AIR POLLUTION : IMPLICATIONS FOR AGRICULTURE AND THE ENVIRONMENT

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1. INTRODUCTION

There has during recent times been a growing concern that the world's natural resources (eg air, soil and water) would become over-exploited because of the ever increasing world population. Fears have been expressed that as development pressures mount with time, the world's existing bio-reserves and protected areas might eventually be capable of preserving only a small number of endangered species of fauna and flora.

Because air, like soil and water, is a natural resource it needs to be managed as such. It supports almost all forms of terrestrial life; two-thirds of all biological species, including man, depend on it. The quality of ambient air has an impact on a variety of economically important processes. Unhealthy air can reduce human production potential as well as plant productivity, resulting in crop and timber losses. Damage costs due to air pollution are estimated to be a few per cent of the gross national product of industrialized countries.

This paper will first reflect upon continental and global scale environmental impacts of air pollution and then discuss the air pollution situation in the RSA and, in particular, its implications for local agriculture. Finally, measures will be outlined for ensuring an acceptable quality of air as well as the sustained use of air as a natural resource.

2. CONTINENTAL AND GLOBAL SCALE ENVIRONMENTAL IMPACTS OF AIR POLLUTION

For many decades, air pollution was generally considered as a local problem, closely associated with man's industrial activities and urban living patterns. Because of the rapidly growing world population and expansion of industrial development it has now become a global problem.

Currently there is general concern that pollution of the air due to man's activities can cause detrimental effects and changes to the environment on continental and global scales. One such effect, the 'greenhouse' effect, resulting from the build-up of carbon dioxide and trace substances ('freons', N_2O and methane) in the atmosphere due to combustion, is predicted to cause climatic changes which will have world-wide implications for food production. It is also expected, that the heating of the world's atmosphere will cause the ice-caps at the poles to melt and ocean levels to rise with attendant detrimental affects on the ecology and economy of coastal zones.

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A second effect, the partial destruction of the stratospheric ozone layer by aerosol propellants, is expected to cause an increased ultra-violet radiation at the earth's surface with resulting adverse effects on man and the environment. The recent discovery of a 'hole' in the atmospheric ozone layer over the South Pole has renewed scientific and public interest in this issue.

A third effect, acid precipitation ('acid rain'), is claimed to have already caused extensive damage to forests and natural vegetation in countries like Europe and the USA.

A fourth effect which has lately also become a cause for concern is the global climatic impact that might result from the large injections of smoke and dust particles into the upper atmosphere following a nuclear war. According to predictions this would result in vast areas being subjected to several months of darkness, subfreezing temperatures and toxic smog which would lead to the loss of crops and the extinction of many species in the food chain.

Finally, the recent nuclear explosion incident at Chernobyl (USSR) has clearly demonstrated how, within a matter of a few days, the cloud of radioactive material spread across the entire European continent. The real impacts of this incident on the inhabitants and the environment will be revealed only in time to come.

It is therefore evident from the above examples that air pollutants do not know boundaries and that man through his activities can indeed cause profound effects on climate and the environment.

3. THE AIR POLLUTION SITUATION IN THE RSA

In common with many other countries, the RSA is experiencing air pollution problems. Because of local meteorological conditions and topographical features, the greater part of the country is characterized by an inherently poor potential for the dispersion of air pollutants. This is manifested by the visible air pollution occurring in highly industrialized areas such as the Witwatersrand, the Vaal Triangle and the Eastern Transvaal Highveld regions.

Furthermore, because the RSA is a fast developing country there will be a continued demand for the generation of energy. However, the generation and consumption of energy are unfortunately accompanied by the production of air pollution. Consequently, as the gross national product (GNP) per capita increases, so the energy consumption and hence air pollution production will increase. Moreover, the energy consumption/GNP relationship indicates that the RSA has a relatively high energy consumption to GNP ratio and hence a relatively high air pollution production to GNP ratio.

3.1 South African cities and towns

With regard to actual air pollution levels occurring in South African cities and towns there are indications that these are rising, and for some pollutants do occasionally exceed internationally accepted air quality standards. The present situation will now be outlined in brief for the most important types of pollutants. These all have implications for human health, and the environment.

Smoke and sulphur dioxide: Smoke and sulphur dioxide arise mainly from the combustion of coal. The concentrations of these pollutants in urban areas which have shown steadily decreasing trends due to effective control measures are now levelling out and in some cases are beginning to show a tendency to increase. It is quite possible that the best possible improvements in air quality have already been achieved with the current control measures. Sulphur dioxide concentrations are within acceptable air quality limits but smoke concentrations are at present a cause for concern in black townships. This is because old smokey stoves and braziers are still being used for spatial heating purposes despite the implementation of a large-scale electrification programme.

Trace elements: Trace or metallic elements such as aluminium, copper, cadmium, chromium, iron, magnesium, mangenese, nickel, lead, vanadium and zinc arise from the combustion of coal as well as from metallurgic industries. However motor vehicles are major sources of lead in urban atmospheres.

The concentrations of trace elements so far found in urban and industrial areas are comparable to those encountered in most large urban and industrial centres of the world. However, relatively high concentrations of lead have been recorded in the coastal cities of Cape Town and Port Elizabeth but it is expected that these will drop because of the recent reduction in the lead content of petrol.

Traffic pollutants: Motor vehicles are the primary sources of carbon monoxide, hydro-

carbons and oxides of nitrogen in urban centres, moreover, hydrocarbons and nitrogen oxides are known to be the precursors of photochemical smog which consists of substances as ozone, aldehydes and PAN.

Rising concentrations of nitrogen oxides and ozone have been recorded over a number of years in the larger cities. It has also been found that ozone concentrations in Cape Town and Johannesburg did occasionally exceed the accepted international air quality standards. moreover, it should be noted that the potential for photochemical smog formation has been enhanced by the recent addition of alcohol mixtures to petrol sold and used in the RSA. This has, in fact, been reflected by measurements of elevated levels of aldehydes in the air of those cities where motor fuels contain alcohol.

In view of the current findings there are grounds for some degree of concern regarding traffic pollutants and these will have to be monitored closely in future to establish when the introduction of control measures are warranted.

Volatile organic substances: Volatile organic substances are released by various industrial processes as well as by motor vehicles.

Surveys conducted thusfar have revealed the great complexity of organic substances occurring in the air of South African urban and industrial centres. Although no 'unexpected' substances have as yet been detected there does appear to be an increase in the complexity of organic substances present in South African air. This is probably due to the increasing diversity and sophistication of industries in the RSA. Consequently, volatile organics should be monitored regularly in future so that the required control measures could be introduced in time.

Pesticides: Pesticides are used in many agricultural and forested parts of the world. Application by aircraft spraying is quite common. However, pesticides are potentially toxic to humans and their injudicious application can cause extensive damage to agricultural crops.

A number of pesticides (chlorinated hydrocarbon insecticides and organophosphate insecticides) have been measured in the air of several urban and agricultural regions, ie Pretoria, Delmas, Groblersdal, Marble Hall, Rust de Winter Nature Reserve, Barberton, Nelspruit and Tzaneen. In all cases concentrations were well below the air quality standards. However, it was found at that the exposure of workers who handled and applied these pesticides sometimes exceeded permissible limits. This finding accentuated the importance that workers in the agricultural sector should wear adequate protective clothing and appropriate gas masks when handling and applying pesticides.

3.2 The Eastern Transvaal Highveld

A comprehensive research programme is being carried out in the Eastern Transvaal Highveld to assess the air pollution situation and its impacts in this area. Here some 80 per cent of the country's electrical power is generated and also important agricultural activities exist. Besides power stations there are various large and small industries, smouldering coal dumps, domestic cooking and interior heating as well as veld burning which all are important sources of atmospheric pollution.

Results obtained up to now indicate that ground level concentrations of sulphur dioxide were usually, but not always, below air quality standards. Also, indications of acid deposition ('acid rain') have been found but more extensive observations are needed to confirm this finding.

3.3 Background air pollution

The knowledge of air pollution levels and trends as observed in areas remote from human activity is essential to aid in prediction of the impact of man's activity on global climate and hence on agricultural activities.

A number of trace gases (carbon monoxide, methane, ozone, N_2O, F_{11} and carbon tetrachloride) that might be causing climatic changes are being monitored at a specially equipped station situated at Cape Point.

Invaluable information on the levels and trends of the above-mentioned trace gases have already been acquired over a number of years. It has, for example, been found that halocarbons (F_{11} and carbon tetrachloride) have maintained steadily increasing annual growth rates over the past seven years in the Southern Hemisphere. This information will further the understanding of atmospheric chemical processes and the impacts thereof on the global climate and environment.

4. AIR POLLUTION INDUCED INJURY TO AGRICULTURAL CROPS IN THE RSA

It is important to point out that, in carrying out investigations on air pollution induced inury to agricultural crops, certain of the pollutant induced symptoms may be similar to those caused by diseases, insects, mineral deficiences, environmental stresses (heat, cold, drought) senescence and other agents (pesticides). Consequently, due cognizance should be taken of these pitfalls when diagnosing the causes of crop injury. Moreover, it is of relevance to mention that the nature, composition and treatment of soil also play an important role in the susceptibility of agricultural crops to air pollution.

Only a few cases of air pollution induced injury to agricultural crops have so far been recorded in the RSA. These incidents usually occurred in relatively small areas and in the close vicinity of the relevant sources. Steps were taken where it was deemed necessary to ensure the application of more efficient control measures. In addition, a number of detailed investigations on the impact of air pollution on various types of vegetation and agricultural crops have been made. A discussion of these incidents and investigations is presented below according to geographical regions.

4.1 Transvaal

A metallurgical industry, situated near the Bon Accord Dam north of Pretoria, caused noticeable injury to vegetables which were grown in its vicinity. Fortunately, this industry is no longer being operated.

Reports have been received of air pollution induced injury to sub-tropical crops being grown near Nelspruit. This resulted from dust emissions from a nearby metallurgical industry. A consented effort was made to improve the control measures which were originally applied by this industry.

A comprehensive investigation is being carried out in the Eastern Transvaal Highveld (see section 3.2) to assess the impact of air pollution in this area on, inter alia, agricultural crops, forest species as well as on the biota and chemical components in water streams. It is envisaged that the rich variety of lichen species occurring in this area could be used to detect early signs of environmental stress. No clear evidence of air pollution impacts has so far been detected in the Eastern Transvaal Highveld or its neighbouring regions. It is, however, of interest to point out that during the past two growing seasons there appeared to have been a more wide spread yellowing of pine needles, but no attempt has as yet been made to quantify this observation.

4.2 Orange Free State

A few years ago injury caused by fluorides has been reported to occur in pine trees, grapes and garden plants grown in the town of Sasolburg. A fluoride monitoring system had been set up as a result of a collaborative effort between the various industries concerned and it is still being maintained. The purpose of this action was to monitor the ambient air fluoride concentrations with the ultimate aim of assessing the efficiency of existing control measures applied by these industries. It was found that the measures at the fertilizer industries had to be improved. The position was rectified and since then, no complaints of injury have been received.

4.3 Natal

A case study was conducted to establish the effect of fluoride on sugar cane at levels which were expected to occur in the neighbourhood of a to-be-erected aluminium smelter at Richards Bay. The objective was to assess the efficiency of the proposed control measures. This study was conducted on sugar cane grown in a well-ventilated greenhouse wherein different levels of fluoride were generated. It could, inter alia, be demonstrated that sugar cane was quite resistant to fluoride induced foliar injury, particularly at levels that could be expected in the environment of the planned aluminium smelter.

Subsequent to the erection and commissioning of the aluminium smelter a monitoring system had been established by the staff of the smelter to determine the fluoride concentrations in the air, sugar cane, pine tree needles, bluegum tree leaves, grass, surface water and milk within a 25 km radius of the smelter. The findings are regularly reported to the central control authority, the Department of National Health and Population Development. Up to now, the emissions from the smelter have been in accordance with the set limits and no complaints or symptoms relating to plant or crop injury have been received or recorded.

4.4 Western Cape

Complaints by farmers that pollution had induced injury to decidious fruits (grapes,

peaches and apples) in the Somerset West area lead to an investigation by the Fruit and Fruit Technology Research Institute. It could be proved that the reported injury had been caused by emissions from a nearby fertilizer factory which was consequently requested to improve its control measures.

A study has recently been initiated to assess the effects of air pollutants on plants and agricultural crops in the Western Cape. This study will also aim to develop a suitable bio-indicator system whereby the extent of air pollution can be estimated within the Western Cape region. Preliminary results obtained thus-far indicated some fluoride injury to garden plants and trees growing in the vicinity of certain industries. Further investigations are, however, required to confirm these findings before any steps can be taken.

5. MEASURES FOR ENSURING AN ACCEPTABLE QUALITY OF AIR

As already mentioned, air should be regarded as a natural resource and therefore needs to be managed as such because of its environmental, economic and social importance. It is therefore imperative that a sound policy be adapted to ensure that the quality of air will remain acceptable and that the sustained use of air as a natural source will be guaranteed.

A strategy to obtain these objectives should embrace the following measures:

- Formulation and enforcement of a uniform policy by way of suitable legislation to control emissions of air pollutants.
- Ensuring that pollution sources are taken into consideration in landuse planning to cause the least possible effects to public health and the environment.
- Setting standards for permissible emissions of all kinds and continually reviewing these standards.
- Supporting the continued monitoring of pollution sources and ambient air in order to determine whether the standards for emissions are being met and whether they are realistic in terms of adequately protecting public health and the environment.
- Undertaking research to adequately evaluate the influences of air pollutants on the environment in view of the high costs of pollution control measures.
- Training adequate manpower to ensure the provision of back-up research and technological capabilities which are essential towards aiding the formulation and implementation of realistic air pollution control strategies.
- Informing and educating the general public regarding the progress and successes achieved with the implementation of control measures in order to obtain their collaboration.

6. CONCLUSION

This paper has firstly served to demonstrate that air pollution does not know boundaries and consequently causes impacts on local, continental and global scales which can have serious implications for man and his environment.

Secondly, it has been shown that air should be regarded as a natural resource and therefore be managed as such. This calls for realistic and effective measures to guarantee its sustained use as a natural resource and to ensure that its quality remain acceptable.

Finally, with regard to the RSA as well as its neighbouring countries it is imperative, on the one hand, that a continued monitoring of air pollution levels in important areas be maintained and, on the other hand, that plants and crops in the main agricultural regions be regularly observed for possible injury by air pollutants. This approach will allow timely decisions regarding control-measures to be made in order to ensure adequate protection of the inhabitants, the agriculture and the environment of these countries.

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