Estimation of Landfill Surface Methane Emissions Using Geospatial Approach Combined with Measured Surface Ambient Air Methane Concentrations

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Major uncertainties are introduced into landfill gas generation, especially landfill fugitive emissions, when single-phase or even multi-phase first-order reaction kinetics are used to model the decomposition of biodegradable waste and the methane gas it produces. Large field datasets on emissions from landfills, have indicated a relatively constant rate for observed methane generation and recovery per total unit mass of buried waste. This means that measurements of methane emissions from landfills are becoming more critically important to help policymakers and industry leaders mitigate and reduce landfill methane emissions. Amongst all currently available methods the tracer release-based estimates of total emissions are the most accurate method, but it tends to be labor intensive, very expensive and therefore not ready for wider implementations especially for small landfill operators.

Theoretically, surface air methane (CH_4) concentrations, in ppmv, recorded at a short distance away from the soil/atmosphere interface should be positively correlated with surface fluxes. It has been suggested that CH_4 flux, in g/m^2/d, can be quantified from simple measurements of CH_4 concentrations close to the landfill surface. This paper describes a study where ground and drone landfill surface emissions monitoring (SEM) campaigns were performed at several municipal solid waste landfills in the USA during the same day/week as conducting tracer correlation method testing to estimate total emissions from participating landfills. The SEM data (ground and drone, Figure 1) were geospatially treated to predict surface concentrations over the entire waste-covered areas of the landfill. Different correlations, from the literature, were used to convert ppmv to g/m^2/d using the geospatially generated data. The calculated surface emission fluxes were then used to obtain estimates of total surface emissions. These estimates were compared to those obtained using tracer correlation campaigns performed during the same period as SEMs. A new correlation between surface methane concentrations and surface emissions fluxes is then proposed.

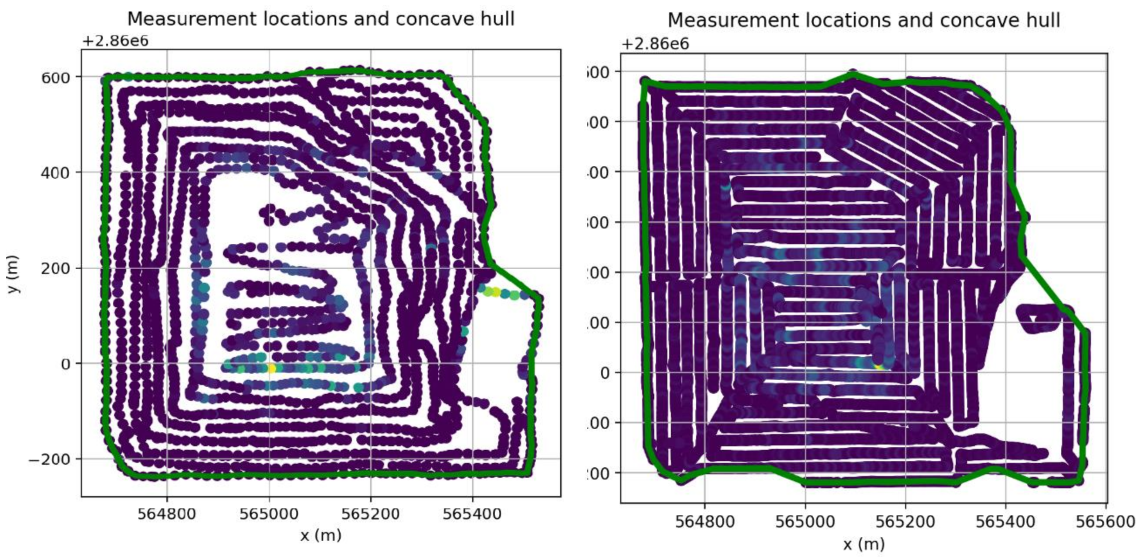

Figure 1. Plot of Ground-based SEM and Drone-based SEM Data.

The developed correlation and geospatial analysis were then used to obtain estimates of surface emissions from the whole landfill. These estimates were then compared to those obtained using tracer correlation campaigns performed during the same period as SEMs. Results indicates the correlation-based estimates are within 30% of tracer values. This correlation can be used with the proposed geospatial treatment of SEM data to assess different remediation strategies to reduce surface methane emissions. The results of the study also showed that the effectiveness of remedial activities is affected by the SEM data variability and statistics, suggesting that remediation should not be a size-fits-all approach. For instance, fixing exceedances only approach might not have the same effects under different field conditions.