

Chapter 5

Evaluation of study

In this chapter, the project is evaluated by considering the successes and shortcomings encountered for each objective of this investigation (Par. 5.1). In Par. 5.2, several future recommendations, drawn from the results, are suggested.

5.1. Project evaluation

The results from Chapter 4 are discussed in relation to the project objectives from Chapter 1.

Objective I: Measure atmospheric gaseous species, i.e. SO₂, NO₂, O₃, CO and particulate matter (PM₁₀) at a monitoring station in the western Bushveld Igneous Complex for at least a full seasonal cycle.

Data was collected for two years, three months and nine days, therefore for more than two full season cycles. Weekly visits to the monitoring site facilitated optimal instrument operation and data collection. For all the species monitored, data coverage of more than 85% was achieved for the sampling period, except for NO₂, which had 59% coverage.

Objective II: Process high resolution data obtained from atmospheric measurements for the entire sampling period.

The four gas analysers and the general meteorological systems generated data for every minute. Aerosol mass concentrations and light absorption properties were logged every two minutes. This high resolution data was processed into 15 minute averaged data, by fit-for-purpose in-house Matlab programmes (written in collaboration with co-workers from the University of Helsinki). During this processing, automated calibration corrections were done and periods containing data of high uncertainty with regard to data quality (e.g. during maintenance and recovery periods after power outages) were rejected.

Objective III: Compare ambient concentrations of the measured species to current national and European air quality standards and assess the status quo of air quality in the western Bushveld Igneous Complex.

The comparison between the measured concentrations and national, as well as international standards showed that most measured species levels were within legislative limits, except for ozone and particulate matter that frequently exceeded the standards. O₃ exceeded the eight-hour moving average standard of 61ppb on average 322 times per year. The main contributing factor was identified to be high concentrations of O₃ precursor species from regional sources. This problem can only be solved by reducing the regional sources of O₃ precursors (e.g. NO₂ and CO). PM₁₀ exceeded the current South African 24-hour standard of 120µg/m³ 6.6 times per year, while the future 2015 standard of 75µg/m³ was exceeded 42.3 times per year. The European 24-hour standard of 50µg/m³ was exceeded 120.2 times per year. The main source of PM₁₀ was identified as local household combustion. This can only be rectified by socio-economic upliftment of low-income groups.

Objective IV: Determine the seasonal and diurnal trends for the atmospheric gaseous species and PM₁₀ measured.

From the results of the inorganic gaseous species, seasonal and diurnal trends were successfully obtained for NO₂, SO₂, O₃, CO, BC and PM₁₀. Nitrogen dioxide, SO₂, CO, BC and PM₁₀ concentrations were highest during winter and ozone peaked during spring. Diurnal trends were also composed for all measured species. SO₂ concentrations peaked once per day during the mornings (07:30-10:00). NO₂, CO, PM₁₀ and BC exhibited bimodal diurnal peaks. The first peak occurred between 06:00 and 10:00, while a second peak was observed between 17:00 and 22:00. As expected, O₃ peaked during daytime, while solar radiation peaked at approximately 13:00, which preceded the O₃ peak that occurred between 14:00 and 16:00.

Objective V – correlate the atmospheric concentrations of the species measured to possible sources in the region

The major contributing sources could be identified as high-stack industry emissions for SO₂ and household combustion for NO₂, CO and PM₁₀. For O₃, the main contributing factor was identified to be regional sources, with high O₃ precursor species concentration.

5.2. *Future perspectives*

Three recommendations with regard to possible studies in future are suggested:

- During the 2008 sampling period, several scheduled municipal wide power outages occurred (load shedding). Load shedding particularly occurred during the winter months to compensate for the increase in electrical demand. This, in turn, forced an increase in household combustion (cooking and space heating). A study focussing specifically on the effect of load shedding on air quality would most certainly be interesting and relevant within the South African context.
- Further papers and studies describing the effects of O₃ and PM on health in the western BIC would be very relevant, as these two species frequently exceeded legislative values.
- Only a small fraction of the data collected during the measurement campaign was presented in this study. Several other measurements were taken, e.g. particle formation, optical properties of aerosols, etc. Additional research on these measurements and their effects on RF would help to reduce the uncertainty with regard to climate change's relevant parameters over southern Africa.