Technical University of Denmark

The Role of Time Dependency in Life Cycle Assessment of Landfills – Accounting for Sinks and Releases

Damgaard, Anders; Yoshida, Hiroko

Published in:
Proceedings of the 8th Intercontinental Landfill Research Symposium

Publication date:
2014

Document Version
Publisher's PDF, also known as Version of record

Citation (APA):
Damgaard, A., & Yoshida, H. (2014). The Role of Time Dependency in Life Cycle Assessment of Landfills – Accounting for Sinks and Releases. In Proceedings of the 8th Intercontinental Landfill Research Symposium Florida, USA.

The Role of Time Dependency in Life Cycle Assessment of Landfills – Accounting for Sinks and Releases

Anders Damgaard, PhD, Technical University of Denmark, adam@env.dtu.dk
Hiroko Yoshida, PhD Student, Technical University of Denmark, hyos@env.dtu.dk

Introduction

In life cycle assessment (LCA) is commonly adopted a 100 year time horizon for how emissions are assessed (Brandão et al., 2011). This implies that the total amount of a release of an emission is calculated and tallied over a set time period and this value is then multiplied with a characterization factor representing the global warming potential (GWP). This approach works quite well for studies where for all processes the emissions are released in a very short time frame. The issue arises when comparing processes where the emissions are released over varying and long time frames, such as municipal solid waste (MSW) technologies, as the timing of the release here play a critical role for the interpretation.

Methodology

The objective of this analysis is to compare static versus dynamic characterization factors when modelling landfills. This is done through by comparing the release in kg's of CO_2-equivalent for a landfill with three different decay rates, 1) 0.02 yr^{-1}, 2) 0.038 yr^{-1}, 3) 0.12 yr^{-1}. The modelling was carried out in the EASETECH model (Clavreul et al, 2014) from which was obtained a temporal profile of the emissions, and the conversion to dynamic values were then carried out in $DYNCO_2$ (Levasseur, 2014) as the EASETECH model currently does not support the dynamic characterization factors. The landfill was model with a functional unit consisting of 1 Mg of Danish residual household waste with a biogenic carbon content of 173kg, and with 1st order decay rates based on De la Cruz and Barlaz (2010). The gas collection was modelled with 4 time periods of 5, 10, 25 and 60 years, and corresponding collection rates of 35, 65, 75 and 0 percent. For the uncollected gas the top cover oxidation rate was set to 10, 20, 36 and 36 percent for the four time periods. For simplification were the values kept static for all three cases and the modelling only considers the release of methane and the sequestration of carbon.

Results

Figure 1 shows the GWP potential for the modelling with the three decay rates. For each decay rate is given the dynamic value (solid line) as well as the static value (dotted line) for a 100 year time horizon. Initially, methane emission creates the steep rise in GWP from landfill, but it decrease gradually overtime due to the short half time of methane in atmosphere and the effect of carbon storage in landfill. After 100 year, the dynamic GWP is quite close to the static GWP for all waste types. The results shows that the impacts from landfill is highly time dependent and requires the application of multiple time horizons to capture the life cycle impact of landfill operation.

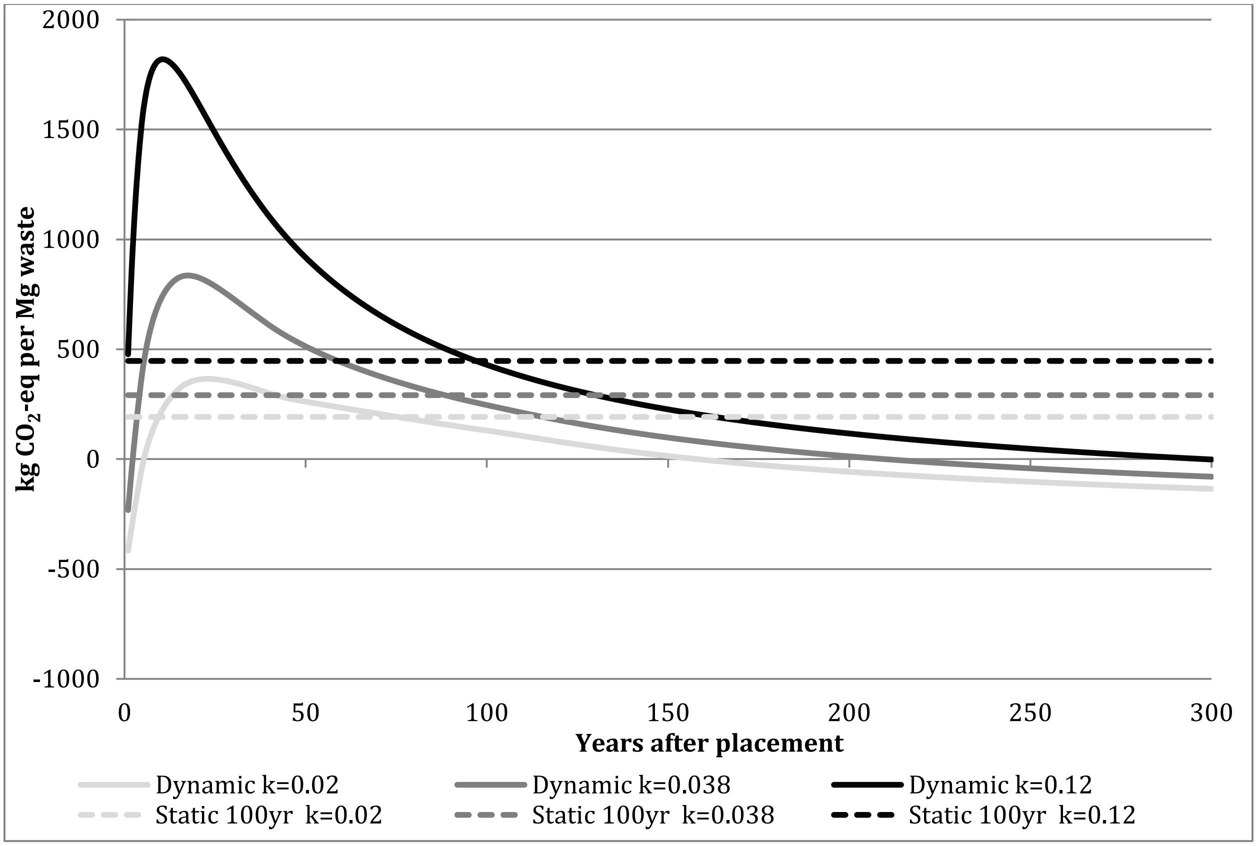

Figure 1: kg GWP as kg CO2-equivalent given as a function of time represented by dynamic and static characterization factors. The static factors are for a 100 year time horizon.

References

Brandão, M., Levasseur, A., Kirschbaum, M.U.F., Weidema, B.P., Cowie, A.L., Jørgensen, S.V., Hauschild, M.Z., Pennington, D.W., Chomkhamsri, K. (2012). Key issues and options in accounting for carbon sequestration and temporary storage in life cycle assessment and carbon footprinting. *International Journal of Life Cycle Assessment,* 18, 230–240.

Clavreul, J., Baumeister, H., Christensen, T.H., Damgaard, A. (2014) EASETECH – an Environmental Assessment System for Environmental TECHnologies. *Under review: Environmental Modelling & Software.*

De la Cruz, F.B., Barlaz, M. (2010). Estimation of waste component-specific landfill decay rates using laboratory-scale decomposition data. *Environmental Science & Technology* 44, 4722–8.

Levasseur, A. (2014). DYNCO$_2$ DYNAMIC CARBON FOOTPRINTER. Excel model. [Online] http://www.ciraig.org/en/dynco2.php, accessed March 10 2014.