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Verification of Receptor Exposure to Palm Oil Mill Odor Using In-Field Olfactometer with Odor Characteristic

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A study was performed to confirm the reliability of in-field olfactometer in conjunction with odor characteristic in recognizing odor exposure to the community and identifying likely odor source. Odor samples were obtained from four of the mill's open effluent treatment ponds, and analysed in the laboratory for comparison with the odor values recorded at 18 receptor locations up to 4 km away from the mill. It was found that the palm oil mill emitted 'rotten-egg' odor with concentrations between 6,100 – 15,000 OU/m^3, 5,000 – 12,000 OU/m^3, 4,800 – 8,700 OU/m^3 and 4,100 – 15,000 OU/m^3 from its acid, anaerobic, facultative and aerobic ponds, respectively. The same characteristic "palm oil mill effluent" smell were noticed 50 % of the assessment times at two locations, receptor locations 1 and 7, which were roughly 1.3 km north of the mill. Simultaneous characterisation of odor at source and the receptor along with the local wind profile had helped to identify the odor issue from the palm oil mill to the community. This approach is proposed as a preliminary assessment tool for localities where resources and expertise in odor assessment is limited.

1. Introduction

The processing of 1 ton of crude palm oil uses 5 - 7 m^3 of water where consequently 50 % of wastewater or palm oil mill effluent (POME) is generated. Despite new efforts to incorporate biogas capture systems, a majority of the 421 mills still treat the POME using open ponding system (Tabassum et al., 2015) which unfortunately allows uncontrolled odors emissions to the surroundings.

The impact of odor from an existing facility can be determined using dynamic olfactometer, dispersion modelling (Bokowa, 2010) and VDI 3883 Guideline (Torres et al., 2010). However, some of these methods require expert knowledge, various input data and large number of panelists. For localities where resources, expertise and standards for odor assessments are lacking, the use of effective yet easy-to-use and affordable approach may be more practical as a preliminary indicator of odor pollution and identification of its possible source.

Identifying the impact of odor from palm oil mills to the surrounding community remains a challenge and one where the potential of field olfactometry and odor characterization has not been explored. Field olfactometry is a portable olfactometer that allows determination of odor to be done in situ, cutting the need for odor sampling and a large odor panelist. The characterization of odor becomes important as an odor marker since as the odor assessment is done in an uncontrolled environment and can be subjected to varying odor characters. The objective of this study is to check the applicability of in-field olfactometer in conjunction with an odor descriptor wheel in recognizing odor exposure to the community and identifying likely odor source(s).

2. Methodology

Odor assessment was done in two phases; at the source (palm oil mill) and at the receptor (labelled as number 1-18) in Figure 1. For the investigation of odor at source, samples were collected at the acid pond (23 x 42 x 6 m), anaerobic pond (40 x 78 x 6 m), facultative pond (61 x 26 x 3 m) and aerobic pond (18 x 44 x 4 m) using flux hood (Scentroid, Canada), vacuum chamber and 10 L Nalophan bags. Samples were collected two times daily, in the morning (9.30 – 11.30 am) and evening (3.30 – 5.30 pm) and later analysed in the

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olfactometry laboratory. The investigation at the palm oil mill was performed for three days each week, for a period of two weeks.

Figure 1: Odor sampling at the palm oil mill effluent treatment ponds specifically at the acid pond (P1), anaerobic pond (P2), facultative pond (P3) and aerobic pond (P4)

At the same time the odor samples were collected during the second week, odor concentration was also determined using an in-field olfactometer (Scentroid SM100, Canada) at the eighteen receptor locations shown in Figure 2. The assessor also noted the odor character using the descriptors in the urban odor wheel developed by Suffet and Rosenfeld (2007).

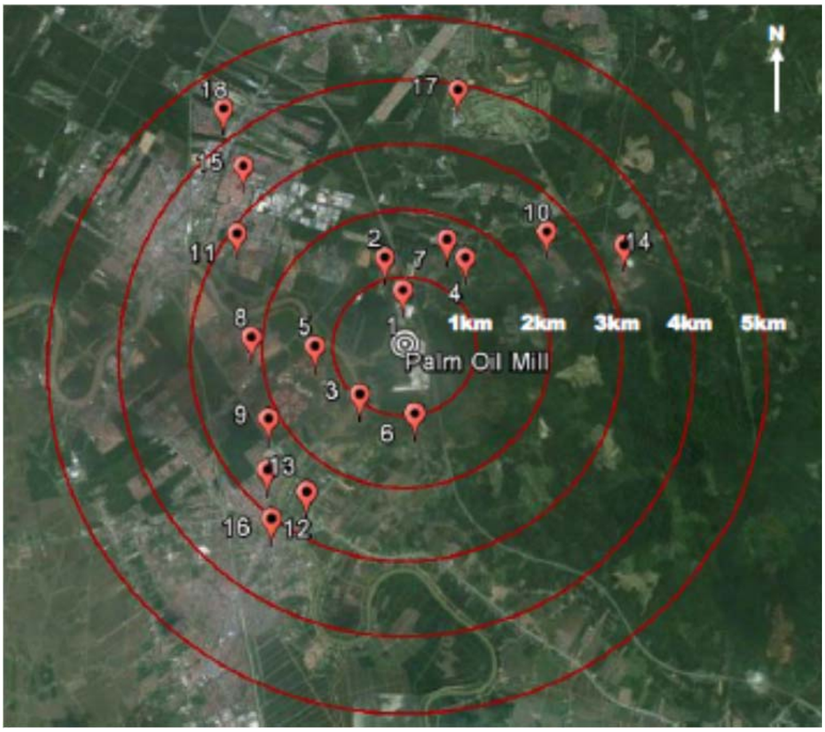


Figure 2: Eighteen receptor locations for odor assesment using in-field olfactometry and odor characterization

The local wind conditions were recorded using an anemometer (Kestrel 4500, Kestrel, USA) placed at the palm oil mill. The wind data was recorded during the sampling and in-field odor assesment event at 10 seconds interval. OriginLab software was utilized to produce windrose graphs from the collected wind speed and wind direction data.

3. Result and Discussions

Figure 3 shows that odor from the palm oil mill effluent ponds were relatively high and varied over the two weeks odor monitoring period. Odor concentration ranged between 6,100 – 15,000 OU/m^3 for the acid pond, 5,000 – 12,000 OU/m^3 for the anaerobic pond, 4,800 – 8,700 OU/m^3 for the facultative pond and 4,000 – 15,000 OU/m^3 for the aerobic pond from the morning and evening observations. This high odor concentration (4,100 – 15,000 OU/m^3) is categorized as having strong and extremely strong intensity (Wu et al., 2016) and would otherwise been in violation if compared to odor limit at source of 300 OU/m^3 imposed on composting plant treatment systems in Austria (ONORM S 2205-1, 1997) and Italy (DGR Lombardia n.7/12764, 2003) (Belgiorno et al., 2013).

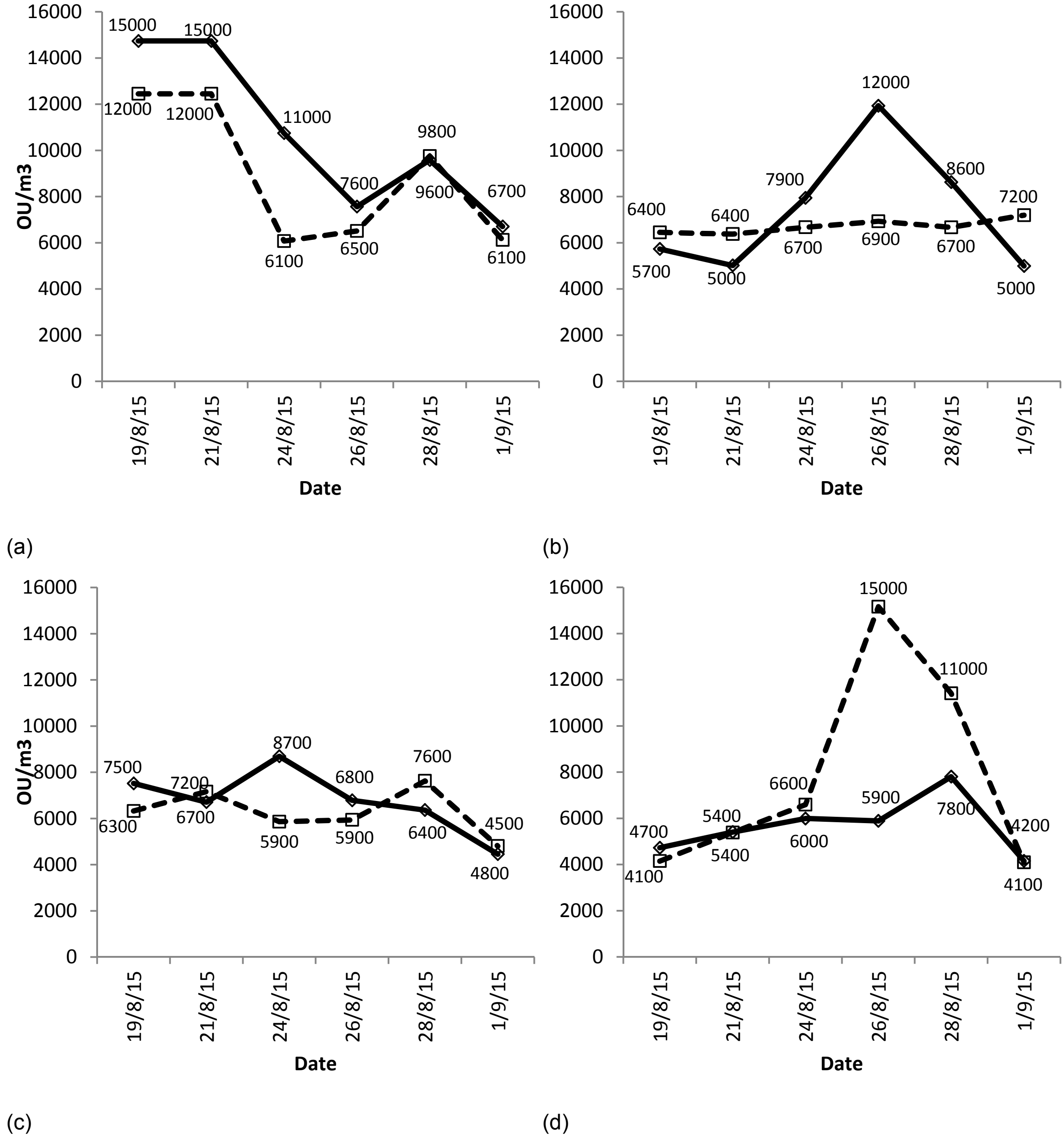
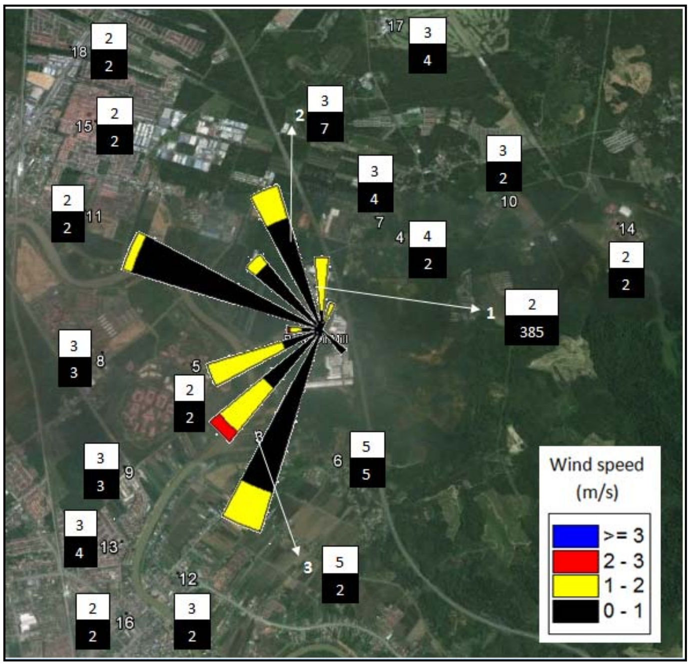


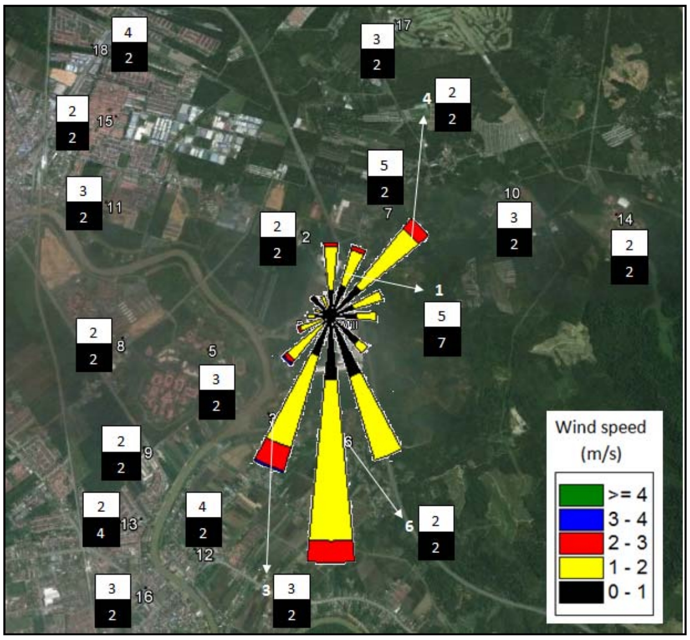
Figure 3: Odor concentration of (a) acid pond, (b) anaerobic pond, (c) facultative pond and (d) aerobic pond in the morning (—–) and evening (----)

The palm oil mill effluent treatment ponds have large open surface area e.g. the anaerobic pond is 39 m in length, 78 m wide and 6 m deep, however, no cover or odor treatment system is currently in place. Given the

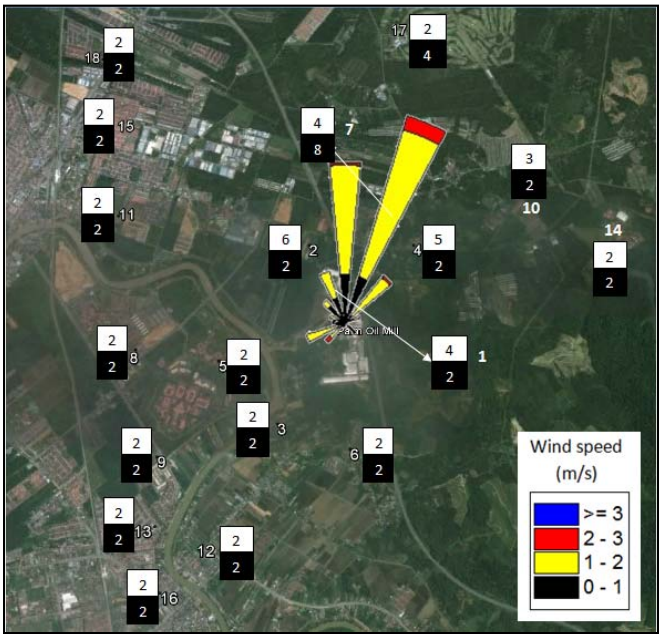
elevated odor concentration of the effluent ponds and its largely uncovered surface area, the rotten-egg smell of the effluent ponds will likely travel beyond the boundary of the palm oil mill into the surrounding community.
As shown by Figure 4, the same "palm oil mill effluent" smell was noticed at receptor locations having odor concentration of 5 OU/m^3 and above. At 5 OU/m^3, odor is faint with some people able to describe the odor and the occurrence of odor complaints (DEFRA, 2010). In general, the rotten-egg smell of the palm oil mill effluent ponds were more noticeable at the receptors in the evening (between 3.30 – 5.30 pm), as evident by the higher concentrations of 7 OU/m^3, 8 OU/m^3 and 385 OU/m^3, compared to the morning which only recorded a high of 6 OU/m^3.



(a)



(b)



(c)

Figure 4: Odor concentration (OU/m³) of eighteen receptor locations observed in the morning (white box) and evening (black box) for three days on the (a) 26/08/2015, (b) 28/08/2015 and (c) 01/09/2015

The highest 385 OU/m^3 was observed at receptor location 1, located 0.44 km north of the mill. Receptor location 1 exceeded 5 OU/m^3 for 50 % of its 6 times in-field olfactometry assessment. Receptor location 7, located further 1.32 km north east of the palm oil mill is another location that recorded 5 OU/m^3 and above values for 50 % of the observation. Receptor location 7 is the furthest location that the “palm oil mil effluent” smell can be detected during this day time assessment. Wind was predominantly blowing from the south especially on Day 2, placing receptor locations 1 and 7 downwind of the palm oil mill. The wind direction and the high odor concentrations at the effluent treatment ponds justify the “palm oil mill” smell at these downwind locations.

4. Conclusions

The odor assessment procedure involved simultaneous odor monitoring at the source and the receptor, the recognition of similar odor character and the wind profile to match the probability of odor exposure at identified receptors. The method was simple in the sense that no dispersion modelling was required to recognize the distance of odor dispersion from a source and its degree of odor exposure. Instead, the identification of the similar odor character, in this instance, the rotten-egg like smell of the ‘palm oil mill’ odor helped to identify possible odor source, which was justified by the similar smell and elevated odor concentration from the palm oil mill pond, located 1.3 km upwind from the affected receptors. The simplicity of the tools (an in-field olfactometer (e.g. Scentroid SM100) and an odor descriptor wheel) with minimal personnel (minimum of 4) is advantageous for localities to preliminarily establish an odor issue and its possible contributor.

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