Domain Specific Language for Indoor Air Quality Analysis in Museums

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Abstract

Indoor air quality plays a major role in preventive cultural heritage conservation. There are several parameters that have an influence on the degradation process. Some examples are temperature, relative humidity, visible light, UV, radiation, particulate matter and reactive gases. All these parameters are measured and stored for monitoring purposes, but the amount of data is overwhelming for caretakers. We need a method that can make an assessment of the influence on these works of art. Given the measured parameters, it would be so much easier to convert measurements into a judgment (good-mediocre-bad). This will help caretakers to improve air quality and to take steps to prevent degradation. Analysis of big data provides the answer for this problem.

Keywords: Domain Specific Language, Indoor Air Quality, Museums

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1. Indoor Air Quality in general

The air we breath has a big influence on our health. A lot of attention has been paid to the air quality outdoors, with reducing the emissions of cars and factories, but the air quality indoors has not been researched so well. We spend most of our time indoor, so why hasn't there been more research regarding this subject? The construction materials used in our homes can have an effect

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on the air quality, just as combustion of fuels, think about cooking or heating our home, release gasses that infleunce the air quality. All these factors and many more can cause health issues or even endanger us. The World Health Organisation (WHO) has released a report on the dangers of indoor air quality for human health, which can be publicly viewed [1].

2. Indoor Air Quality in museums

In the previous section the effect of Indoor Air Quality on humans was discussed, but why wouldn't the Indoor Air Quality influence other materials as well? It has been proven that the Indoor Air Quality does have an effect on cultural heritage, mainly due to the degradation proces of materials. Materials degradade naturally but the quality of the air can speed up this process. The main difference between materials and humans is that humans can repair themselves, but materials do not possess such abilities. Restauration is possible, but if will always differ from the original work, and it will never be as good as the original work. That's why it's important to preserve our cultural heritage.

3. Existing tools

3.1. AirSense

AirSense [2] is an Intelligent Home-based Sensing System for Indoor Air Quality Analytics. Other monitoring techniques focus on Indoor Air Quality measurements and visualization, but the lack of information about the pollution sources as well as the intensity of the pollution causes ignorance of the polluted air at their homes. AirSense is able to automatically detect pollution, identify the source of the polution and estimate personal exposure to that pollution. It also provides actionable suggestion to help people improve the Indoor Air Quality.

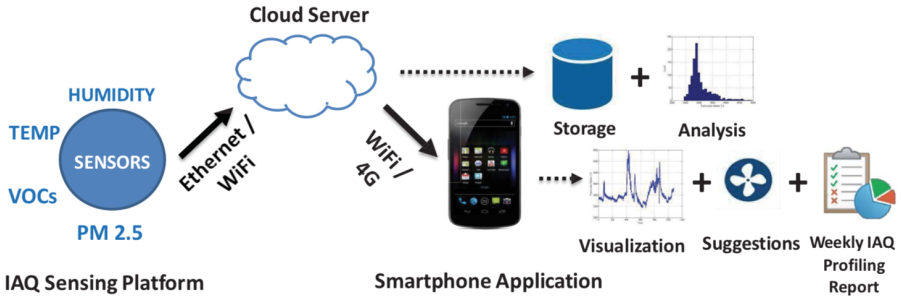
The AirSense system architecture is composed of several components. The first one is an Indoor Air Quality sensing platform that has several sensors build in to detect parameters in the air, such as temperature, humidity, particulate

matter, volatile organic compound, and more if desired. The data is collected every 5 seconds and is send to a cloud server.

The cloud server does the processing of the data and stores the results in a database and some graphs are created.

The smartphone application allows the user to view the information and get suggestions as to what parameter needs to be changed to improve the Indoor Air Quality.

The entire architecture is shown in the figure below.



AirSense system architecture

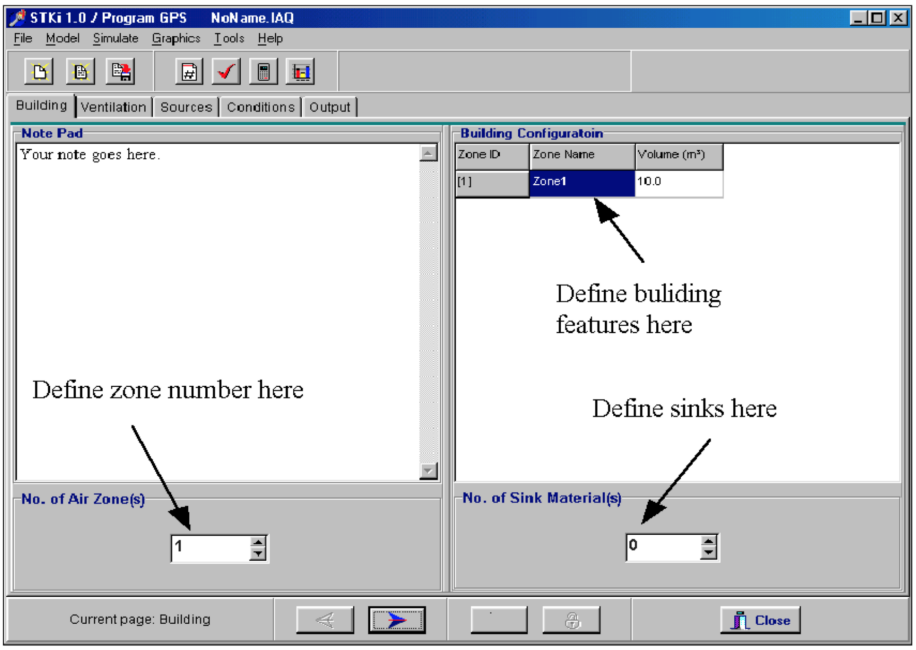
3.2. IAQX

IAQX [3] is an Indoor Air Quality simulation software package that complements and supplements existing Indoor Air Quality simulation programs. IAQX helps users analyze the impact of pollutant sources and sinks, ventilation, and air cleaners. It performs conventional Indoor Air Quality simulations to calculate the pollutant concentration and/or personal exposure as a function of time. It can also estimate adequate ventilation rates based on user-provided air quality criteria. This is a unique feature useful for product stewardship and risk management.

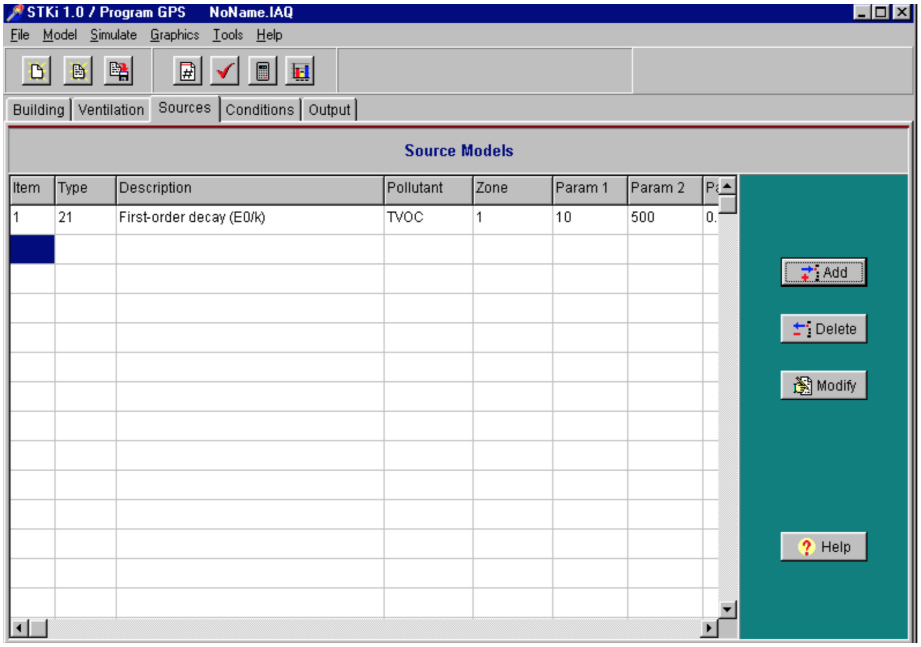
IAQX consists of a general-purpose simulation program and a series of standalone, special-purpose programs. The general-purpose program performs multizone, multipollutant simulations and allows gas-phase chemical reactions. The four special-purpose programs contain more complex mass transfer models than the general-purpose programs, including:

- Models for predicting volatile organic compound (VOC) emissions from solvent-based indoor coating materials based on product formulation
- Models for indoor solvent spills
- A model for VOC emissions from diffusion-controlled homogeneous slabs such as new carpet backing
- A model for indoor particulate matter

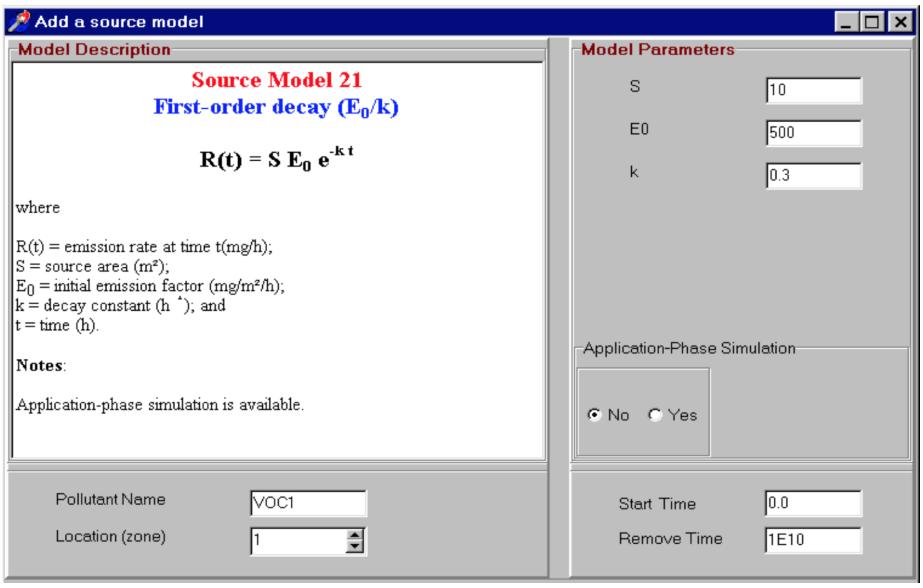
Some interesting views are shown in the images below.



The available zones within the simulation



Emission sources page



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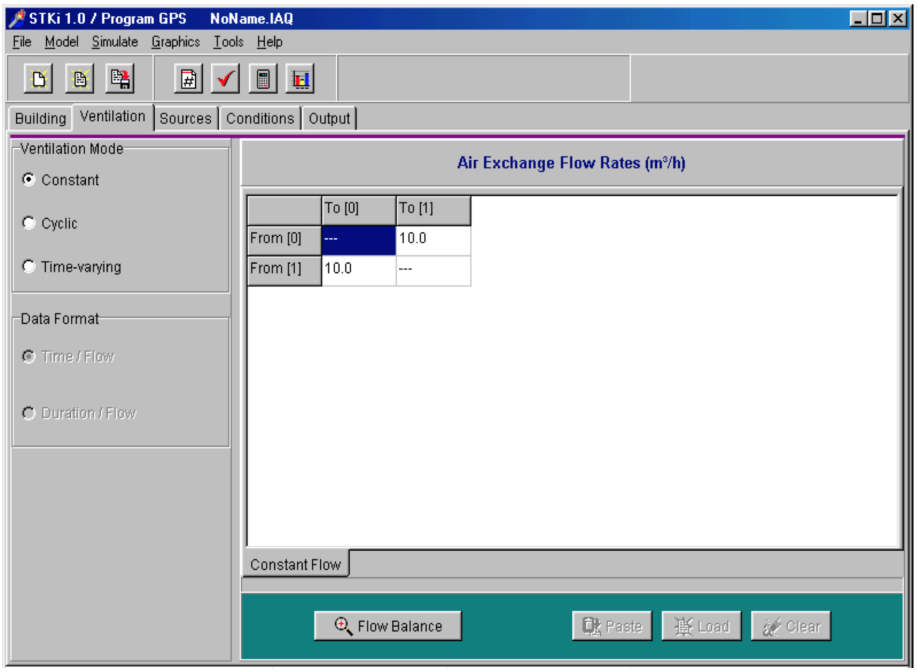
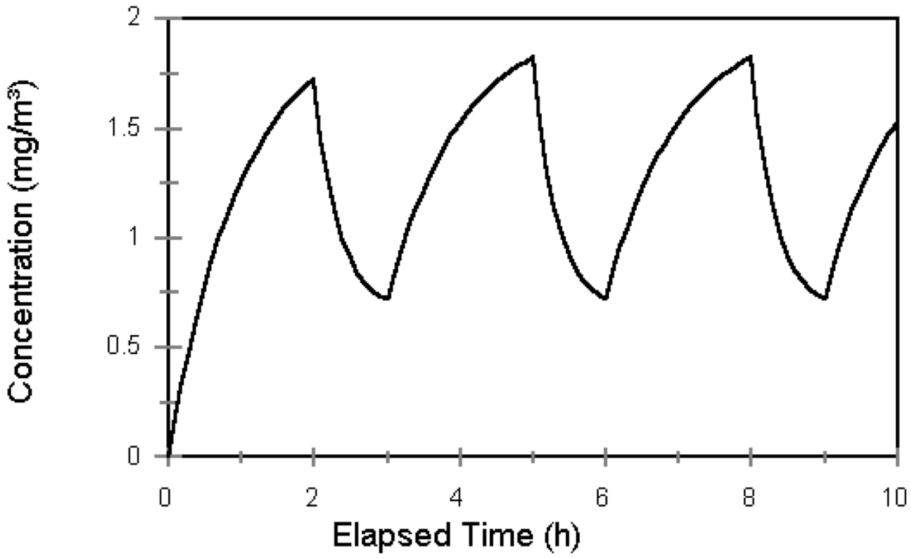
Emission source model page



Ventilation page to generate the airflow



Example result of concentration during a period of time

References

[1] WHO, Who guidelines for indoor air quality: selected pollutants, http://www.euro.who.int/__data/assets/pdf_file/0009/128169/e94535.pdf.

[2] B. F. Q. X. T. P. M. Zhang, Airsense: An intelligent home-based sensing system for indoor air quality analytics, UbiComp september 2016 (2016) 12–16. doi:http://dx.doi.org/10.1145/2971648.2971720.

[3] Z. Guo*, Development of a windows-based indoor air quality simulation software package. environmental modelling and software, https://www.epa.gov/air-research/simulation-tool-kit-indoor-air-quality-and-inhalation-exposure-iaqx 15 (2000) 403–410. doi:10.1016/S1364-8152(00)00020-7.