# THE COMPILATION OF A REGIONAL EMISSIONS INVENTORY – PROGRESS TOWARDS REGIONAL SCIENTIFIC CO-OPERATION

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## SUMMARY

*The southern African region shares a common air mass that may circulate over the sub-continent for several days. Air pollutants emitted from various sources accumulate and travel across national boundaries before moving out over the oceans. The transboundary movement of pollutants is an area of growing concern, particularly in developing countries. In order to develop appropriate policies and protocols to address cross-border pollution, policy-makers need good quality information at the appropriate scale.*

*The Air Pollution Information Network – Africa (APINA) aims to link the scientific and policy development communities concerned with transboundary air pollution. Recently a group of scientists and researchers from Malawi, Mozambique, Botswana, South Africa, Zimbabwe and Zambia met to exchange information on national emissions and to compile a regional emissions inventory. The inventory will be used to link country emissions from various sources with atmospheric measurements conducted in the SAFARI 2000 campaign. Once the extent and impact of transboundary air pollution is properly understood, fair and appropriate regional policies to promote economic growth and reduce environmental damage, can be developed*

*The participating scientists not only shared information, but also developed a common understanding of the methodologies, and shared a commitment to maintain the inventory as new information becomes available. Such international collaboration is essential when addressing regional scale issues such as air pollution, and can be successfully achieved through informal working groups.*

## 1. INTRODUCTION

The compilation of an emissions inventory for the southern African region has been identified as an urgent need from two significant perspectives.

The first motivation for a regional inventory has been the recognition of the possible transboundary effects of air pollution, which was highlighted at the Policy Dialogue meeting held in Harare in September of 1998[1]. The meeting was convened by the Air Pollution Information Network – Africa (APINA) under the auspices of the Southern African Development Community – Environment and Land Management Sector (SADC-ELMS). Policy-makers and representatives from industrial, research and scientific communities focussed on the problem of regional and transboundary air pollution in Africa, with a focus on the southern African region. The output of the meeting was the "Harare Resolution on the Prevention and Control of Regional Air Pollution in Southern Africa and its Transboundary Effects". The need for a regional protocol on air pollution was emphasized, and will most likely be addressed in the "Environmental Charter for the SADC region" which is currently being developed by SADC-ELMS in conjunction with UNEP. Inherent in the call for a regional protocol on transboundary pollution is the realisation that policy development requires accurate scientific information as a basis[2].

The second driver is a call from the scientific community involved in the

Southern Africa Regional Science Initiative - SAFARI 2000. The SAFARI campaign in 1992 demonstrated the existence of a unique meteorological phenomenon over southern Africa – a persistent high pressure system which causes a large-scale counter clockwise closed circulation pattern extending almost to the equator. Polluting emissions are thus not readily dispersed and can accumulate for up to two weeks [3,4]. Emission sources include anthropogenic sources such as industry and biomass burning, and natural biogenic emissions. The SAFARI 2000 experiment aims to characterise, quantify and validate the estimates of regional emissions by capitalising on the unique closed circulation system, and so to gain a better understanding of the interaction between terrestrial and atmospheric processes[5,6].

## 2. LINKING SCIENCE & POLICY

The European experience with transboundary air pollution led to international policy negotiations and the Convention on Long-Range Transboundary Air Pollution (LRTAP). Collaborative research at an international level formed the foundation on which the policy negotiations and Convention were built. The economic growth of developing countries is recognised as essential, but growth should be stimulated without leading to environmental degradation and the subsequent costs of remediation. Instead lessons learned in the industrialised world may be applied and modified to suit both the economic and environmental needs of developing countries.

The programme on Regional Air Pollution in Developing Countries (RAPIDC) supports both scientific collaboration and policy discussions in developing countries. The programme is currently funded by the Swedish International Development Co-operation Agency (Sida) and co-ordinated by the Stockholm Environment Institute (SEI). Three subregions are presently targeted – the Mercosur countries of Latin America, South Asia and the Southern African Development Community (SADC)[7]. The interaction between science and policy development for the South Asia region is illustrated in Figure 1, and could be similarly applied to the SADC countries. This paper focuses on the SADC region and how international co-operation drives the need for scientific information.

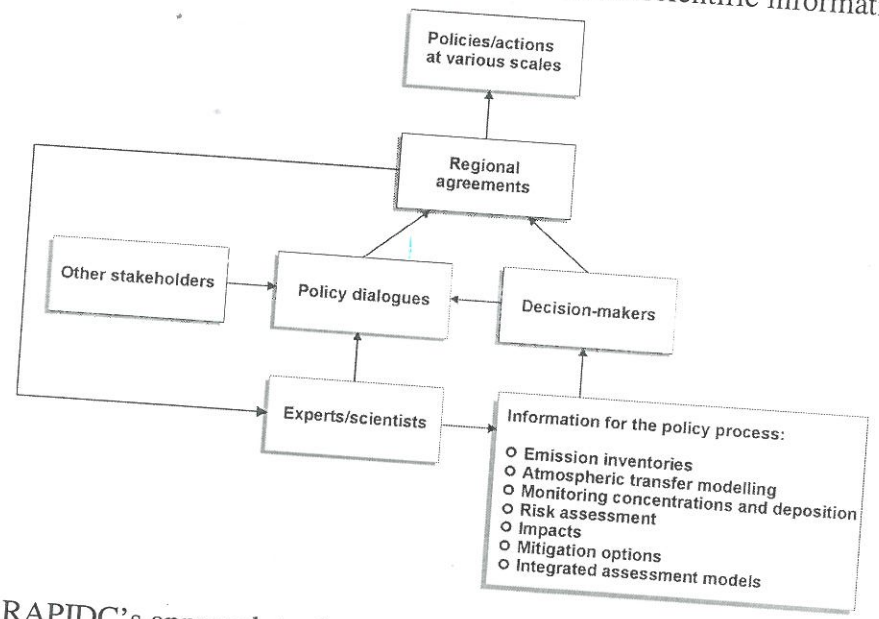


Figure 1: RAPIDC's approach to developing regional co-operation on air pollution control in the South Asia region[7].

The availability of scientific information that illustrates the extent and nature of air pollution impacts is an important driving force in regional co-operation. Monitoring and quantification of pollution levels, together with emission inventories and dispersion modelling allows pollution sources to be identified where mitigation will improve air quality.

## 3. NETWORKS

The electronic age has allowed scientists and researchers access to an enormous host of organisations and individuals operating within a discipline. The RAPIDC programme catalysed the formation of APINA, the Air Pollution Information Network – Africa. Similar networks exist in Latin America (APINLA) and South Asia (APINAP). APINA is a network of scientists, researchers, industrial representatives and policy-makers which aims to link the scientific and policy-development communities concerned with air pollution and its effects. APINA has recently gained official recognition by SADC-ELMS as an important source of regionally relevant information to feed the policy –development process. The regional co-ordinator for APINA is Dr Stephen Simukanga at the Zambia School of Mines, University of Zambia, while the APINA secretariat is currently hosted by the Institute for Environmental Studies (IES) of the University of Zimbabwe.

With the benefit of its regional perspectives the APINA network is well positioned to identify and bridge the needs of both the scientific community and policy-makers in the region[2].

## 4. APPROACH

Based on the requirements of both the policy development and scientific communities, APINA initiated a workshop to compile a regional emissions inventory. Considerable information has already been compiled for greenhouse gases in southern Africa for the 1990 National Emissions Inventories for the United Nations Framework Convention on Climate Change. These data would be used as the basis for the regional inventory and would contribute to a spatial inventory model for Africa south of the equator. Although information for South Africa was included, inputs from other southern African countries were lacking[8].

APINA contacts in Botswana, Malawi, Mozambique, South Africa, Zambia and Zimbabwe were thus approached and invited to send suitable representatives to the workshop. A comprehensive list of information requirements for the inventory was distributed prior to the workshop. Sectors detailed in the inventory followed those of the Intergovernmental Panel on Climate Change (IPCC) guidelines[9] (Tables 1 and 2). Temporal driver data were requested in order to extrapolate information from 1990 to the period 1999-2001, when the atmospheric constituents over southern Africa will be measured in the SAFARI 2000 experiment. Data in any format would be acceptable but spatial data in ArcInfo coverages, GRIDs or shapefiles were preferred

Table 1: Emission sectors according to the IPCC guidelines.

| | | |
|---|---|---|
| Energy | Fuel combustion | Energy industries |
| | | Manufacturing industries |
| | | Transport |
| | | Other sectors (where fuel combustion sources were not included above) |
| | | Other (mining) |
| | Fugitive emissions from fuels | Solid fuels (such as charcoal production and coal mining) |
| | | Oil and natural gas (mainly petroleum refining) |
| Industrial processes | Mineral products | Non-energy related emissions |
| | Chemical industry | Non-energy related emissions |
| | Metal production | Non-energy related emissions |
| | Other production | Non-energy related emissions |
| Solvent and other product use | | Mainly volatile emissions |

Table 2: Information requirements for the regional emissions inventory

| Emissions data | Temporal driver data | Spatial driver data – prefer GIS - vector or raster coordinates on a 20km grid. |
|---|---|---|
| 1990 country totals for $CO_2$, $CH_4$, $N_20$, NOx, CO, NMVOC, particulates and $SO_2$ for the IPCC defined sectors<br><br>Other emissions inventory, modelled or measured emissions data from the same or later years. This can be used to fill in the gaps and to test forecasts and spatial disaggregation based on the 1990 inventory.<br><br>Emissions defined according to IPCC methodology and units<br><br>Local/project specific air pollution studies or measurements | Annual rates of changes in emissions (per emission species) per sector. This takes into account economic growth and the effects of emission reduction controls.<br><br>Inter-annual fluctuations ie monthly/seasonal distribution of economic activity or emission production per sector | Transport (roads, railways, road type / status, traffic volumes, fuel sales per unit area, off-road / construction data).<br><br>Energy (fossil-fuel power stations, and their generating capacity)<br><br>Industry (locations, processes and / or the types and quantities of their emissions)<br><br>Mines (location of mines and the types and quantities of their emissions)<br><br>Fuel (locations of oil wells, refineries, filling stations, types and quantities of emissions)<br><br>Biomass burning (population density, data on domestic biofuel consumption rates, settlement type (rural or urban)) |

## 5. REGIONAL WORKSHOP

The primary goal of the workshop was to compile an emissions inventory for countries in the southern African sub-region, using the GHG country studies for 1990. In addition workshop participants would gain a shared understanding of the methodologies and assumptions employed in compiling the information, which would ensure comparison in the future. Finally, by contributing information of considerable import to the SAFARI 2000 project, the workshop participants would ultimately gain access to all the data from the SAFARI 2000 experiment.

In all, six SADC countries (Zimbabwe, Zambia, South Africa, Mozambique, Malawi and Botswana) were represented at the workshop that was held from 17 to 19 July 2000 in Pretoria. Greenhouse gas inventories for 1990 were included for all the participating countries except Malawi and Zambia. Zambia has since supplied their IPCC greenhouse gas inventory summary for 1990 and 1994.

Some countries included sulphur dioxide emissions in their inventories, for example, Zambia and South Africa. For those that did not, information on sulphur dioxide emissions was based on the 1995 SADC report on sulphur emissions[10]. Where more accurate information exists for a country, this was included.

Annual changes in all emissions were based on sectoral contributions to gross domestic product (GDP), the country representative's knowledge, and other information where available (for example if a power station closed down, or if a new industry had been built since 1990). These annual rates of change will enable a more accurate extrapolation of the emissions information from 1990 to 1999/2001.

A first attempt at estimating intra-annual (monthly) changes was also performed for each country. For each gas species in each sector it was assumed that emission rates

were unchanged from month to month unless we could find evidence to the contrary or there was specific information on the timing and extent of monthly or seasonal variation. For example, fuel use increases in the winter months in the more southern countries.

Workshop participants surveyed the data used in the spatial model for disaggregating the emissions from the inventories and corrections were noted. Requirements for more detailed 'spatial driver' data included better population and road traffic data for most countries.

## 6. WORKSHOP OUTPUTS

An Excel spreadsheet with aggregated emissions information for the southern African region – which will be distributed to all participants for maintenance and updating of their country's information. The master copy can be temporarily housed at CSIR, until a suitable alternative is arranged.

Input data, the spatial disaggregation model (ArcInfo AML) and outputs will be distributed to workshop participants on CD ROM and will constitute the scientific output of the workshop.

Graphical outputs from the spatial disaggregation model will be accessible from the APINA website. An example is shown in Figure 2.

A metadatabase of available information for each country was compiled.

Improved information on local emissions information was obtained such as validation of industrial emissions and the addition of road networks. Detailed roads data were obtained from Zimbabwe. The USAID database for Zimbabwe and Zambia was also obtained but it has been difficult to access the data therein.

The workshop served to strengthen networks between participants and encouraged a mutually beneficial understanding of science needs in the region. In addition participants shared their learning regarding the use of emission inventory data and the process of producing a spatial emissions inventory.

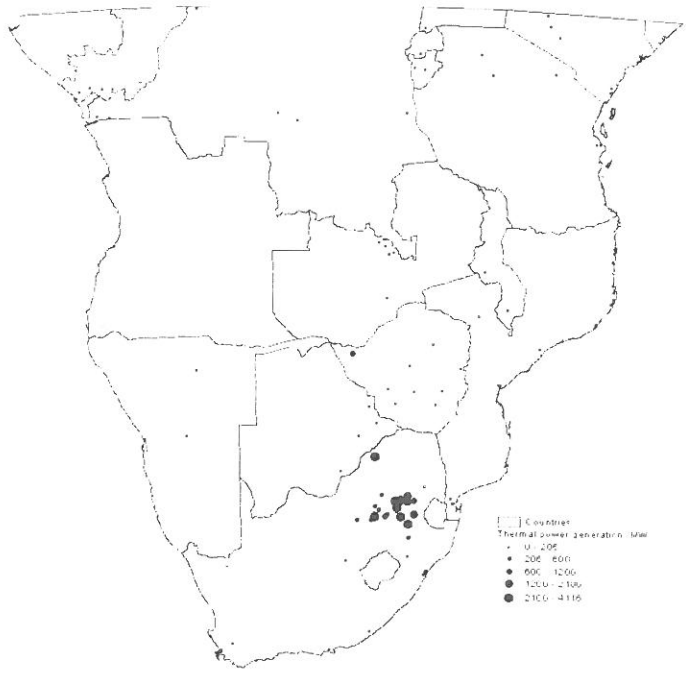

Figure 2: Map showing thermal power emission sources, classified by energy production capacity[8]. This map will be updated with corrections derived during the workshop.

## 7. CONCLUSIONS

The success of the regional workshop demonstrated the effectiveness of the APINA network and the willingness of members to participate in a regional initiative. The regional inventory data represents a milestone in what is hoped will be one of many more collaborative science projects that will ultimately contribute to effective and relevant policies on transboundary air pollution in the region. The inventory information, spatial drivers, inter- and intra-annual changes are all open to improvement and more robust description which will develop as the collaborations strengthen.

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