PERSPECTIVES OF DISTRIBUTED MONITORING NANO-SENSORS BASED NETWORKS INTEGRATION INTO THE MODERN CITY INFRASTRUCTURE

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Abstract: *There is a very notable trend that, the part of world population who live in cities grow, thus grows of the accompanying infrastructure: transportation system, energy system, water delivery system. This leads to some environmental changes, which are hardly estimate, without having precise enough monitoring system. In this article, it is described a possibility to use the distributed nano-sensor based networks in order to implement stable monitoring systems.*

Keywords*: nano-sensor, distributed network, monitoring system;*

Background

Almost three-quarters of the EU population live in urban areas: cities, towns and suburbs, with more than 40% residing in cities alone. The share of the urban population in Europe is projected to rise to just over 80% by 2050 [1]. Cities and communities are therefore essential for Europeans' well-being and quality of life as they serve as hubs for economic and social development and innovation. They attract many people because of the wide range of opportunities for education, employment, entertainment and culture that are available there. This large concentration of people and wealth, however, often comes with a range of complex challenges, like air pollution. Ensuring the sustainability of urban transport, by improving the accessibility and attractiveness of public transport systems, among other measures, is one of these challenges. Another is dealing with the negative environmental impacts arising from the large quantities of waste they generate. Cities are consequently seen as both a source of economic, environmental and social challenges as well as a solution to these issues. As such, they may be viewed as a key driver for achieving a sustainable future.

Another potential advantage of urban sprawl relates to the economy and air pollution. Companies may tend to move to city outskirts because of the need for more space and to improve connections with the wider transport system. Although this may increase the distances between residential areas and workplaces, and thus increase commuter traffic and air pollution, some authors argue that sprawl reduces freight transport into central city areas, and therefore reduces air pollution in cities and traffic congestion. The decentralizations of both residential and employment areas is seen by some as an efficient way to reduce air pollution and the travel distances for commuters between work and homes [2].

One of urban sprawl related challenges is air pollution, and is a global threat leading to large impacts on health and ecosystems. Emissions and concentrations have increased in many areas worldwide. When it comes to Europe, air quality remains poor in many areas, despite reductions in emissions and ambient concentrations. Effective action to reduce air pollution and its impacts requires a good understanding of its causes, how pollutants are transported and transformed in the atmosphere, how the chemical composition of the atmosphere changes over time, and how pollutants impact humans, ecosystems, the climate and subsequently society and the economy. To curb air pollution, collaboration and coordinated action at international, national and local levels must be maintained, in coordination with other environmental, climate and sectoral policies. Holistic solutions involving technological development, structural changes and behavioral changes are also needed, together with an integrated multidisciplinary approach. Air pollution is perceived as the second biggest environmental concern for Europeans after climate change (European Commission, 2017b) and people expect the authorities to implement effective measures to reduce air pollution and its effects [3]. In this work an overview of sensors networks for monitoring is discussed.

Monitoring systems

One of the main tasks of the modern monitoring systems is the preparation of gridded emission data sets as input for long-range transport models. As data submitted by parties is not always complete and as several parties do not submit data it is necessary to fill in missing information before these emission data sets can be used by modelers. To gap-fill those missing data, CEIP applies different gap-filling methods. After the gap-filling, sector emissions are used for spatial emission mapping, i.e. the EMEP grid.[4]

Information on pollutant's emission to the atmosphere and other environmental media is one of the key parameters required for model assessment of pollution levels and transboundary fluxes. Completeness and uncertainties of emission data can significantly affect quality of the model estimates. Sensitivity analysis of the modeling results has shown that, in many cases, emission uncertainties largely determine the overall uncertainty of the model assessment.

Application of chemical transport models for assessment of HMs (Heavy metals) pollution levels in the EMEP (European Monitoring and Evaluation Programme) countries requires anthropogenic emission data spatially distributed (or “gridded”) over the regular EMEP grid. It should be noted that modeling of air concentration and deposition fluxes needs emission data covering the entire EMEP domain that includes not only territories of all EMEP countries but also adjacent areas (Northern Africa, Middle East etc.). Along with this, application of the gridded emission data for modeling requires evaluation of additional emission parameters. They comprise chemical composition of emitted pollutants, vertical distribution of emission height and temporal variation of anthropogenic emissions along the year.

The gridded (distributed) environmental monitoring systems should have at least some basic properties:

- Low energy consumption / High operation efficiency. Nano-sensors, being devices with very low power consumption, should keep this advantage [5].
- Simplicity of adding every new node (sensor). It is necessary to implement a network-system, where every new sensor could be integrated without additional configurations and adjustments.
- Disconnection of some sensor or moving to idle mode (offline) should not influence the overall system behavior.
- Self-diagnosis capability. In a system with thousands of sensing nodes, it is necessary to have an automatic failure detection function.

Fig. 1. Monitoring mesh-type network.

Conclusion

Nano-sensors being multifunctional, cheap, having low power consumption, are very suitable candidates to be used for creation of a city-wide or region-wide distributed monitoring system. Such a system, being autonomous enable non-stop monitoring all day long, without instant human access. The modern cities, which have a tendency to create an intelligent infrastructure will benefit from having additional information about environmental state, and from improvements of predictive ability of climate models.

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