Chapter 7
Air Quality Modeling and Metamodeling Approach

Miloslava Kašparová
University of Pardubice, Czech Republic

Jiří Křupka
University of Pardubice, Czech Republic

ABSTRACT

This chapter deals with modeling and metamodeling of air quality in the Pardubice region of the Czech Republic. From a regional point of view, the Pardubice district is the most problematic area in regards to air pollution. Concentrations of traffic, industry and power stations (Opatovice and Chvaletice) activities are the cause of this situation, although emissions of all pollutants have markedly decreased within the last ten years. A decrease in air pollution was achieved particularly by restriction and restructuring of industrial production, use of emission standards, changes in legislation in the area of air protection, etc. The mentioned air quality modeling belongs to classification tasks. It means the authors deal with the classification problem, with the creation of classification models (classifiers) and they focus on metamodeling (combining classifiers). Through the application of modeling and metamodeling the authors use selected algorithms of decision trees (C5.0, chi-squared automatic interaction detection and classification and regression trees) that belong to useful explanatory techniques.

INTRODUCTION

Many environmental problems involve the degradation of renewable natural resources or their use at rates greater than they can be replenished. Many of the impacts of pollution are long term and wide ranging (Hersh, 2006). Air pollution is one form of environmental threats. There are a number of different types of air pollutants, including: suspended particulate matter, lead, and sulphur dioxide, carbon monoxide and nitrogen

DOI: 10.4018/978-1-60960-156-0.ch007

oxides. Sources of suspended particulate matter include incomplete fuel combustion and vehicle exhaust gases, particularly from diesel engines. Health effects include increased incidence of respiratory diseases such as asthma, bronchitis and emphysema, and an increased in the mortality of people (Hersh, 2006).

Concerning the environment of the Czech Republic, there has been a decline of nitrogen oxides emissions, sulfur dioxide and volatile compounds since 2000; on the other hand, emissions of dust particles remain stagnate. 29% of the territory in the Czech Republic (without inclusion of the pedantic ozone) belongs to areas with aggravated quality of atmosphere. The problem is represented mainly by tiny dust particles of PM_{10} and $PM_{2.5}$, multinuclear aromatic hydrocarbons and nitrogen oxides. The concentrations of nitrogen oxides exceed the allowed limit in some traffic exposed localities; however, this matter is an antecedent of tropospheric ozone, another toxic matter whose limit values exceed the limit in a vast area of the Czech Republic. Heating in households participates in PM_{10} emissions by 38%, transportation by another 20%; heating in households partakes in $PM_{2.5}$ emissions by 27% while transportation by 31%. 62% of the Czech population is exposed to an excess limit concentration of PM_{10}. In contrast with most European countries, the amount of these particles has not been decreasing in the Czech Republic, recently. Actually, two thirds (66%) of poly-aromatic hydrocarbons emissions are caused by household heating. 69% of the population is exposed to limit exceeding concentrations of benzo(a)pyrene which is a representative of this type of matter. The occurrence of allergic disorders is increasing in our republic. In 2006, 30% of children were diagnosed with one form of allergic disorder; one half of this number was in the form of respiratory allergies. In comparison to 1996, the number of children with allergies grew by one half in 2001; in 2006, an increase of a similar height was noted. Professional studies prove that pollution of the environment, especially pollution which is caused by tinny dust particles, leads to higher risk of allergic occurrence (MoE, 2007).

Air Quality Evaluation is based on the result of the weight concentrations measures of substance in the air. The evaluation of air quality (CHMI, 2009) is in Table 1. The Air Quality Index (AQI, index) is an index for reporting daily air quality. It tells how clean or polluted air is, and what associated health effects might be of concern for us. It is determined on the basis of five major air pollutants: sulfur dioxide [SO_2], nitrogen dioxide [NO_2], carbon monoxide [CO], ground-level ozone [O_3] and suspended particles [PM_{10}]. In (CHMI, 2009), AQI is measured for every air pollutant in the particular locality and the highest is presented. An index is listed only when data for at least NO_2, O_3 and PM_{10} is available, if these are regularly measured within the locality. This evaluation (Table 1) takes the possible influence of human health into account (SPE, 2004). New limits of monitoring and air quality evaluation are specified in the regulation of the Czech Republic government No: 597/2006 Coll. These limits are set separately for health protection and vegetation and ecosystems protection.

In the Czech Republic, the State Environmental Policy of the Czech Republic (SEP CR) (SPE, 2004) belongs to documents that deal with protection and quality assurance of the environment in this country. It is a fundamental reference document for other sectors and regional policies, from the standpoint of the environment. Although the SEP CR is a governmental document its implementation requires an active participation of the general public, partners in the business sector, science and research and others. It is a policy that should be followed by Czech corporations, as well as other organizations, as an instrument that will assist them in their strategic and every-day operative decision making, so as to lead not only to the creation of new economic, social and cultural values, but also to an improvement in the quality of life and quality of the environment.