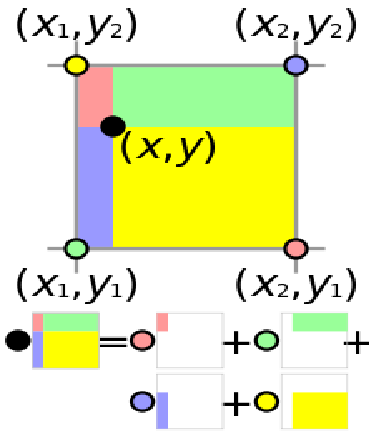

Fig. 1 Geometric visualization of bilinear interpolation (Wikipedia, accessed date 18 June 2014)

Bilinear interpolation has been conducted with MATLAB R2013b (Mathworks Inc., USA). Boundary of landfill site has been decided by the satellite photograph of each site taking into consideration of progress of landfilling. Emission rate at the boundary has been set 0. Interpolation has been conducted on uniform grid having length of 0.5 m.

3. Results and Discussion

Fig. 2 and Fig. 3 show interpolation result of each site. Hot spots have been found at each site. Different tendencies has been found in 2 sites. Methane emission estimates using arithmetic mean were 278.89 and 867.69 ton/year for the W and M landfills, respectively. From the interpolation result, methane emission estimate decreased to 256.57 ton/year (8.0% decrease) in the W landfill to 645.34 ton/year (25.6% decrease) in the M landfill (Table 1).

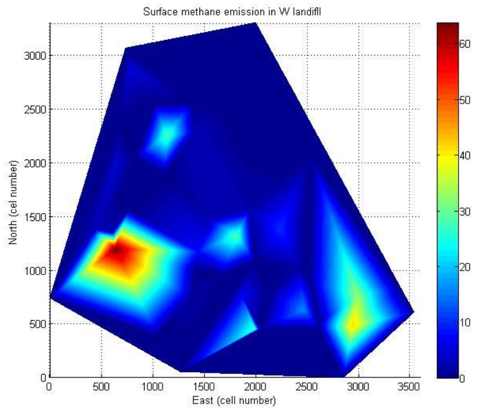

Fig. 2 Interpolation result of the W landfill

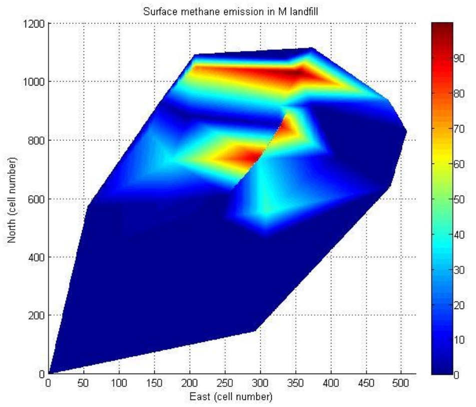

Fig. 3 Interpolation result of the M landfill

Table 1 Comparison of statistics between observed and spatial analysis

	W landfill		M landfill	
	Observed	**Spatial Analysis**	**Observed**	**Spatial Analysis**
Number of points	42	304,679	31	344,217
Emission estimate (tonCH4/yr)	278.89	256.57	784.91	645.34
Arithmetic Mean ($mgCH_4/m^2/min$)	6.97	6.41	20.02	14.27
Median ($mgCH_4/m^2/min$)	0.61	1.82	1.72	1.53
Std.Dev ($mgCH_4/m^2/min$)	13.80	10.17	31.14	20.84
Min ($mgCH_4/m^2/min$)	0*	0*	0*	0*
Max ($mgCH_4/m^2/min$)	63.66	63.51	100.01	99.94

* '0' represents no CH_4 concentration increase detected

Table 2 shows heterogeneity and degree of intensity of surface methane emission. 50.35% of methane emitted from 10.5% of total area in the W landfill. Also 50.40% of methane emitted from 12.47% of total landfill area in the M landfill. Similar result has been found in other researches. Spokas et al. (2003) reported 35.4% of area contributed 99% of the methane emission analyzed with spatial interpolation. To know the impact of heterogeneity, the analysis has been without maximum observed values in each sites. By eliminating the maximum values, the emission estimates have decreased 42.5% and 19.6% in the W and M landfills, respectively. Therefore, including hot spot can make big change in the result.

Table 2 Heterogeneity of surface emission

Site	Flux($mg/m^2/min$)	% Area of total	% Flux of total
W landfill	0 ≤ flux <1	41.47	3.17
	1≤ flux <5	26.49	10.22
	5≤ flux <10	10.31	11.40
	10≤ flux <20	11.19	24.86
	20≤ flux <40	8.64	36.38
	40≤ flux	1.91	13.97
M landfill	0 ≤ flux <1	49.38	1.64
	1≤ flux <5	5.91	1.45
	5≤ flux <10	5.51	3.11
	10≤ flux <20	10.51	11.15
	20≤ flux <40	16.22	32.25

40≤ flux	12.46	50.40

4. CONCLUSION

The objective of this paper is to analyze the extent of heterogeneity of the surface methane emission from landfill. Methane emission estimate using linear interpolation was lower than that of arithmetic mean. Approximately 50% of methane is emitted from about 10% of landfill surface in two landfills. Excluding the maximum point out of 42 and 31 points in the W and M landfills made 19.6~42.5% decrease on the emission estimate. Therefore, it is critical to define hot spot and include hot spot when measuring surface methane emission.

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