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Investigation of urban air pollution applying GIS and mathematical statistical methods
PH.D. THESES

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Introduction

The significance of the environment valorized fully by the threshold of the 21th century. Nowadays, as a result of the urbanization, the growth of the number of the city's size, the social transformation and together with the rapid development of science and technology one of the most important problems to be solved is the mitigation of air pollution.

Through the continued growth, the change in the composition of the city atmosphere has harmful effects on human health, living organisms, soil, water and other environmental elements as well. It is therefore an essential step to exactly know the composition of the ambient air and the air polluting components contained therein. With the help of accurate measurements it is possible to determine the concentrations of various air pollutants and their components. Thanks to the continuous measurements we can get a clearer picture of the state of the air and after the evaluation of the results it could support further action.

The main object of my research for that very reason was air pollution within the causes of urban pollution and changes of the air quality. In my dissertation, I paid special attention to the increasing urbanization and motorization, and increased air pollution from traffic and its impact on urban air quality and human health.

Methods

Processing of a wide range of national and international literature was carried out as a basis of the research, based on which research hypotheses and methodological procedures are formulated.

For the verification of my hypotheses the following main methods were used:

a) analysis and evaluation of national and international literature on air pollution, urbanization, motorization,

b) exploring monitoring systems related to air pollution,

c) applied models for the transmission of the air pollution, modelling methods,

d) comparative analysis and evaluation of data related to the topic of national and EU statistical publications,

e) variance method, called Ward cluster analysis method,

f) statistical calculations, regression calculations, least squares method,

g) time-series analysis, spatial analysis,

h) digital terrain modelling, IDW interpolation,

i) Dimensional analysis, Buckingham π theory.

Theses

New scientific results achieved during my PhD research was formulated in the following four theses:

1. Thesis: I have demonstrated using mathematical techniques that the growth of urbanization and the intensification of road traffic, air pollution has become a major environmental problem in urban areas.

   a. It has been shown that the rate of urban population growth was more than 4%, and the highest increase occurred in the case of cities with more than 3 million inhabitants.

   b. I have found that car transport has increased the most, while the use of public transport declined steadily.

   c. It has been revealed that simultaneously with increasing urbanization the length of roads and the number of passenger cars per 1,000 residents has increased (17%) as well.

   d. I have pointed out that the increasing urbanization and motorization had an impact on urban air quality. 20-40% of the urban population was exposed to PM_{10} concentration in the ambient air, which is above the EU limit, and 14-65% of the population is affected by

more than 25 high-ozone days exceeding the daily $120\mu g / m^3$ limit concentration.

2. Thesis: It has been shown that the connection between the number of deaths occurring in the respiratory, circulatory and digestive system illnesses and traffic related air pollution is confirmed by using statistical methods.

    a. I have found that the relationships of the SO_2 (44%) and the CO (20%) concerning respiratory system disease are the two strongest.

    b. I have pointed out that the deaths occurring because of the diseases of the circulatory system have a very strong link between the concentrations of NO_x and CO air pollutants (80%).

    c. I have determined a strong link between the deaths occurring because of the diseases of the digestive system and the concentration of NO_x (80%), CO (65%) and PM_{10} (51%).

    d. I have found that the two most dominant air pollutants are NO_x and CO with the strongest correlations while O_3 showed the weakest link.

3. Thesis: I have shown that the level of the traffic related air pollution can be characterized with sufficient accuracy by applying dynamic measurements in a district or in the whole town.

    a. Results of the static measurement points have proven that the concentration of the NO_x air pollutant is a system which is changing constantly and has a distribution, so it is insufficient to measure the properties in one point in the city to characterize its level of pollution.

b. I have determined the rate of the change of the air pollutant NO_x and I have detected the most polluted parts of the study area by a spatial analysis performed on my dynamic measurements.

4. Thesis: I have developed a model, which can describe mathematically the level of the ambient air pollutant if meteorological and topographical data are known.

a. I have developed an equation, which allows the detection of the NO_x concentration in ambient air on the basis of five predefined parameters.

b. With this method the concentration of air pollutants can be approximately determined without the monitoring of air pollutants.

PUBLICATIONS

Article:

1. Veronika Vincze-Csom, **Georgina Nagy**, Endre Domokos, Pál Bui, Ákos Rédey, 2012. Study on the impact of the traffic on air quality by using diffusive sampling method in Veszprém. *Environmental Engineering and Management Journal*, 11, 11, 2083-2090.

2. **Georgina Nagy**, Endre Domokos, Anna Merényi, Rédey Ákos, Tatiana Yuzhakova, 2014. Monitoring of Air Pollution Spread on the Car-Free Day in the City of Veszprém. *International Journal of Energy and Environment (IJEE)*, Vol.5, Issue 6, pp.679-684.

3. **Georgina Nagy**, Vilcekova Silvia, Endre Domokos, 2015. Modelling the prediction of the NOx concentration in the outdoor air applying dimensional analysis. *Fresenius Environmental Bulletin,* Vol. 24, Issue 11.

Oral presentation in English with full text appearance:

1. Veronika Vincze-Csom, **Georgina Nagy**, Endre Domokos, Pál Bui, Ákos Rédey, (2013). Environmental air monitoring in city of Veszprém in cooperation with graduate students of School of Environmental Engineering, University of Pannonia. *In Global Conference on Environmental Studies (CENVISU-2013).* Belek, Antalya, Törökország, Április 24-27. AWERProcedia Advances in Applied Sciences. Vol.1, pp.694-703.
2. Tamás Fráter, **Georgina Nagy**, Endre Domokos, (2014). Unmanned Aerial Vehicles in Airborne Environmental Monitoring of Natural Reserve Areas such as Wetlands. *In 4th International Conference on Solid Waste Management, IconSWM 2014 .* Hyderabad , Andhra Pradesh, India , január 28-30. Waste Management & Resource Utilisation: Kolkata: Oxford Publishing House. pp.161-164.

Oral presentation in English with only abtract appearance:

1. Veronika Vincze-Csom, **Georgina Nagy**, Endre Domokos, Pál Bui, Ákos Rédey, (2013). Monitoring nitrogen-dioxide and benzene in air in the Central Transdaniubien Region, in the City of Veszprém. *In 14th EuCheMS International Conference on Chemistry and the Environment.* Barcelona, Spanyolország, Június 25 - 28. Book of abstracts. pp 64.

Oral presentation in Hungarian with only abtract appearance:

1. Endre Domokos, **Georgina Nagy**, Tamás Fráter, (2013). Környezetvédelmi montorozás pilóta nélküli repülőeszközzel. *In XIX. Nemzetközi Vegyészkonferencia*. Románia, Nagybánya, november 21-24. Book of abstracts. pp 54.

2. **Georgina Nagy,** Endre Domokos, Pál Bui, Ákos Rédey, (2013). Dinamikus légszennyezettség mérés városi környezetben. *In XIX. Nemzetközi Vegyészkonferencia*. Románia, Nagybánya, november 21-24. Book of abstracts. pp 44.

3. **Georgina Nagy**, Vilcekova Silvia, Endre Domokos, (2014). A közlekedésből származó légszennyezettség és a légúti megbetegedések kapcsolatának vizsgálata . *In XX. Nemzetközi Vegyészkonferencia*. Cluj-Napoca, Románia, november 6-9. Cluj-Napoca: Erdélyi Magyar Műszaki Tudományos Társaság (EMT). pp. 79.

4. Viola Somogyi, Anna Merényi, **Georgina Nagy**, Endre Domokos, Ákos Rédey, (2014). Veszélyes anyagok légkörben való terjedésének vizsgálata különböző modellek segítségével. *In X. Kárpát-medencei Környezettudományi Konferencia* . Kolozsvár, Románia, március 27-29. Kolozsvár: Ábel Kiadó. pp. 249

5. Anna Merényi, **Georgina Nagy**, Endre Domokos, (2015). A Pannon Egyetem területén kialakuló légszennyezettség a tömegközlekedés függvényében. *In XI. Kárpát-medencei Környezettudományi Konferencia* . Pécs, Magyarország, május 6-9. Kiadó: Szentágothai János Szakkolágium . pp. 62

6. **Georgina Nagy**, Anna Merényi, Endre Domokos, (2015). Légszennyező anyagok és meteorológiai tényezők összefüggésének vizsgálata az idő függvényében Veszprémben. *In XI. Kárpát-medencei Környezettudományi Konferencia* . Pécs, Magyarország, május 6-9. Kiadó: Szentágothai János Szakkolágium . pp. 63

Poster presentation in Hungarian:

1. Endre Domokos, **Georgina Nagy**, Ákos Rédey, Anett Utasi, (2013). Környezeti modellező rendszerek használata városi környezetben. *In XIX. Nemzetközi Vegyészkonferencia*. Románia, Nagybánya, november 21-24.

Poster presentation in English

1. Anna Merényi, Endre Domokos, **Georgina Nagy**, (2015). Modelling of the influence of public transport int he urban air quality. *In International Conference on Chemical & Process Engineering*. Milánó, Olaszország, május 19-22.