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Examining the feasibility of prediction models by monitoring data and management data for bioaerosols inside office buildings

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ABSTRACT

Exposure to bioagents can cause several health problems, including acute allergies, infectious diseases, and myctoxicosis. Nevertheless, all conventional methods for measuring airborne bioaerosols have significant limitations such as high cost, prolonged measurement time, and discontinuous measurements.

This work develops a simple and cost-effective method for indoor airborne bioaerosols that uses monitoring data such as coarse particle (PM_{10}), fine particle ($PM_{2.5}$), and carbon dioxide (CO_2) concentrations, and temperature (Temp), and relative humidity (RH) both indoors and outdoors. Some IAQ management data, such as the number of stories, air ventilation types, air exchange rate, potential indoor particulate sources, and population density were quantified in this study. Both monitoring data and management data are considered simultaneously, and multiple linear regression and nonlinear regression analyses are applied to develop prediction models for bacteria and fungi concentrations in office buildings. The indoor and outdoor air qualities of 37 office buildings in Taipei, Taiwan were sampled to develop the prediction models for buildings in Taipei Metropolitan.

Results showed that the predictions of a single office building were better than those of all office buildings in the city. The prediction using multiple linear regression models performed best for both indoors bacteria and fungi concentrations. Furthermore, analytical results show that the prediction with both monitoring and management data inputs were better than with monitoring data only. This real-time prediction model can serve as a simple and cost-effective tool for predicting bioaerosol concentrations to identify and prevent IAQ problems.

1. Introduction

Exposure to bioaerosols may cause serious health effects, such as allergies, infectious diseases, myctoxicosis [1,2]. Taiwan is a humid island and the concentrations of bioaerosol are relatively high. Many buildings in Taiwan are suffering from mold problem or high bacteria concentration. Li [3] reported that the average indoor concentrations of bacteria and fungi were 1502 CFU m^{-3} and 195 CFU m^{-3} in Taipei. Li [4] also showed that the bacteria and fungi concentrations in six government office buildings with heating ventilation and air conditioning system (HVAC) were 181–8069 CFU m^{-3} and 147–1129 CFU m^{-3}, respectively. Liu [5] investigated 10 office buildings in Taiwan, 70% with fan coil unit (FCU) system and 30% with air handling unit (AHU) system, and reported that the average fungi concentration was 3256.5 CFU m^{-3} (97–22,135 CFU m^{-3}). Wu et al. [6] showed that 29.0%–56.1% and 0%–31.5% of office buildings with AHU systems have the bacteria and fungi concentrations higher than 1000 CFU m^{-3} while 42.9%–79.8% and 26.4%–80.0% in office buildings with FCU systems, respectively.

Comparing with other countries, Chao et al. [7] investigated 4 office buildings with HVAC systems during one year in Boston, and showed that the average fungi concentration was low (i.e., 42.05 CFU m^{-3}). Law et al. [8] sampled bacteria and fungi in 2 office buildings with HVAC systems in Hong Kong. The bacteria and fungi concentrations were 171–379 and 7–123 CFU m^{-3}, respectively. Mui et al. [9] sampled occupied offices, conference rooms, and small personal offices in Hong Kong, and found the average bacteria and fungi concentrations were 580 and 147 CFU m^{-3}, respectively.

Many studies explored the environmental factors of indoor airborne bioaerosols. Indoor fungi mainly come from outdoors, and outdoor fungi concentration is usually higher than indoors. Sometimes indoor fungi concentration is higher than outdoors during rainy days because the suspended fungi could be settled by rain [10,11]. Humidity is found to be a more important factor than

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