Current situation of municipal solid waste management in Juba

Solid waste management in Juba is under the responsibility of several stakeholders. The Ministry of Housing, Land and Public Utilities and the Ministry of Environment are both deeply involved in the topic.

The Ministry of Environment has been created few months before the time of writing. In Juba these ministries are present at two different levels: Government of South Sudan (GoSS) and Central Equatoria State. Moreover, the sanitation office of Juba County is the one supervising the on-going collection activities. As reported hereafter, both public and private stakeholders are also involved in the activities of collection (Collivignarelli et al., 2011).

Analysis regarding the production and composition of waste were carried out by the authors in October 2010. Household production was estimated equal to 0.42 kg/inh/day and its average composition showed high percentages of vegetables (32.6%), plastic (18.2%), paper (12.1%) and textiles (11.8%). Other important fluxes in Juba waste stream are mainly the ones coming from commercial activities: industrial activities are very limited at the moment.

A formal system of waste collection is in place only in the three payams comprised within proper Juba town (Juba, Munuki and Kator). In the other thirteen payams, which form Juba County, an organized system is absent. Three different organizations are in charge of waste collection in the three payams: they signed an agreement with Central Equatoria State and Juba County. This agreement imposes garbage collection fees, as well as dividing the town into three competence areas. Two private companies are responsible for the collection in Juba and Munuki payams respectively, whereas the collection of waste in Kator payam is under the responsibility of the payam authorities. The collection service is usually limited to commercial areas and streets; only in Kator payam the collection from residential areas has recently started. The system of collection chosen is door-to-door (see Photograph 1). Systems of informal collection are also widespread: people owing a car collect waste from residential areas, under request, and usually dispose them in open plots or drainage channels in an uncontrolled way. This service is present in all the payams of Juba.

No formal activities of recycling are in place in Juba. The main activities of informal reuse and recycling regard plastic bottles, aluminium and iron. Used plastic bottles are often collected along the streets by street children and then refilled with a local brew or oil. Aluminium and iron are recycled at Konyo Konyo Market, the biggest market in Juba. Scrap aluminium and iron are bought directly from householders or collected along the streets and then they are melted by using charcoal and moulded to produce knives, pestles, spare-parts of cars or motorcycles and agricultural tools.

Finally, wastes collected by the formal system are discharged in a dumping site located about 20 km from Juba town. The site is neither provided with any measures for pollution control nor fenced. The site is not operated at all: wastes are usually just disposed and accumulated on the ground. The site is a breeding field for mosquitoes and flies and it is open to the access of animals, like goats, and scavengers looking for food. 360 people were reported to live close to the dumpsite, mainly making their lives from garbage. Also waste coming from streams other than the municipal one (e.g. from the slaughterhouse or from health-care facilities) are usually disposed of at this site.

Port au Prince, Haiti

According to the Human development Index, Haiti is one of the poorest countries in the Western Hemisphere and one of the most densely populated in the world - almost 10 million inhabitants in 2008 - and, with an area of 27,750 km² (CIA, 2010). Political violence and natural disasters have been happening throughout its history. In 2004, an armed rebellion forced the resignation and exile of the previous President Jean-Bertrand Aristide, and a provisional government took control with security provided by the United Nations Stabilization Mission in Haiti (MINUSTAH). The current president was elected in 2006, and on 28th November 2010 new general elections took place. Hurricanes, tropical storms and major flooding in 2004 and 2008 left many people in need of humanitarian aid (especially in the city of Gonaive). On 12th January, 2010, a 7.0 Richter magnitude earthquake struck Haiti and devastated the capital city, Port-au-Prince. Although the exact number was difficult to verify, more than 230,000 people were killed. The Presidential palace, Parliament and many other important structures were destroyed, along with countless homes and businesses, leaving many homeless people. Moreover, since October 2010, a cholera outbreak has been spreading throughout the country, causing the hospitalization of more than 117,930 people and 4,030 deaths (OCHA, 2011).

One third of the population lives in the West Department where Port-au-Prince is located. Over 2,500,000 people reside in Greater Port-au-Prince which is comprised of seven municipalities (IHSI, 2007) and the annual population growth rate is about 5%. Heavy migration from rural areas to towns and cities, mainly due to centralization of economic activities in the urban areas, caused the development of slum areas and poor living conditions.

Current situation of municipal solid waste management in Port au Prince

A solid waste management assessment was carried out during February and March 2010, and reviewed during October 2010 through field missions and reviewing existing literature.

Before the earthquake, numerous stakeholders were dealing with solid waste management in Port-au-Prince, making the system very complex. There were several ministries involved with different and sometimes overlapping competencies. Under the funding responsibility of the Ministry of Interior and Territorial Communities (MITC), the CDS (Cellule Solid Waste) had the function of coordinating the SMCRS (Metropolitan Service of Solid Waste Collection) which was the main public body responsible for the collection within Port-au-Prince Metropolitan area. The Ministry of Public Health and Population (MSPP) was responsible for health-care waste from hospital and clinics. Public budget allocated and people working were not enough to cover the whole city. Private companies, such as Boucard and Pyramide, were also involved in solid waste collection since 2005. Under the responsibility of Ministry of Planning and External Cooperation (MPCE), UN agencies and NGOs were involved during specific period of time and with pilot actions in solid waste collection and transportation.

The waste management system had an institutional or formal system and an informal one. The formal solid waste sector in the Metropolitan Area of Port au-Prince consisted of the State agencies (SMCRS and municipal refuse collection services or divisions) and the private companies. On the institutional level, the Metropolitan Service of Solid Waste Collection was fully responsible for waste collection after voluntary disposal at collection points (public dustbins) or spontaneous dumps (street corners, markets, etc.), but was not able to cover the whole city (see Photograph 2). More than 77% of the upper middle class households benefited from a waste collection service. On the other hand, 93% of poor households in disadvantaged districts did not have any service, and there were no public dustbins (Noel, 2010). This means that the households in these districts collected and disposed waste in drainage channels, along streets, at building corners etc. Where the institutional collection system did not work, households relied on a private service to remove their waste. This service was provided by individuals equipped with wheelbarrows or by a company with motorized vehicles.

The only recycling activities in Port-au-Prince were carried out by the informal sector. Tins, plastic bottles were stored at homes and sold to itinerant buyers. However, scavengers sold materials collected in drainage channels and open dumps to middlemen, who re-sold them to small and medium scale processing and manufacturing industries. For example, the G.S. Industries and the Tropical Recycling enterprises bought used plastics for 3 gourdes/lib (0,07 \$/lib). The informal solid waste sector was comprised of workers who provided solid waste collection services for several private institutions and for upper and middle-income households or practiced scavenging activities at the dumping sites. The scavenging practices by the urban poor became a survival activity and livelihood strategy that helped them reducing the impacts of poverty on their households. Between 150 and 200 scavengers segregated re-usable and recyclables at the dumping sites (Noel, 2010).

Solid waste from the official collection system in Port-au-Prince was transported to two main dumping sites: Truitier and La Saline.

After the earthquake on 12th January 2010, the situation became even more complicated, including not only the normal solid waste stream but also debris and demolition waste. Joint actions have been initiated by UNDP, UNICEF and UNEP to support DINEPA (National department for potable water and sanitation) and its effort to respond to the emergency. Many other agencies -around 20 NGOs- were involved in this first phase of emergency waste collection. The collection was done through cash-for-work mechanism which allowed large number of people to participate in the work, while the economic activities needed time to start again. At disposal level, a UNEP assessment found out that mixed waste such as demolition waste and domestic waste was and is dumped not only in the existing dumps, but also and in large quantities along the roadsides and in the sea.

Challenges for the solid waste management sector**Juba, South Sudan**

In Juba, the immediate effects of the long lasting civil war were the presence of big quantities of ordnances and mines and in terms of solid waste management the increasing amount of health-care waste. Moreover, a side effect was that the majority of skilled people living in Southern Sudan fled the country. After the war, a huge number of international organizations settled in Juba, determining its rapid expansion. They generated

a waste stream characterized by high percentages of paper and plastic, similar to typical “Western” compositions. A system of solid waste management was completely absent during the war and waste was burnt at household level. So far, some schools have been opened but it is not easy to find high-level teachers. Moreover, demining activities are on-going but they are mainly concentrated in other areas of Central Equatoria State or in other States, whereas some places in Juba are still mined (such as the currently used dumping site). The city grew up without any planning and only recently a system of waste management has started being planned, for example by dividing the competence areas among different organizations. No policies aiming at controlling and reducing the waste produced by international NGOs are in place.

The challenges for the solid waste management sector in Juba were discussed with local stakeholders during a workshop held by the authors in July 2010. The issues highlighted are briefly described in the following:

- *lack of awareness among the population and technical skills* about solid waste management. Literacy rate in South Sudan is very low (24%; UNFPA, 2010) and it is far lower than the one registered in North Sudan (UNDP, 2008), due to the deliberate retardation and neglect of socio-economic development of South Sudan perpetrated by the dominating North Sudan (Machar, 1995). Local inhabitants commonly burn waste within their yards; there is no perception of the risks linked with this practice and a system of collection is in place only in very few residential areas. Moreover, as already mentioned, during the war the majority of people having technical skills fled the country;
- *lack of laws and regulations and lack of enforcement*: laws and regulations have been elaborated by the central government in Khartoum before and after the peace agreement signed in 2005. Only in the last months, Government of South Sudan has been drafting its own laws, among which an environmental law, containing also a chapter about solid waste management. Actually, this law contains only very general issues and there are no practical indications. Moreover, the participants of the workshop underlined that even if a law were approved, it would be very difficult to guarantee a proper enforcement;
- *lack of coordination among the different levels of the government and lack of funds*: the solid waste management sector is under the responsibility of several stakeholders. So, a big confusion about roles and responsibilities in the solid waste management sector can be observed. This situation is even more complicated considering that local institutions are very recent in South Sudan and not stable: new ministries, such as the Ministry of Environment, have been created in the latest months. Moreover, funds to be used for the solid waste management sector are limited. The fee collection system is working only in some areas of Juba and involve only commercial activities. Furthermore, several international organizations have been or are working in the solid waste management sector in Juba, such as UN agencies, JICA, USAID, etc, and the attempts to coordinate the activities have started in September 2010; and
- *issues concerning the disposal phase*: a dumping site is located in the neighbourhoods of Juba, but it is not provided with any measure of control or environmental protection. Juba County is looking for another site, but it is very likely that issues of land ownership will overcome technical and scientific reasons for the choice of the site. It has also to be pointed out that some areas located not far from Juba on the other side of river Nile are nowadays not considered safe because of frequent attacks by tribes living in the region and the presence of mines in several areas. Also in the current dumping site the blasting of unexploded ordnances dating back to the years of the war is not infrequent.

Moreover, the growing amount of waste connected with the very fast growing of the population, the import of products from abroad and the consequent change in the composition of the waste stream, together with the almost completely absence of recycling activities, will need to be faced in the next years.

Port au Prince, Haiti

In the aftermath of 12th January earthquake, the already deficient waste management in Port-au-Prince was further affected, like other basic service delivery and key infrastructures. The earthquake provoked widespread destruction that caused other waste streams to be produced. Main priority was to assist the over 300,000 injured people in emergency hospitals and clinics that have been set up, but inevitably increasing health-care waste. Demolition of dangerous buildings augmented the amount of construction waste to be disposed of. Restoring the viability of the main streets has been one of the issues that the Government -with the aid of the international community- have been dealing with, employing heavy equipments to remove

debris waste. Nearly one quarter of the country's population was displaced and organized themselves in camps. A large amount of waste was also produced from the food aid packaging and rations. Basic needs have been addressed -like shelter, water and food- and the issue of solid waste collection has been tackled through "cash for work" initiatives. They allowed many people to participate in the cleaning up campaigns and to establish some livelihood mechanisms.

The challenges that Port-au-Prince is facing in the solid waste sector have been even more exacerbated due to the 12th January 2010 earthquake and the recent cholera outbreak, which is still ongoing. Main challenges are:

- *lack of awareness* among the population on how and where to dump materials. Haiti is the poorest country in the western hemisphere, with Human Development Index of 0.4 and level of literacy of about 53% (UNDP, 2010). Recently, the open and indiscriminate burning is even more practiced due to the widespread fear of the cholera disease;
- *lack of policies and institutional instability*: there are some general policies, and in 2007 the Cellule Solid Waste was established with the specific task of implementing a deep assessment and the development of regulations which have not yet been done;
- *improper disposal practices*: the dumping sites are inadequately located at less than two kilometres from the sea and in the immediate vicinity of dwellings. In addition, the indiscriminate dumping is done on permeable ground, thus permitting the direct access of leachate to the groundwater. Therefore dumping of household waste does not only constitute a potential source of contamination of surface waters, but it also affects groundwater and the drinking water distribution network (Bras et al., 2007). The need of proper dumpsites arouse even more after the earthquake, where municipal solid waste has been mixed with different other waste streams and other illegal dumping sites have been selected. Municipality is struggling to find a site where to build a landfill. The indiscriminate demographic growing of the city resulted in unplanned crowded urban area where space for landfilling has become an issue. Moreover, land ownership plays a big role when selecting a site for dumping. Finally, the geologic instability of several sites makes the research even more complicated. Up to now, also with the involvement of international aid (such as USAID), the Government is not able to assign a site;
- *limited human and financial resources*: solid waste fees are included in the electricity bill, but they are not enough to pay collectors' salaries. Thus, financing the service remains a continuous challenge that the authorities are facing though, thanks to external funding, some activities could be sustained.

Solid waste management is practiced in a context of rapid demographic growth and urban poverty. The migration from rural to urban areas generates slum development that produce large quantities of unmanaged solid waste, representing a major threat to public health and a key obstacle to effective environmental management.

Comparison of the solid waste management sector in Juba and Port au Prince

A comparison of the different systems for collection, recycling and disposal that are in place in the two cities involved in the study is reported in Table 1. They have already been described in the previous paragraphs, but this table allows a direct comparison of the services and is the basis to confront the challenges highlighted in the two cities.

Both municipalities are facing big difficulties while looking for an area suitable for waste disposal. The choice of a suitable site is challenging due to problems of land ownership both in Juba and in Port au Prince, but also to the presence of unexploded ordnance and to tribal fights in Juba (making several areas unsafe) and to the geological instability of numerous sites in Port au Prince. Finally, incorrect disposal practices are very widespread due also to the very low accessibility to a proper education system.

The SWM systems currently in place were deeply affected by the conflict and the disaster, which effects are reported in detail in Table 2. Some of these effects are different in the two cities, such as for example the produced waste streams. On the other hand, the reduction of entrepreneurship and the difficult access to the existing disposal sites are common in the two areas.

Table 1. Comparison of the solid waste management services		
Phases	Juba	Port-au-Prince
Collection	Door to door collection mainly in commercial areas of three payams. Presence of informal collectors.	No primary collection Secondary collection from communal collection points in some areas of the city. Presence of informal collectors.
Recycling	Recycling of aluminium Informal reuse of plastic bottles.	Informal recycling of plastic bottles and cans. Informal recycling at the dumping site
Disposal	Open dumping. Presence of scavengers.	Open dumping. Presence of scavengers.

Table 2. Effects of conflict and natural disaster on the SWM system		
Phases	Juba	Port-au-Prince
Production	Increased production and change in the waste streams due to international organizations	Debris and demolition waste Increased health-care waste
Collection	Presence of mines and ordnances Risky access to some areas	Viability problems Infrastructures, workers and equipments negatively affected
Recycling	Recycling of materials coming from the conflict (handcuffs, chains etc.) Reduction of entrepreneurship	Existing small scale recycling negatively affected Reduction of entrepreneurship
Disposal	Risky access to the dumping site	Existing dump sites overfilled Illegal disposal in the sea

The main challenges for the SWM sector, highlighted in the previous section, are common to both cities. They are mainly attributable to the instability of the institutions, which can be linked to the fact that both Countries are among the least developed in the world but this issue is exacerbated by the different situations they are facing. Lack of awareness could be addressed through increased sensitization trainings and activities among population. More support is needed to develop and enforce appropriate policies and to guarantee good coordination among institutional partners. The introduction of a sustainable cost recovery plan can face financial issues. Capacity building and technical assistance should be foreseen during this key phase of re-organizing the system.

As regards more technical aspects of solid waste management, in Juba after the removal of mines and ordnances, a careful plan of a solid waste management system should be carried out starting from scratch. It should attribute a great importance to recycling activities, able to give a positive impact on the economic system negatively affected by the war. Favouring the return of skilled people is also of the utmost importance in order to provide a good level of service. A control on waste quantities produced by international agencies and NGOs should also be put in place. In Port-au-Prince, the reallocation of Internally Displaced People is going to take long time, since it is a very serious and sensitive issue: there should be in place a transitory program of waste collection before people will be re-allocated to a permanent space. At the same time, a plan for solid waste management should include a contingency plan for dealing during natural disasters, since Haiti is a very prone area for earthquake, landslides, flooding and hurricanes.

In conclusion, it has to be underlined that a solid waste management system should include all the different factors (institutional, social, financial, technological, environmental, etc.) to be sustainable in the long run. The system could be designed starting from scratch which can have some advantages on the technical side, but has to consider the institutions already involved in the sector or the ones restored after a conflict or a natural disaster.



Photograph 1.
Collection at Malakia market, Juba



Photograph 2.
Port au Prince illegal dumping

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Notes

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