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Emission Reductions of Greenhouse Gas emissions and domestic waste composting in less advanced countries. Why new assessment tools are requested.

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Abstract

Waste management in least developed countries is a growing problem for municipalities lacking financial means. Composting organic fractions is an alternative to wild dumping in term of sustainable development. Not only does it diminish the quantity of waste to dump, but it creates jobs and gives a quality amendment for agriculture. Composting projects are not generally sustainable financially on their own; and this is the reason why carbon financing is a good option to help the investment and functioning of a platform. Lately the Clean Development Mechanism (CDM) methodologies for calculating greenhouse gas emissions from composting became more and more conservative to the point that, according to the calculations, a composting project in a city X in West Africa could emit more Greenhouse Gas (GHG) than wild dumping. A Life Cycle Analysis of composting could introduce more adequate parameters and thus help composting projects to be sustainable.

Introduction

Several recent global studies [1] [2] highlight the growing challenge of domestic waste management.

In Least Developed Countries (LDCs) the resources for waste management is proportional to Gross Domestic Product. Today, those resources are already lacking to solve the problem, while waste quantity will double in the next 20 years. Those LDC's cities need better answer for waste management.

The composition of this waste, rich in organic matter, makes composting a very attractive solution in a holistic approach taking into account at the same time the need to increase sustainable agricultural production, creating jobs, reducing residual volumes to landfill, reducing fertilizer additions, adaptation to climate change. [3]

In addition, composting reduces in many different ways methane emissions, very important player in the short-term of climate change, as its global warming potential at 20 years is 72 times carbon dioxide's one. [4].

The official assessment methods of emission reductions related to composting, which provide access to carbon finance and thus can usefully complement local funding available, do not take into account the full benefits of composting. [3]

Material and Methods

Experiences that have arrived to these conclusions have been conducted in the development of the domestic waste composting project of Mahajanga (Madagascar), managed by Madacompost

and other composting projects studied or developed in the program Africompost[1], led by GoodPlanet, Gevalor and Etc Terra.
For these projects, studies are conducted that aim to establish and to validate the emission reductions discountable using different standard certification as Clean Development Mechanism (CDM), sensu stricto, or so-called voluntary standard as the Verified Carbon Standard (VCS) or the Gold Standard.

CDM method's analysis

The main accepted tool to calculate GHG reduction emission in composting projects is the CDM methodology and its associated tools [5]; some different standards have their own methodology (such as Climate Action Registry or the Chicago Climate Exchange) but they are previous versions of the CDM.
The CDM methodology changes very often – the average validity length for a version has been six month for the last six years. The current version was displayed on May 25th 2012.

The calculation of the baseline emission, takes into account GHG that organic waste would have emitted if they had been dumped in a solid waste disposal site (SWDS), under anaerobic conditions.
The project emissions are:

- methane and nitrous oxide that organic waste emits while composting
- carbon dioxide from electricity and fossil fuel energy used for composting purpose
- methane from run-off waste-water associated with co-composting

The calculation of those emissions are either based on local values – such as the climate, or monitored values – such as the quality of the SWDS or the quantity of waste that would have been left to decay anaerobically, and on default value – as the decay rate for each type of waste or the fraction of degradable organic carbon in each kind of waste type. Default values are used only if local or measured / monitored values were not available [5]. The crediting period length is generally ten years.
Once all those parameters are available, the calculation is done following a first order decay formula which takes into account the degradation of waste over ten years (even though waste can emit methane for more than ten years): for waste composted during the first year of crediting, the emission reductions are calculated over the ten following years, and for waste composted during the seventh or eighth year of the crediting period, emission reductions are calculated only over the three or two following years.

Life Cycle Analysis (LCA)

A LCA for such composting project could include [6] transportation of waste and compost from their place of production to the place of treatment / use – carbon dioxide emissions due to transportation, composting – methane emissions during treatment, if emitted, compost use – increase of soil carbon storage – soil better water retention – decrease of chemical inputs etc.

Results and Discussion

CDM method's analysis

Since the first CDM compost methodology was displayed, in 2006, there have been eleven different versions. Those versions are more and more conservative in order to insure that no fake carbon credits are delivered. Whereas some improvements seem justified – such as calculating the

[1] Africompost is a program led by Gevalor- GoodPlanet and ETC Terra (and financed by FFEM and AFD) aiming to set up 6 composting platforms in African cities. Those platforms, after an experimental test will treat some 10 to 20 000 tons of household waste. See also http://www.gevalor.org/projets-compostage/un-projet-federateurn-africompost.html

emissions on wet waste tons instead of dry at the beginning, some other seem less justified – or very conservative:
While composting may produce some methane if the aerobic conditions (oxygen rate over 5%) are not fully insured [7] and this criterion can be easily insured; the production of nitrous oxide, both in SWDS and during composting, doesn't seem to be quite established [8]. Though the methodology allows some direct measurement of methane and nitrous oxide emissions in compost windrows instead of using the default value, the machinery necessary to do the measurement of both gases as required by the methodology is too expensive and sensitive to be used on a small composting platform in LDC. Using default values can bring a project to actually have negative emission reduction during the first year of the project or said the other way around: dumping waste in a poorly managed SWDS produces less GHG emission than composting organic waste. See table 1 hereunder.

Table 1. Calculation comparison for a project X between two versions of the methodology for the first year of composting.

	25000 tons organic waste treated in the year of calculation. Calculation version 10.	25000tons organic waste treated in the year of calculation. Calculation version 11.
Year 1	**1675** TCO2eq reduction emission	**-1125** TCO2eq reduction emission

Concerning the formula used, a lot of real reduction emission are not discounted: for X tons of waste composted in year one, the reductions emissions are acquired over ten years as it is showed in figure 1, though they were composted in year one and therefore are never going to emit methane again. In the end it is 20% in average of reduction emissions that cannot be claimed. Figure 2 shows the reductions emissions when associated with the year of treatment and not the year of eventual degradation in a SWDS.

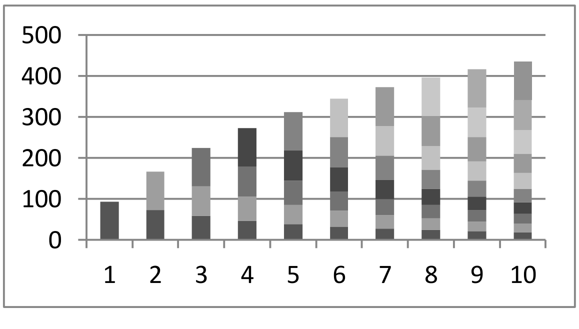

Figure 1. X tons of waste composted every year. Calculation of emission reduction with the methodology.

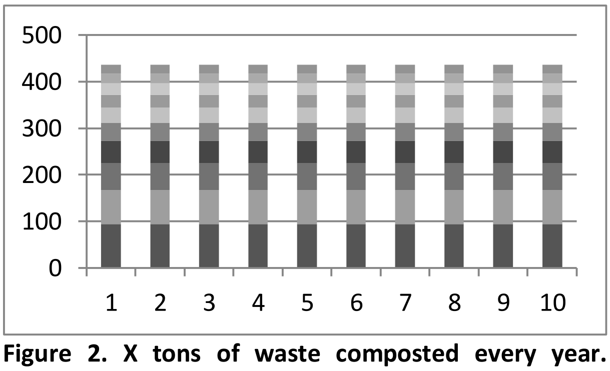

Figure 2. X tons of waste composted every year. Accumulation of the reduction emission due to each year to the year of treatment.

Especially in the project emission, are only taken into account the drawbacks: methane and nitrous oxide emissions – eventual emission from anaerobic storage – leachates of composting and not its advantages: on the one hand for climate change: agronomic parameters (chemical input saving), soil parameters (water retention, erosion) etc. on the other hand for social purposes: job creation – (re)insertion of informal workers.

While domestic waste composting projects have evident benefits in LDC's, methane reduction projects (such as landfill methane capture) with less advantages mentioned above, have both higher emission reductions and are organized the other way round: higher emission at the beginning of the crediting period and less at the end, when investments are less needed thus are more attractive for investors. Figure 3 illustrates on the left side the reductions emissions allowed for compost, and on the right side reduction emission allowed for landfill methane capture.

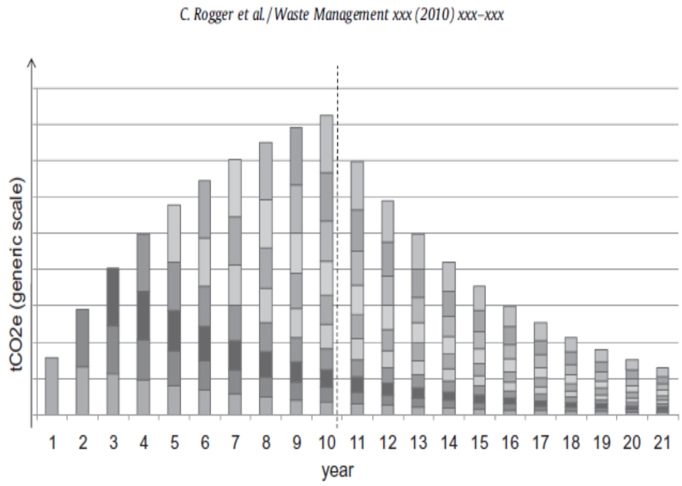

Figure 3. Methane baseline of a 10 year stream of waste calculated according to the UNFCCC tool (2010). Rogger and alii. [3]

Conclusion and perspectives

The CDM methodology's evolution are not in favor of composting though it is a good alternative to wild dumping in term of sustainable development: social – economic and environmental. A path that could be promising to recognize composting benefits in terms of sustainable development, and to make its implementation financially sustainable, could be to develop an approach, based for example on life cycle assessment for LDCs, like the one developed by the Californian Environmental Protection Agency (EPA) for California [6]. It would require a study to insure the values of parameters for LDC's instead of California but could take into account some agricultural parameters.

The formula found by the Cal EPA for GHG reduction emission from composting platform is:
CERF (compost emissions reduction factor) = $\mathbf{C_sb + (Wb + Eb + Fb + Hb)*C - Te + Pe + Fe}$
With
C_sb = Emission reductions associated with the increased carbon storage in soil (MTCO2E/ton of feedstock)
Wb = Emission reductions due to decreased water use (MTCO2E/ton of compost)
Eb = Emission reduction associated with decreased soil erosion (MTCO2E/ton of compost)
Fb = Factor to account for the reduced fertilizer use (MTCO2E/ton of compost)
Hb = Factor to account for the reduced herbicide use (MTCO2E/ton of compost)
C = Conversion factor used to convert from tons of compost to tons of feedstock
Te = Transportation emissions from composting (MTCO2E/ton of feedstock)
Pe = Process emissions from composting (MTCO2E/ton of feedstock)
Fe = Fugitive emissions from composting (MTCO2E/ton of feedstock)

Adding this formula, or another, more adapted in terms of LCA (existing or to be found) which takes into account compost agronomic parameters, with the CDM formula, taking into account the emission reduction from solid waste disposal site could be an interesting approach.

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