Identify the Odor Emission Sources in an Industrial Park by Integrated Data Mining Approach

Yu-Shiuan Cheng, Ho-Wen Chen, and Yen-Hisun Chuang

***Abstract*—Odorous gases are the most significant pollution that resident argue about living in the surroundings nearby industrial park. Sustainable ammonia emission is a common odor sources in industrial areas. Odor often impacts to human sensations and upper airway irritation, principally because most volatile chemicals have the potential to activate temporary burning, stinging, tingling or painful sensations in the eyes. However, in the case of such multi-source odour emissions especially industrial park, common chemical analyses or odour concentration measurement methods are not often applicable. Although several studies have been conducted for prevention and control of odorous gases, no comprehensive research exists about recent achievements in this area. Expected to Tainan Science Park as a research area, using different kind of historical data collection with possible odor emissions from industrial park, and apply the Gaussian diffusion model to simulate contamination of receptor. Following by Gaussian diffusion model steps, connect with linear programming method and also estimate pollution contribution. Then find out the sources of pollution so that the future government utilize cases for this petition as valid reference.[λ]**

***Index Terms*—Odor, Southern Taiwan Science Park, Gaussian diffusion model, linear program.**

I. Introduction

Gases that affect primarily the sense of smell are known as the "odorous gases". When asked to describe the odorous compounds, most people refer to them as a negative and unpleasant sense [1]. The serious damage by forcing in atmosphere come from the range of human activities, which expanded the types of change, including consumed a lot of energy, coupled with the development of science and industry. Industrial process such as cleaning, impregnation, and painting, may be used in the organic solvent. The odor and waste gas will emission to the atmosphere, seriously impact the nearby residents, factory employee health, and living quality. Therefore, the odor petition cases and industry pollutant have gradually attracted much attention. During use discharged into the atmosphere, many of which are difficult to decompose or natural ability diluted chemicals. The concentrations of air pollutants making up the odor by conducting meteorological correlations and sampling for a panel of volatile organic compounds (VOCs), sulfur gases, and polycyclic aromatic hydrocarbons (PAHs) in the neighborhood and near suspected sources during odor events indicate potential industrial sources of a transient and noxious odor [2]. Therefore, odor in the air pollution is substantially impact to human body. Residents accuse odor events cause burning eyes and throat, headaches, and sleeping problems.

Undoubtedly, the growing of odor petition cases that people emphasis on the quality of life have been reflected. With an eye to reducing the odor pollution diffuse continually, each countries have stood regulations about odors control and further improved the odor manufacturing [3], [4]. Mao *et al.*, (2012) developed a model to determinate odor pollution source in industrial parks. Through measuring odor intensity and air pollutants over time in-site, with different seasons and wind directions. By odor intensity, weather conditions and air pollutant concentration as the relevant identification. Thus, odor not only play a unique characteristic but also a most harmful role, we should take caution to remove the malodorous substances completely.

As a result of the Taiwan densely populated industrial areas often adjacent to residential areas, domestic smell petition cases increased each passing year. There is a commonly phenomenon that factories or industrial areas has been a residential neighbors everywhere. The primary resource of odor pollution plant contain instrument components, emission pathway, material storage warehouses, and gas gathering plant poor job of wiping machine. Contrast to industry counterpart, odor sources may depend on raw materials, process and operating conditions. They will produce peculiar smell odor and different intensive odor as well. Therefore, odor controlled need to start from the raw materials and process management side of the plant, and then choose the appropriate end control equipment after processing to comply with the relevant provisions of Government Regulation standards.

Except government regulation, identify pollutant sources is more effectively to solve the odor problem. In discussing the air quality and pollutant problem, it is difficult to grasp the true atmosphere situation and analyze the possible pollutant sources impacting to environment. To simulate the real situation of the atmosphere and to understand the exact environment problem, many researchers have developed air quality models and statistical methods recently. Using Receptor Model [5]-[7] and Source Model [8], [9] to evaluate the pollutant concentrations and emission. Source Model divides into three categories. One is The Air Pollution Model (TAPM), another is Industrial Source Complex Model (ISC3) and the other is Back Trajectory. The Source Model can be used to predict meteorological and air pollution parameters on inter-regional, city, or local scales for simulating periods from a day to a year or even more [10]. Mainly based on the emission factors for various industries (Emission factor), climatic conditions, topography and other factors. The dispersion models estimate the effects with various emission sources in environment. However, Receptor model is based

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The authors are with Tunghai University, Taiwan (e-mail: sunny84053078@gmail.com, hwchen@thu.edu.tw, wychen@thu.edu.tw).

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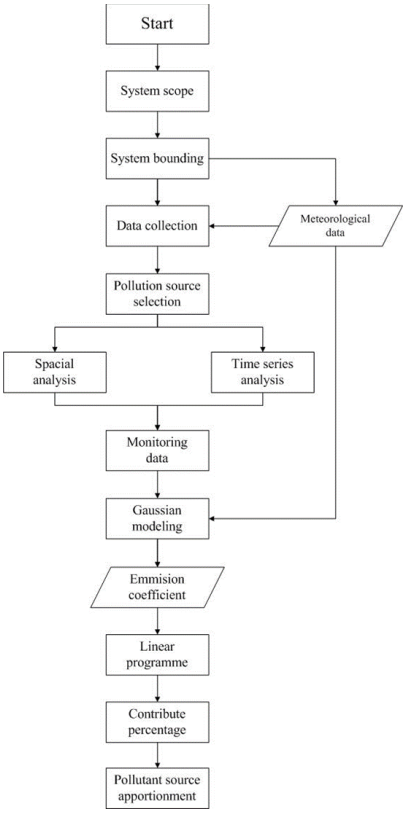
on similar properties between collecting receptor points and sources substance to exploring the relation on sources and receptor points [11], [12]. Hence, it is unable to identify pollutants characterization exactly. Over all, this research use ISC3- Gaussian Model to investigate odor distribution for a pharmaceutical plant of Tainan Science Park.

To the above, this study investigate characteristics of odors materials and their odor intensities emitted from various commercial and industrial sources. An overview of odor from the resident is presented and discussed. We selected using the ISC3 models, linear programming, and simulation both concentration diffusion and pollutant emissions, then reckoning emissions. For the pollutant sources identification and the amount of the contribution up to a certain effect, this study use ammonia as identification of pollutant sources. Researching odor source distribution and high pollution areas.

II. Procedure for Paper Submission



III. Math

In order to understand the odor pollution emitted in the Southern Science Park, this study uses Gaussian diffusion model and linear programming to estimate pollution source of contribution and identification.

IV. Units

A. Background

Southern Taiwan Science Park (STSP) contains Kaohsiung and Tainan parks. Tainan Science Park is the background for this present study. Tainan Science Park located among Xinshi District, Shanhua District and Anding District, an area of 1,043 hectares, adjacent road between National Highway No. 1 and Highway 19 (Fig. 1). The main industrial park contains an integrated circuit, optoelectronic industry, precision machinery, biotechnology, computer peripherals and other industry clusters, among of these species that circuits and optoelectronics industry are two spindle. Due to the manufacturing process of high-tech plant in component process using the photo resist agent such as ACT690 containing DMSO (dimethylsulfuroxide), NEA (n, n-dimethylacetamide), MEA (methyl ethyl amide), NMP (n-methylpyrrolidone) belongs to sulfur and amine organic matter, having a boiling point higher. If substances were in instability at high temperature organic solvent, they would have caused malodorous. In order to clarify the emission pollutants, this study set up 50 sampling points and circle installation around the Tainan Science Park, using meteorological data from Shanhua air monitoring station to investigate contaminated location.

V. Helpful Hints

A. Building Sampling Point

In order to explore the diffusion of the odor and source pollution, a 200m × 200m grid was set up and investigated the pollutant diffusion scope. On the other hand, in an identification part. Since most of the odors in this area come from the river, we focus attention on integrating circuit industry and optoelectronic industry those who commonly used inorganic acid industry and the water near water body and water outlet. In addition, calibrating the odor sensitive point by past data.

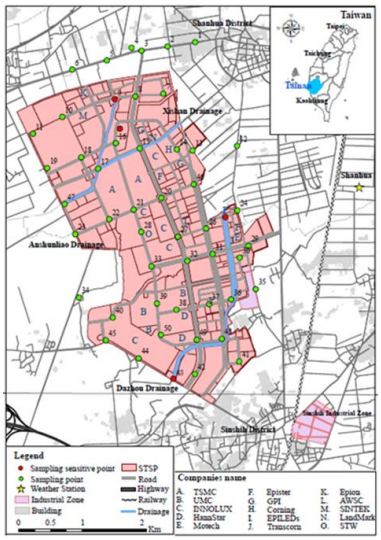


Fig. 1. Science park background.

B. Gaussian Diffusion Model

To discuss the odor diffusion and pollutant source, it is necessary to consider that pollutants discharged from industrial area may be transmitted to the perimeter by the air medium and prevailing climate factors.ISCST3 (Industrial Source Complex Short-Term Dispersion Model) was used to simulate air the impact of emitted pollutants in spatial distribution and calculate each species mass on the ambient air. Equation (1)

C. Linear Programing

The purpose of this paper is to find a set of variable specific distribution, which can satisfy the limit and also reach the minimum value of the objective function. Using each pollutant source distribution W_(j)≥ 0 as restrain formula; estimated value for the target formula and identify the suspected sources contribution of pollution ratio. Finally, apply the contribution ratio to explore the sources of pollutant emissions.

D. Equations

$$C(x,y,z)=\frac{q}{2\pi\bar{u}\sigma_y\sigma_z}\exp\left(-\frac{y^2}{2\sigma y^2}\right)\left[\exp\left(-\frac{(z-h_{ed})^2}{2\sigma z^2}\right)\right]-\{V_g+(7\times10^{-5}P^{0.58})\}C \quad (1)$$

where,

C(x,y,z): pollution concentration , μ g/m^3.

Q: emission speed, μg/s.

Ū: average wind speed, m/s.

H: height of emission plume centerline above ground level, m.

σ_y, σ_z: the diffusion coefficient of y direction and z direction, the 6 grades atmospheric stability A, B, C, D, E and F.

Downwind distance function.

X: meters downwind from the emission source point, m

y: meters crosswind from the emission plume centerline, m

z: meters above ground level, m

E. Other Recommendations

Equation (1) emphasize on individual pollutant source to single receptor point; however, this study focus on amount of pollutant emit to single receptor point. Hence, we change equation from (1) to (2)

$$C(x, y, z, h) = Qi \times X \quad (2)$$

where,

Q_i= the i point of source distribution

X=

$$C(x,y,z)=\frac{q}{2\pi\bar{u}\sigma_y\sigma_z}\exp\left(-\frac{y^2}{2\sigma y^2}\right)\left[\exp\left(-\frac{(z-h_{ed})^2}{2\sigma z^2}\right)\right]+\left\{\exp\left(-\frac{(z+h_{ed})^2}{2\sigma z^2}\right)\right\}$$

Objection:

$$minimize\ a = f(w_1, w_2, \cdots, w_n) = \sum_i(\widehat{E_i} - y_i)^2 \quad (3)$$

restrain formula:

$$W_j \geq 0 \quad (4)$$

where,

$\widehat{E_i}$ is evalua value, and $\widehat{E_i} = a_1w_1 + a_2w_2 + \cdots + a_nw_n$

$a_1, a_2, \cdots, a_n$ distrbution unit ; $w_1, w_2, \cdots, w_n$ distribution ratio

y_i is an actual value; W_j is the i point of source distribution

VI. Analysis Monitor Data

As shown from Fig2. And3. , carrying on meteorological data and data association can be observed when the humidity is over 50%, and there is significant concentration generated. The high probability of occurrence is in low wind speed (<2m / s).

Under general conditions, the ammonia concentration within the Science Park from 40 to 50ppb. But one in the humidity value more than 50% and low wind speed, the concentration of more than 50ppb the probability will increase significantly. And the olfactory threshold is only 37ppb, it is very easy to make people feel stench.

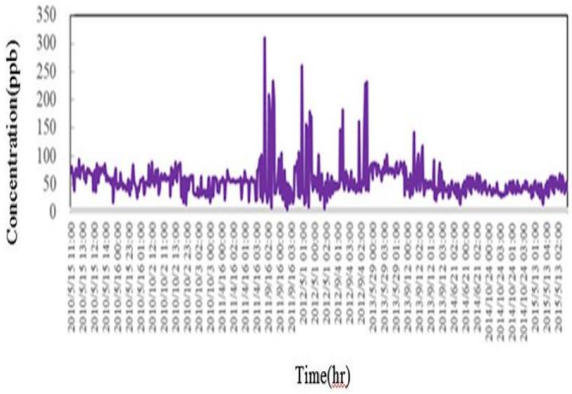


Fig. 2. Ammonia concentration and time series.

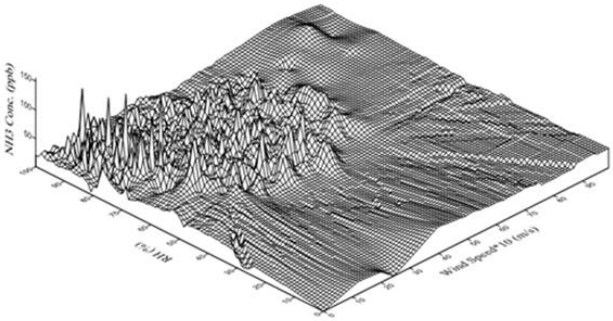


Fig. 3. Ammonia concentration and weather conditions (wind speed, humidity).

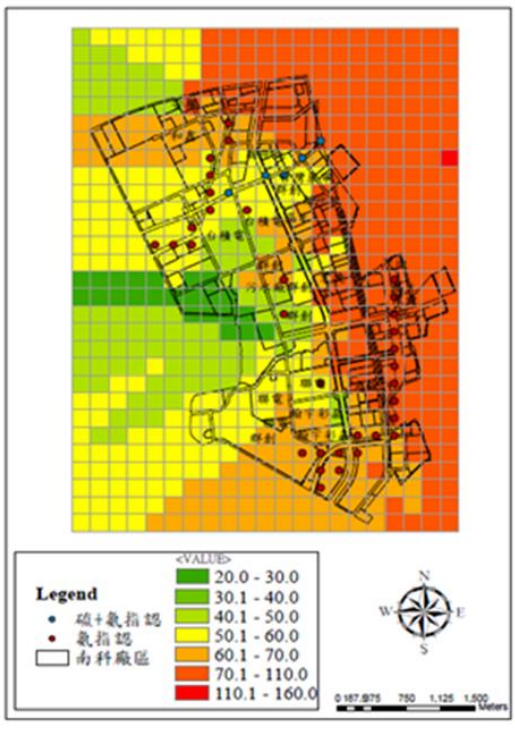


Fig. 4. Spatial analysis of ammonia diffusion.

VII. Results and Discussion

The meteorological data from 2010 to 2015 in the Science Park monitoring stations should be used to analyze the spatial analysis and monitor the concentration. The influence of the wind speed and humidity on ammonia formation was also studied, and the effect of sunlight on ammonia production was clarified. On the basis of analyzing the odors of in the science park, we selected the two seasons to carry out the monitoring of the receptor in the park for several years. Pollutant concentration trends and the use of existing monitoring data to GIS (Geographic Information System) in the Kriging (Fig. 4). Method for spatial analysis, hoping to observe the sources of suspected pollution.

VIII. Conclusion

According to the analysis of mathematical model, 38 suspected pollution sources can be identified. The high contribution from pollution sources is along the river, which may be attributed to sediment.

Using manual monitoring values to analysis spatial concentration, and the results of ammonia analysis indicated that the source of pollution was from the north (upper and middle) and east (right) of the park. The pollution results of the two sources are similar.

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Yu-Shiuan Cheng comes from Taichung city, Taiwan. She was born on May 30, 1995. Currently she is studying in the TUNG-HAI University Department of Environmental Science and Engineering.

She is working in restaurants and department stores. She was willing to learn and love making contact with people. In addition, in 2015, she studied abroad in Australia for two months that spur me to greater self-discipline, problem-solving ability. Last year, she passed the seminar project from ministry of science and technology and went to Japan to publish my papers, at the same time, she has participated competitions in national science and technology college students. From which to cultivate the character of never give up and be more patient to read relevant information.

The title of her presentation is identify the odor emission sources in an industrial park by integrated data mining approach (Dr. Chen, Mr. Chuang, Ms. Cheng).