SCIENCE & TECHNOLOGY IN SOCIETY

3

SATIS

ABOUT SATIS

Science and Technology in Society units are designed to be used in conjunction with conventional science courses, particularly those leading to GCSE examinations. Each unit has links to major science topics as well as exploring important social and technological applications and issues.

The units are self-contained and generally require about 2 periods (around 75 minutes) of classroom time. Each unit comprises Teachers' Notes (blue sheets) and Students' materials (white sheets). Full guidance on use is given in the Teachers' Notes accompanying each unit, which also include background information and suggest further resources.

Each SATIS book contains ten units. The units are numbered in a system giving the number of the book followed by the number of the unit within that book. Thus the first unit in the first SATIS book is numbered 101.

In addition to the SATIS books, a general Teacher's Guide to the project is available, giving guidance on some of the teaching techniques involved as well as ideas for further activities.

Many people from schools, universities, industry and the professions have contributed to the writing, development and trials of the SATIS project. A full list of contributors appears in the Teachers' Guide.

First published 1986 by The Association for Science Education

Designed by P&PS (Cambridge) Ltd. Tel: (0353) 740389

SATIS 3

List of units in this book

List of units in the SATIS series

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Air Pollution — where does it come from?

Contents: A data-analysis exercise concerning sources of air pollution.

Time: 2 periods or more, depending on amount of discussion.

Intended use: GCSE Chemistry, Biology and Integrated Science. Links with work on air pollution, its chemical sources and biological effects. *Note:* extra resources will need to be made available for students to find out the effects of the various pollutants, if this has not been covered in prior lessons.

Aims:

- To complement work on air pollution
- To show the sources of different air pollutants and compare their production by natural and human sources
- To develop awareness that pollutants vary widely in the magnitude of their production and the severity of their effects
- To provide opportunities to practise skills in the analysis and presentation of data.

Requirements: Students' worksheets No. 301. Resources to enable students to find out effects of pollutants (see below).

Notes on some of the questions

Qs. 1 and 2 In school trials it was found that many students had difficulty plotting the bar charts, particularly choosing the right scale. In this revised version of the unit, the job has been made simpler by supplying the axes in Figure 2. However, with able students teachers may prefer to leave the whole job to them, and simply give the students graph paper.

There is no mention in Tables 1 and 2 of carbon dioxide, though it can in some ways be classed as a pollutant because of the 'greenhouse effect'. Teachers may wish to mention this.

Q.3 Sulphur dioxide appears to be the pollutant that is mainly due to human activities. However, it should be noted that hydrogen sulphide is eventually converted to sulphur dioxide in the atmosphere, and this makes the natural and human-made figures for this pollutant of comparable magnitude. Even so, sulphur dioxide still stands out as the major human-made pollutant.

Q.4 Electric power generating stations are the largest source of sulphur dioxide. Its emission can be controlled by using low sulphur fuel or by removing sulphur from fuels before use. This is much more easily done in the case of oil than for coal. The gas can also be removed from flue gases before emission (flue gas desulphurization), though this is expensive.

Q.6 Human-made pollutants upset the natural balance between 'sources' and 'sinks' so that pollutants build up in the atmosphere.

Q.7 The figures in the tables are for the whole world. They take no account of local concentrations of pollutants, which are particularly high in industrial areas.

Q.8 Increasing levels correspond broadly with increasing industrialization in Britain and the accompanying increase in the burning of fossil fuels, particularly coal. The dip in the 1920s and 1930s corresponds to the Depression. The fall since the mid-1960s can be largely attributed to emission control efforts and the increased use of natural gas and other low sulphur fuels, but also to a slowing down of industrial growth.

Further resource materials

Further details of air pollutants, particularly their effects, can be found in a number of standard textbooks — for example:

Chemistry by A. Hunt and A. Sykes (Longman)
Biology for Life by M. B. V. Roberts (Nelson)
Science by Graham Hill and John Holman (Nelson).

More detailed information can be found in, for example:

Air Pollution by W. Strauss and S. J. Mainwaring (Edward Arnold)
'Pollution of the environment' by M. Holdgate, in *Industry: Organization and Obligation*, Science in Society, Book I (Heinemann Educational Books/Association for Science Education).

A useful film on the subject is *The Air my Enemy*, produced by British Gas and available as video or 16mm film. It runs for 25 minutes and can be obtained on free loan from British Gas Film and Video Library, Park Hall Road Trading Estate, London SE21 8EL.

Sources of data

The data in Tables 1 and 2 is taken from W. Strauss and S. J. Mainwaring, *Air Pollution* (Edward Arnold 1984).

The graph showing sulphur dioxide emissions at different dates (Figure 3) is taken from *Acid Deposition in the United Kingdom* (Warren Spring Laboratory 1983).

AIR POLLUTION — Where does it come from?

In this unit you will be looking at the major gases which cause air pollution. What are their sources? How do the amounts produced by humans compare with the amounts of the same gases which are produced naturally?

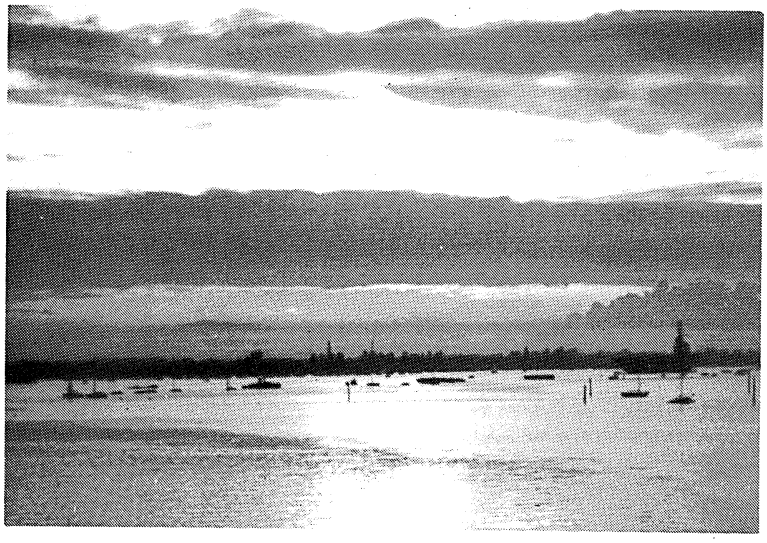

Figure 1 The air looks clean — but is it?

Table 1 shows the sources and amounts of the major air pollutants made by human activities all over the world.

Table 1 Sources of pollutant gases made by humans

Pollutant gas	*Source*	*Amount produced per year throughout the world (millions of tonnes)*
carbon monoxide (CO)	burning of fuels	300
sulphur dioxide (SO_2)	burning of coal and oil, roasting of sulphide ores	146
hydrocarbons	vehicle exhausts, chemical processes	88
nitrogen oxides (NO, NO_2)	vehicle exhausts, burning of fuels	50
ammonia (NH_3)	waste treatment	4
hydrogen sulphide (H_2S)	chemical processes, sewage treatment	3

Table 2 shows the amounts of the same gases made by *natural* sources all over the world. These natural sources have been producing the gases for millions of years.

Table 2 Sources of pollutant gases from natural sources

Gas	*Source*	*Amount produced per year throughout the world (millions of tonnes)*
carbon monoxide (CO)	forest fires, biological processes	3000
sulphur dioxide (SO_2)	volcanoes	9
hydrocarbons	biological processes	1000
nitrogen oxides (NO, NO_2)	bacterial action in soils, electrical storms (lightning flash)	160
ammonia (NH_3)	biological decay	150
hydrogen sulphide (H_2S)	volcanoes and biological decay	65

Questions and activities

1 *Use the figures in Table 2 to plot a bar chart showing the amount of each gas made by natural sources each year. Use the axes on Figure 2 on the next sheet. The bar for carbon monoxide has already been done for you.*

2 *On top of your first bar chart, plot the amounts of each gas from human sources, using Table 1. Show clearly, by colouring or some other method, which is which. The bar for carbon monoxide has already been done for you.*

3 *Compare the values on the bar charts for the different gases. Which pollutant is made much more by human activities than by natural sources?*

4 *In what ways could the emission of this pollutant be controlled so that less is released into the air?*

For millions of years pollutant gases from natural sources have stayed at a steady level in the atmosphere. This is because there are various natural ways that the pollutants get removed from the atmosphere. For example, some of the sulphur dioxide and carbon dioxide are removed from the atmosphere by dissolving in rain.

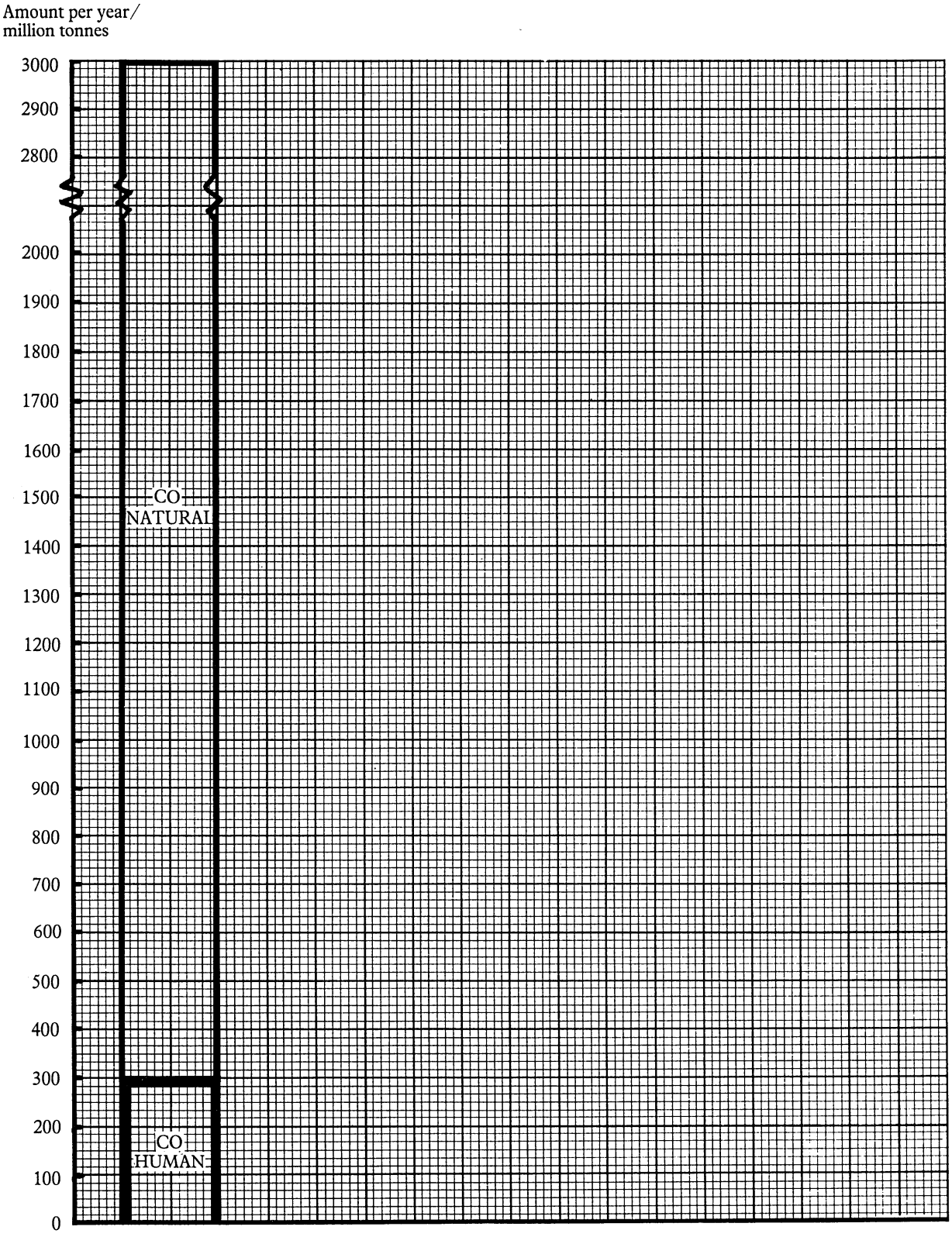

Figure 2 A bar chart showing amounts of different pollutant gases produced per year

Questions

5 *Apart from rainfall, what other process removes carbon dioxide from the atmosphere?*

6 *Even though pollutant gases are removed from the atmosphere naturally, scientists are concerned about adding pollutants made by human activities. Why?*

7 *Judged from the data given in the tables, pollution by humans does not seem to be very serious compared with natural sources. Yet in many cities, particularly in Europe and North America, air pollution is an extremely serious problem. Why?*

Figure 3 shows how the production of sulphur dioxide by human activities in Britain has changed since 1850.

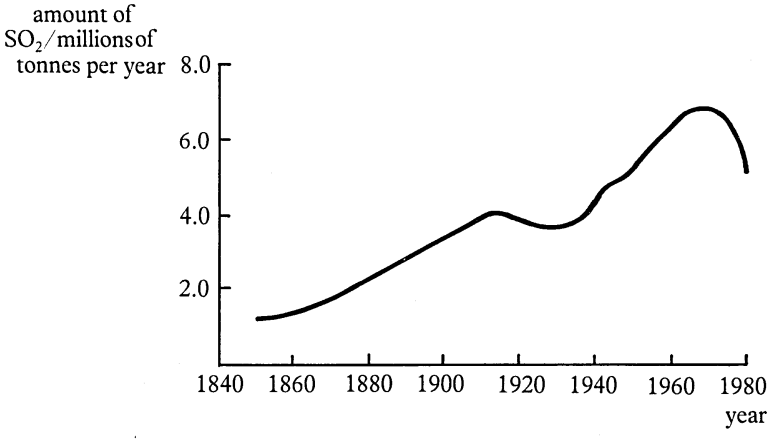

Figure 3 Changes in the production of SO_2 by human activities since 1850

Questions

8 *Suggest reasons why the emission of sulphur dioxide*

(a) rose steadily between 1850 and 1900
(b) dropped in the 1920s and 1930s
(c) rose steeply in the 1940s, 1950s and 1960s
(d) has been falling since the 1970s.

9 *All pollutants have harmful effects. For as many of the pollutant gases as you can, find out some of their harmful effects.*