H2S odour management in a sewer pumping well through air quality measurement and dispersion modelling

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INTRODUCTION

The emission of odorous chemical compounds from wastewater are often the reason for odour nuisance, which is why public complaints of nearby residents become more frequent [1]. The hydrolysis of organic sulphur-containing compounds by bacteria results in the production of sulphur compounds such as hydrogen sulphide (H_2S) which usually cause about 80 to 90 % of the unpleasant environmental odours [2,3].

The presence of these odorant compounds may lead to the loss of amenity, physical disorders and complaints, especially when the presence of an odour sensation is often repeated over time [4], resulting in a poor public image for the sewage treatment works facility [5].

Most of dispersion models are Gaussian models, which uses a realistic descriptions of dispersion, where it represents an analytical solution to the diffusion equation for idealized circumstances. This model assumes the concentration profile across the plume to follow a Gaussian probability curve in steady-state conditions. Odour dispersion simulation, that considers air flow and odour concentration, has been used for determining odour plume extents, and therefore evaluating odour impact assessment [6,7]. This tool was mainly used to determine separation distances to protect people from odour annoyances.

Although Spanish legislation, country in which this work was conducted, there is no guidance on the assessment of odour by odour dispersion modelling [8], the aim of this work is to demonstrate the feasibility of using dispersion models as a tool for decision making and proposing management strategies in odour control in WWTPs sewerage.

MATERIALS & METHODS

The facility studied in this work was a circular pumping well, with 2.3 m diameter and 3 m depth, open to the atmosphere via an open grating located in a residential area. The pumping station was composed by a unique pump that works discontinuously according to water level. In the inlet pipe of the well a grate was installed to avoid the inlet of large solids.

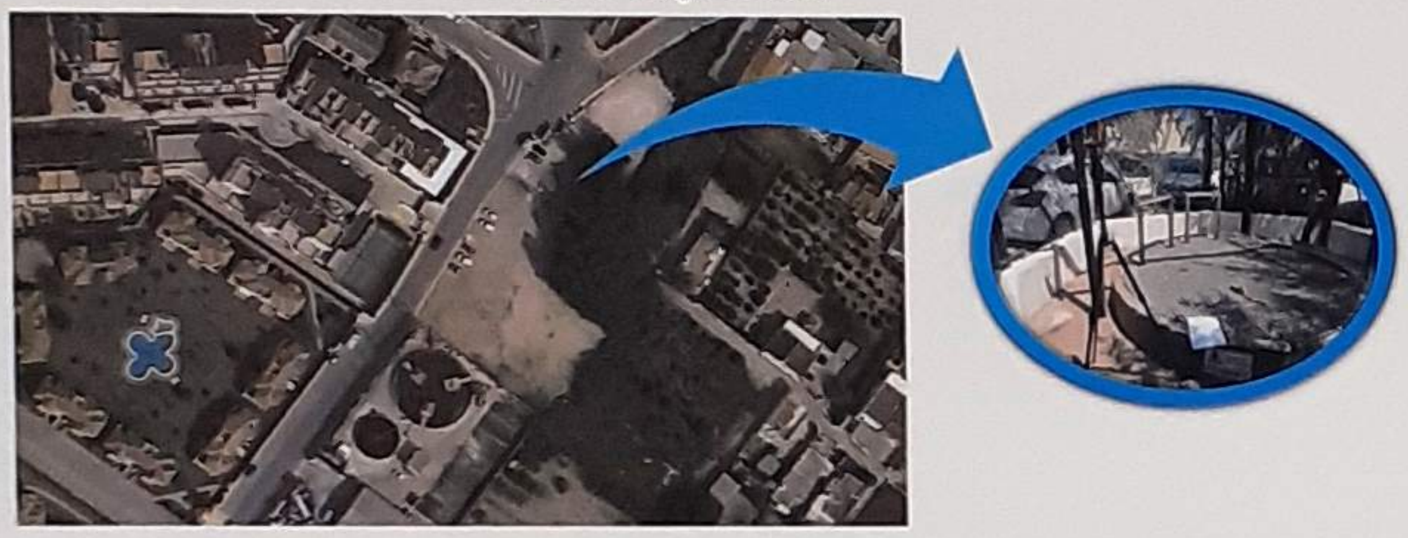


Figure 1 – Location of the pumping well.

Two measuring campaigns were carried out for assessing odorant concentrations in August 2018. These periods were chosen as odour problems are usually the highest in summer due to elevated temperatures along with the increase of organic loads because the increase of resident numbers owing to tourism.

Gas detector Dräger Polytron 7000 were used for the measurement of H_2S concentration. The measurement range was from 1 to 100 ppm, with an accuracy of either ≤±3 % of ≤±5 ppm, whichever was the greater value. The instruments recorded one measurement per minute that was saved in an external register.

Figure 2 – Gas detector Dräger Polytron 7000

Figure 3 – Panelist measuring with Nasal Ranger®

Field olfactometry was carried out with Nasal Ranger® by two calibrated panellists. The odour concentrations were measured in European Odour Units (OU_E) and categorized from 1 to 5 in odour intensity. Odour values above 15 OU_E/m^3 belong to the intensity group 5 which indicates highest offensiveness.

AERMOD modelling system, which is a steady-state Gaussian plume model, was used in this study. A rectangular 6400-point receptor grid with cells of 2.5 m x 2.5 m size and a total edge length of 200 m was utilized. Since the maximum time-resolution of AERMOD is 1 hour, all gas and meteorological data with a higher temporal resolution were resampled to the target resolution.

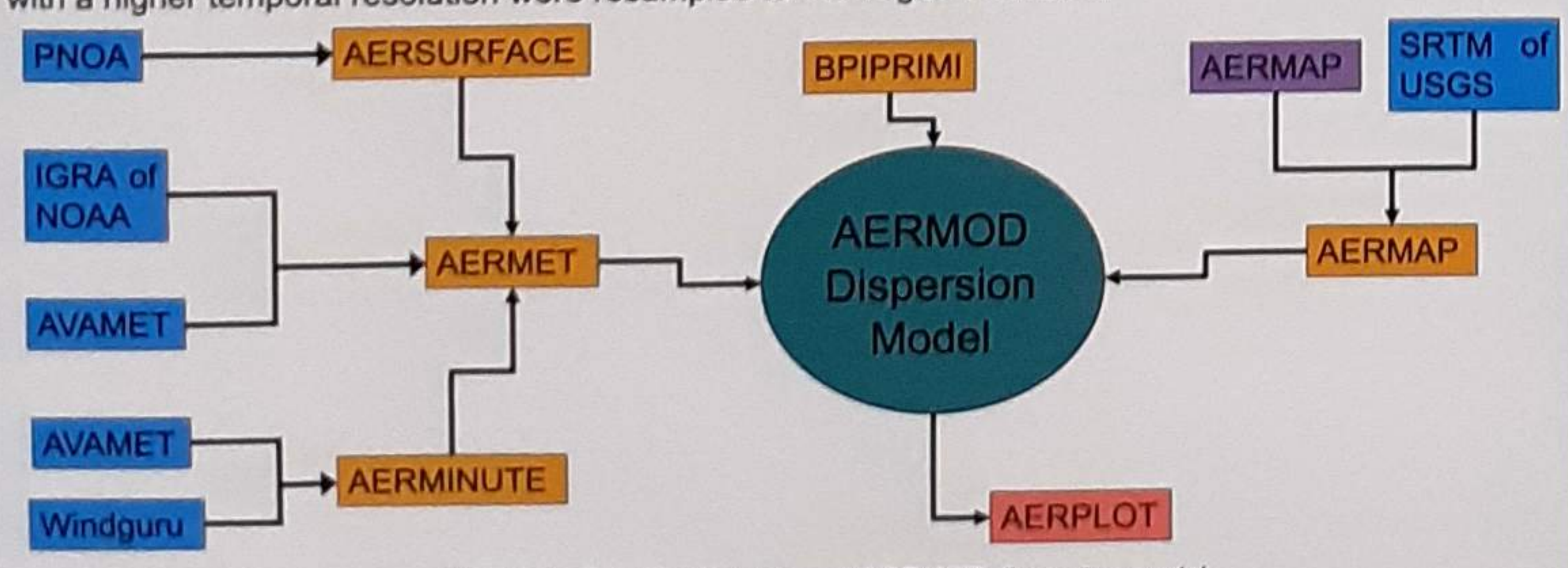


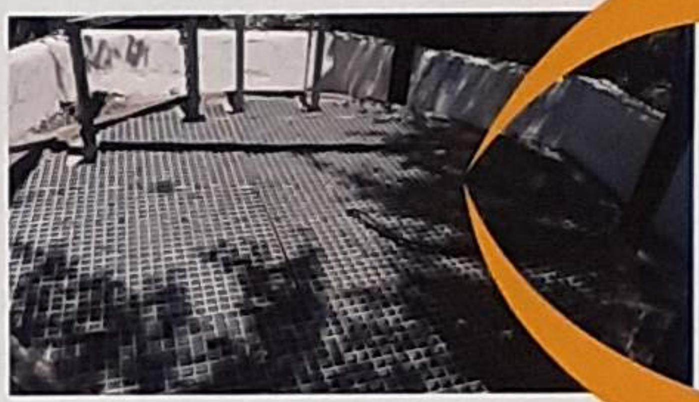
Figure 4 – Source of inlet data of AERMOD dispersion model

RESULTS & DISCUSSION

The first H_2S measurements revealed that the pumping well emitted concentrations above the human detection threshold. Detailed temporal pattern analysis of the key variables indicated that the probability of the closest area with risk of odour nuisance to inhabitants was highest from June to August. Thus, it was decided to seal the pumping well.

BEFORE SEALING

Field ofactometry results confirmed the annoyances of neighbourhood were associated to pumping well H_2S emission. Neighbouring activities could perceive mean odour concentrations of 5.2 OU_E/m^3, with peak concentrations of 8.3 OU_E/m^3, during the 70 % of time which identified the cause for annoyances.



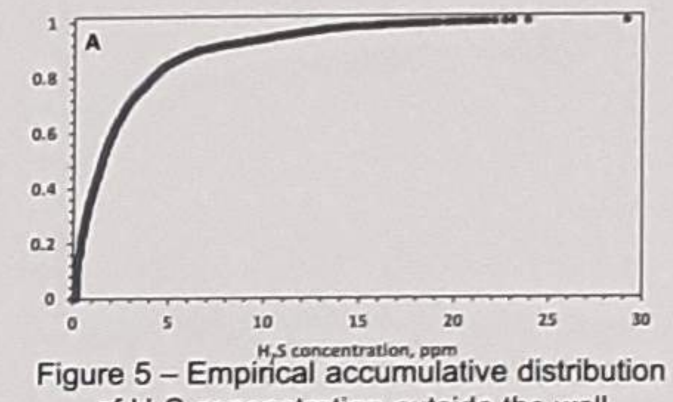


Figure 5 – Empirical accumulative distribution of H_2S concentration outside the well

Field olfactometry parameter	Before sealing
Percentage of measurements with odour, %	70.0
Average concentration odour, OU_E/m^3	5.2
Maximum odour concentration, OU_E/m^3	8.3
Minimum odour concentration, OU_E/m^3	0.0

AFTER SEALING

The comparative field olfactometry results show the drastic reduction in odour in the surrounding of the pumping well after sealing the emission source, ceasing the complaints. Although no annoyances were achieved, the H_2S concentration measured inside the pumping well rose significantly to 30th percentile around 20 ppm, which needs to be considered when opening the well for maintenance works.

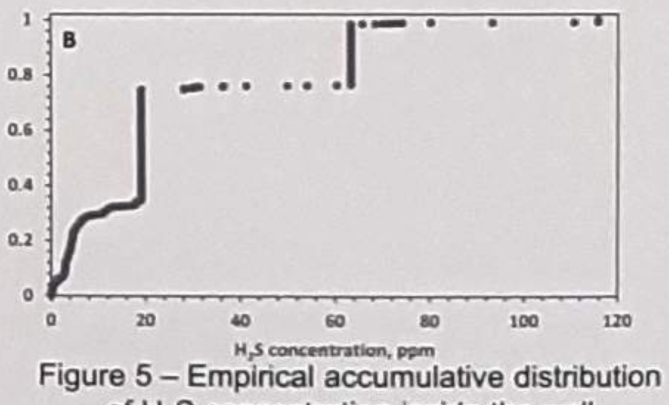


Figure 5 – Empirical accumulative distribution of H_2S concentration inside the well

Field olfactometry parameter	After sealing
Percentage of measurements with odour, %	0.0
Average concentration odour, OU_E/m^3	0.0
Maximum odour concentration, OU_E/m^3	0.0
Minimum odour concentration, OU_E/m^3	0.0

CONCLUSIONS

Dispersion modelling was revealed as a useful tool for assessment and management of odour emissions.

The identification of the emission source enables to apply ad-hoc solutions that led to cease odour annoyance

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