9. Summary

In the first part of my study, after the literary review of atmospheric aerosol and applied sampling methods, I investigate and explain the variation of urban aerosol particles collected in Debrecen and compare our results with 21 other European cities. Then I review the results of the analysis of aerosol samples which collected in the frame of two NRDP projects in several sites simultaneously.

In the second part of my work I give a description about the human respiratory system and the Stochastic Lung Model. Finally I summarize the development of the program code for asthma and apply the Stochastic Lung Model using the elemental size distribution data as input parameters.

Results

1. I investigated the long term and seasonal variation of fine and coarse Debrecen urban aerosol from 1996 to 2004.
   - From the monthly average concentrations I found that the PM2.5 and black carbon concentrations has maximum in summers and minimum in winters.
   - I found that the average concentrations of soil origin elements, as calcium, iron, manganese, silicon and titanium, had maximum in summers and minimum in winters in both fractions and in the coarse fraction of potassium.
   - I have found that the anthropogenic elements, as sulphur, lead, zinc and copper in both size fractions and potassium in the fine fractions showed minimum in summers and maximum in winters.
   - Decreasing tendency was observed for the investigated period in the case of the concentration of the fine aerosol and most of the fine fraction

elemental components. The concentration of coarse aerosol and of the soil origin elements increased which was confirmed by correlation factor calculations. Through this the effect of the increased contribution of resuspended dust due to the increased traffic of motor vehicles of the last years in Debrecen could be detected.

2. The results obtained for Debrecen aerosol between June of 2000 and December of 2001 in Debrecen was fit into a study which covered 21 European towns.
   - I compared the average values of silicon, sulphur, PM2.5 and black carbon of each sites and I found that the values in Debrecen were less than the average except the black carbon which was a little bit over average.
   - The winter and summer ratio of PM2.5 at each site was determined, and I found that Debrecen had about average value.
   - I analyzed the summer and winter variation of chlorine and the dependence of the measured concentrations on the distance from the ocean. I found that the summer and winter values were one of the smallest in Debrecen due to the large distance from the ocean.
   - The Si/Al ratios and the difference from the world average value were determined. I found that its value in Debrecen was a bit under average.
3. Coarse and fine aerosol samples were collected in the frame of an NRDP project from 21 July to 3 August 2003 in three places simultaneously (Debrecen, Budapest and K-puszta) with two-stage Gent-type samplers.
   - The silicon, calcium, titanium and iron, as natural elements, appeared in the largest concentrations in Budapest in both fractions. In Debrecen and K-puszta I measured much less values, and the concentrations in Debrecen were only a little bit higher than in K-puszta.

- I found that the concentrations of anthropogenic elements, as sulphur, potassium, copper, zinc and lead, were also the largest in Budapest, and in Debrecen and K-puszta were nearly the same. In the fine fraction I measured the largest concentrations of copper, zinc and lead in Budapest and the smallest in Debrecen and in the case of the sulphur and potassium the largest average concentrations in K-puszta was detected while the smallest in Debrecen.
- In the case of chlorine in the coarse fraction the concentration was the largest in Budapest and the smallest in Debrecen.

4. Aerosol samples with high size resolution were collected in the frame of the NRDP project from 21 July to 3 August 2003 in two sites simultaneously (Budapest and K-puszta) with 7-stage cascade impactors.
   - I showed that calcium, titanium and iron, i.e. the natural elements, had larger concentrations in Budapest than in K-puszta, because these aerosol particles were not able to deposit in towns due to the continuous heavy traffic.
   - I explained the strange behavior of the silicon with weather conditions. From 21 to 28 July the weather was hot and dry in K-puszta. From 29 July began a period of thunder storms with large amount of precipitation. In this time the concentration in the 0,25-0,5 μm and the 16 μm+ size ranges were less than in the dry period because of the wash out due to the rain. In the other size ranges the concentrations were much higher in Budapest than in K-puszta.
   - The concentration of chlorine, zinc and lead, i.e. most of the anthropogenic elements, were larger in Budapest than in K-puszta in the most cases.
   - Sulphur was found in higher concentration in K-puszta than in Budapest in most size ranges. This was explained that these secondary sulphate

aerosol particles originated from regional transport, since the time needed for formation can be 1-2 days, and they travel large distances before deposition.

5. In the Stochastic Lung Model I developed three Asthma Models applying the Bronchial Asthma Factor (BAF), as a new variable, which determines the rate of the contraction of the airways comparing to the healthy ones in the tracheo-bronchial region:
   - Asthma Model I: one BAF value has to be given which is valid for the whole tracheo-bronchial region.
   - Asthma Model II: for each tracheo-bronchial generation a BAF value has to be given, which means 21 independent data.
   - Asthma Model III: a range of BAF values has to be specified for each generation and the code selects randomly a value considering the given correlation factor.
6. I compared the three Asthma Models and made the following statements:
   - I didn't find significant differences between the three Asthma Models, except in the case of the fourth class patients.
   - I investigated the differences of the deposition probabilities between males and females. I found the biggest differences in the cases of the health and I-II classes, while in the III class the smallest.
   - I studied the deposition probabilities in the function of generation number for particle sizes and demonstrated that in the most cases the maximum were at generation 12 in the tracheo-bronchial and at generation 21 in the acinar region.
7. I have grouped the investigated elements according to their size distribution and compared the groups according to their deposition rates in the acinar and the tracheo-bronchial region using the Stochastic Lung Model. The natural origin elements like iron, silicon and calcium, were found in 2-8 μm size

range with the largest rate, and had the largest probability of the deposition in the tracheo-bronchial region, especially at the case of asthma patients. The anthropogenic elements, like sulphur and lead, were found in the 0,25-2 μm size range with the highest frequency, and deposited in acinar region with the biggest probability.