State of the Environment Report for Malta 1998

Submitted to the

Environment Protection Department

Through

The Malta Council for Science and Technology

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This STATE OF THE ENVIRONMENT REPORT - 1998 is a comprehensive report about the local environment and has been commissioned by the ENVIRONMENT PROTECTION DEPARTMENT, through the MALTA COUNCIL FOR SCIENCE AND TECHNOLOGY (MCST). In their turn, the MCST commissioned a panel of independent experts who, in their individual capacity contributed on specific subject areas.

The panel of experts was composed as follows:-

Victor Axiak - The Coast and Frechwater Resources, Liquid Waste and Panel Co-ordinator)
Vincent Gauci – Solid Waste, Environmental Policy and Education
Adrian Mallia – Population, Tourism, Landuse and Non-renewable Resources
Edward Mallia - Energy
Patrick J. Schembri – Living Resources, Fisheries and Agriculture
Alfred J. Vella – Air Quality

Other experts contributed on particular sections of the report.

This report is intended to be one of a series of such periodic reports which will enable the general public to evaluate the state of the environment in the Maltese Islands.

Although the report was financed from public funds, the report does not necessarily reflect official views. Moreover, the Environment Protection Department is not responsible for any use or misuse of the information included in this report.

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The Environment Protection Department would appreciate receiving copies of all articles and publications where the State of the Environment Report is referred to.

V. Gauci
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PREFACE

All activities of Man have an impact on the local and global environment. It has become increasingly important to gauge these impacts, both because these impacts are becoming more and more significant and also because Man's expectations have increased more than ever before in the last ten years.

Moreover, the aspect of sustainability, that is whether what we are doing today to satisfy our needs will have an impact on future generations, has become an over-riding concern. It is therefore important that all decisions are taken with an informed mind.

For this to be possible, there must be accurate and accessible information about the state of our environment. Indeed, in signing the Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters in December 1998, Malta has pledged amongst other things to keep the public informed about the state of the environment.

This is precisely the scope of this report, which intends to be one of a series of regular snap-shots of the state of the local environment. Such reports will facilitate a co-ordinated response to be made and eventually will enable trends to be discerned.

While the report shows that there is considerable work still to be done in the environmental field, it is nevertheless a milestone towards achieving sustainable development.

The Hon. F. Zammit Dimech LLD, MP
Minister for the Environment

The Hon. F. Zammit Dimech
Minister for the Environment
12th August, 1999

7. AIR QUALITY

Team Leader: Alfred Vella

Team Members: David Bugeja

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7. AIR QUALITY

7.1 Introduction

Air quality in a country is generally determined by economic activity. In Malta, industrial production is heavily reliant on electrical energy and thus, the most serious air pollutants from industrial activity are principally those emitted from chimney stacks at the power houses in Marsa and Delimara. In addition to these two point sources of pollution, the other serious contributor to air pollution in Malta is transportation. Most of the petrol and especially diesel engine vehicles are not equipped with air pollution abatement equipment and thus their exhaust gases and particles are being emitted into the local ambient air with probable significant effects on air quality and health of the general population. Other lesser sources of air pollution, which may however be very important locally are: quarrying and construction activity; incinerators; dockyard activities; fuel storage and dispensing; garage industries involving spray paint operations; landfill sites; concrete batching plants and fireworks.

The detailed state of pollution of Malta's ambient air is largely unknown since no robust monitoring programme of air pollutant measurements was ever undertaken prior to 1997; at the time of writing (1999), such monitoring work is still lacking. The only information on local air quality as exists derives from sporadic publications from academics at the University of Malta and some data generated by the Pollution Control Coordinating Unit (PCCU) of the Environment Protection Department. The present report is based on such data as has appeared up to 1997.

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7.2 Sulphur Dioxide

Together with nitrogen oxides, sulphur dioxide (SO_2) is the source of environmental acidification. The gas converts into sulphuric acid which can kill aquatic organisms, damage habitat and erode buildings and monuments. The alkalinity of Maltese soil is particularly effective in buffering the effects of sulphur dioxide but does not protect vegetation from the direct effects of the gas on leaves, fruit etc. SO_2 contributes to both local pollution and large scale pollution through long distance transport in the atmosphere.

SO_2 emissions are determined by industrial structure and energy consumption, which is affected by both energy intensity and efficiency. Emissions are also influenced by the standard of pollution abatement and control and the use of clean production technology.

The two power stations in Malta (at Marsa and Delimara) are not equipped with end of pipe sulphur dioxide removal systems; nor do they burn fuel using fluidized bed technology with lime injection which is the main technique of sulphur dioxide abatement employed in modern fossil fuel derived power generation. This technique is not without problems for Malta since the disposal of the gypsum by-product may not be trivial. Pollution control is achieved by dispersal from chimneys, of which, only the one at Delimara is of suitable height. The four chimneys (two of 45 m height and two of 80 m) at Marsa station are prone to fumigate and downwash smoke onto neighbouring densely populated sites. Electrostatic precipitators present on three of the 7 boilers for the removal of particles do not work well with fuel oil because of the high humidity of the flue gas.

A pilot study of air pollution from sulphur dioxide was undertaken during May-December 1990 and was published three years later[1] and this represents the only study to date where active sampling techniques were used to cover a wide area of the island. The results indicated that the sulphur dioxide concentration in ambient air was strongly dependent on atmospheric conditions: at Paola, concentrations (1 hour averages) ranged from below detection limit (25 ?g m^{-3}) to 160 ?g m^{-3} depending on wind direction; in Marsa, downwind from the power station (wind from the NE), values ranged from 200 to 320 ?g m^{-3} but were otherwise low or even below detection limits; in Hamrun, with southeasterlies blowing, concentrations ranging between 110 to 220 ?g m^{-3} were observed. These preliminary results suggest that the power station at Marsa is the principal polluter in the area with respect to sulphur dioxide and automotive traffic contributes in a very minor way. Indeed, in 1990, traffic-derived SO_2 was less than 5% of the total SO_2 pollution load emitted into Malta air. The percentage contribution from road traffic has been further reduced by the sharp increase in powerhouse emissions brought about by the operation of the Delimara station.

The WHO guidelines for short term (approx. 1 hour) exposure to sulphur dioxide are as follows (in ?g m^{-3}): 500 (with no particulate matter); 125 (combined with particulate matter)[2] . Human exposure to SO_2 and its products in air contributes to respiratory morbidity and mortality; particularly sensitive to airborne sulphur dioxide are children and the elderly, asthmatics and individuals with cardiovascular or chronic lung disease. The health effects of sulphur dioxide are known to be much more pronounced when the gas is accompanied by suspended particles and water vapour. No information on the particulate load in Malta air is currently available but results from a study on the effects of air pollution on limestone surfaces[3] shows that the atmosphere in areas which are close to major traffic roads is indeed polluted with carbon particles which deposit onto exposed surfaces of the built environment. Particulate carbon is associated with vehicular exhausts, particularly those from diesel engines. For these reasons, and using the results of the 1990 study together with meteorological information on wind direction, one can conclude that it is likely

[1] Vella AJ, Caruana S and Demanuele J, 1993, *Malta Medical Journal*, v 5(2) 34-38.

[2] Anon, 1987: Air quality guidelines for Europe, WHO, Copenhagen.

[3] Vella AJ, Camilleri AJ and Tabone Adami JP, 1996, *Environmental Geochemistry and Health*, v 18(40) 165-170.

that inhabitants of areas surrounding the Marsa power station lived in an atmosphere that was polluted with harmful amounts of sulphur dioxide originating from the power station for about 15% of the time.

In 1997, the situation had changed from that of 1990 in the following ways: (1) coal burning at Marsa was discontinued in favour of fuel oil; (2) a new power station was built in Delimara, which caused a substantial part of the generating power to shift to the new site and (3) automotive traffic volume increased dramatically over that obtaining in 1990. It is practically impossible to predict the net result of these three effects on the sulphur dioxide pollution status in the areas of interest. The situation can only be remedied by the launch of a robust programme of air monitoring especially in areas of perceived high risk. Policy decisions regarding steps to be taken in order to improve air quality require such crucial primary data.

During 1997 the B`Kara local council contracted out a diffusion tube analysis programme for sulphur dioxide monitoring: measurements of one month duration were taken on a bimonthly basis over a period of five months. The results are shown in Table 7.1.

According to EU standards, the annual mean guideline value for sulphur dioxide is 50 ?g m^{-3}. The Valley Road sulphur dioxide average value was about 75% of the guideline limit while the Old Church area value was significantly lower. These results, which, in view of the methodology adopted, can only be regarded as indicative, suggest that traffic-generated sulphur dioxide in Birkirkara, while probably within EU guideline values, is not negligible.

Table 7.1: Mean monthly SO_2 concentrations (Diffusion Tube Analysis), B`Kara Local Council August-December 1997

Location	Month	$[SO_2]$ /?g m^{-3}
Valley Road	August 97	30.0
Old Church Area	August 97	20.6
Valley Road	October 97	33.4
Old Church Area	October 97	16.7
Valley Road	December 97	47.6
Old Church Area	December 97	9.1

Although sulphur dioxide pollution in areas which are distant from the power stations is indeed expected to be significantly lower than that in proximate areas, the values in Table 1 which represent *monthly averages* measured from passive samplers cannot be compared with values quoted earlier from the 1990 study which pertain to *hourly averages* taken from active samplers.

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7.3 Nitrogen Oxides

Nitrogen oxides (NO_x), mainly nitric oxide (NO) and nitrogen dioxide (NO_2), are predominantly emitted by transport sources as well as by other energy uses and industrial sources. In Malta, there are no chemical industries which release significant amounts of nitrogen oxides into the air as a process by product. Another source of airborne nitrogen oxides is nitrogeneous fertilisers when used in excessive quantities in agriculture. Nitrogen oxides are associated with both respiratory morbidity and mortality in humans. NO_2 is particularly poisonous and can irritate the lungs and lower the resistance to respiratory infections. In the presence of sunlight, NO_x react with volatile organic compounds (VOCs) to form tropospheric ozone and other oxidizing chemicals: these are oxygen compounds that are toxic to living forms, including human beings. Nitrogen oxides convert into nitric acid in rainwater and condensation water (fog, mist, cloud) and they exacerbate the deleterious effects of sulphur dioxide on aquatic organisms, stone artefacts, agriculture and habitat.

Published data on nitrogen oxide concentration in Malta air is limited to that provided by the B'Kara Local Council study of August-December 1997: the information is reproduced in Table 7.2.

Table 7.2: Mean monthly NO_2 concentrations (Diffusion Tube Analysis), B`Kara Local Council August-December 1997

Location	Month	$[NO_2]$ /?g m^{-3}
Valley Road	August 97	61.3
Old Church Area	August 97	29.5
Valley Road	October 97	76.6
Old Church Area	October 97	43.8
Valley Road	December 97	56.4
Old Church Area	December 97	33.1

The EU guideline value for the annual mean NO_2 concentration is 40 ?g m^{-3}. The values in Table 7.2 suggest that air pollution in Valley Road is significantly higher than that in the old church area and this is compatible with the traffic density difference at the two sites. Also, the data suggest that in Valley Road, the pollution status exceeds the EU guideline value for deemed safe exposure to the gas.

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7.4 Ozone, carbon monoxide, particulate matter, volatile organic compounds

No reliable data on these air pollutants were available for 1997 and none was published prior to the date.

Ongoing work by the Atmospheric Pollution Unit of the Department of Physics (University of Malta) involves monitoring of background ozone and carbon monoxide at a remote site in Gozo (Ta-Gordan lighthouse). Ozone is also being measured at Xewkija and at Ta-Qroqq campus, Msida. The results of this work have not yet been published.

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7.5 Lead in air

Leaded petrol containing tetraethyl lead is the main source of airborne lead-containing particles in the ambient air in Malta. Lead chloride and lead bromide particles are emitted from exhaust pipes and settle out slowly from the air. During their transit from the air to the ground, lead-containing particles can be inhaled; contamination of house- and street-dusts with lead compounds and consumption of contaminated food, especially bread, can also contribute to ingestion of the toxic heavy metal. The presence of high levels of lead in the local environment and, in particular, in the blood of the local population is a well established fact[1] and indicates significant pollution with respect to this toxic metal. With the banning of importation of red lead-containing paint, the main source of lead input into the local environment is leaded petrol, with shotgun lead pellets being a second, probably less significant source.

Emissions of lead into the air from the combustion of leaded petrol can be calculated on the basis of the empirical relationship, namely, $E = 0.75\ K_{Pb}\ b$ where E is the emitted lead load in kg, K_{Pb} is the lead content of petrol in kg/kg and b is the total consumption of petrol in kg. The average lead content of imported leaded petrol is 0.0004 kg/kg and in 1997, 60322 tonnes of the fuel were imported. Thus, for 1997, the emitted lead load was 18100 kg. This compares favourably with the value for 1990 which was 21000 kg. Despite the fact that the size of the car fleet has increased at an average of 10% per year over the period of interest, the consumption of unleaded petrol has increased from about 2% in 1990 to about 25% in 1997.

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[1] C. Savona-Ventura, Lead in the Maltese environment and its significance to man, 1998, *J.Euromed Pharm.*, v 1(4) 8-13 and references therein.

7.6 Greenhouse gases (GHG)

The main greenhouse gases (GHGs) are carbon dioxide (CO_2) , methane (CH_4) and nitrous oxide (N_2O). While there are natural emissions of GHGs, anthropogenic emissions have been identified as a source of climate change and are the subject of an international instrument (UN Framework Convention on Climate Change). Such emissions are determined by a country's energy use and production systems, its industrial structure, its transportation methods, agriculture and livestock management, waste management and consumption patterns of the population.

The Intergovernmental Panel on Climate Change (IPCC) has determined that the earth's temperature could rise by between 1 and 3.5 degrees Celsius by 2010: an average rate of warming probably higher than any in the last 10 000 years.

Parties to the Climate Change Convention are committed to return, by 2000, their anthropogenic emissions of carbon dioxide and other GHGs not controlled by the Montreal Protocol to their 1990 level.

No data is available on nitrous oxide concentrations in Malta air. However, background levels of carbon dioxide, carbon monoxide (which is an intermediate product of oxidation of hydrocarbons) and methane have been routinely measured since 1993. Samples of air have been collected on a quasi-weekly basis since October 1993 using a portable Martin and Kitzis sampler from Pinu Point Gozo (36^{o} 15'N, 14^{o} 13'E, 125m above sea level). The site was chosen since it is a relatively isolated area with little effect of contamination from locally generated air pollutants.

The collected air samples are sent for analysis to the National Oceanic and Atmospheric Administration/ Climate Monitoring and Diagnostic Laboratory (NOAA/CDML) in the USA.

Table 7.3 illustrates data collected for the calendar year 1997.

Table 7.3 Measured background concentrations of greenhouse gases (EPD)

Date	Time	Sample	CO/ppb	CH_4 / ppb	CO_2 /ppm
5/1/97	0830	307-91	104.570	1825.360	367.38
5/1/97	0830	308-91	104.500	1827.220	367.32
15/1/97	0830	251-91	138.810	1805.430	364.18
15/1/97	0830	252-91	137.690	1806.000	364.20
3/2/97	0815	4153-91	297.430	1826.300	369.93
3/2/97	0815	4154-91	298.250	1832.720	369.86
27/2/97	0825	609-91	163.850	1805.770	366.93
27/2/97	0825	610-91	164.350	1809.140	367.05
4/3/97	0900	841-91	173.930	1815.320	369.12
4/3/97	0900	842-91	172.970	1822.610	369.04
8/3/97	0900	829-91	165.900	1805.060	366.48
8/3/97	0900	830-91	165.670	1806.000	366.41
24/3/97	0900	1193-91	214.610	1841.740	370.52
24/3/97	0900	1194-91	214.570	1844.900	370.60
18/4/97	0900	541-91	162.270	1807.070	367.97

Table 7.3/ continued Measured background concentrations of greenhouse gases (EPD)

Date	Time	Sample	CO/ppb	CH_4 / ppb	CO_2 /ppm

18/4/97	0900	542-91	161.210	1806.090	367.91
26/4/97	0815	1463-91	206.670	1829.970	370.99
26/4/97	0815	1464-91	206.190	1826.070	370.99
28/4/97	0800	269-91	201.730	1770.650	368.11
28/4/97	0800	270-91	203.210	1768.560	368.06
8/5/97	0915	605-91	168.430	1743.810	366.63
8/5/97	0915	606-91	252.840	1765.120	375.02
17/5/97	0815	537-91	174.560	1819.650	367.82
17/5/97	0815	538-91	174.770	1821.010	367.88
21/5/97	0735	589-91	220.270	1758.470	367.57
21/5/97	0735	590-91	217.310	1761.300	367.54
29/5/97	1000	57-91	234.010	1819.570	364.99
29/5/97	1000	58-91	233.580	1816.490	364.89
3/6/97	0730	293-91	161.790	1727.940	365.27
3/6/97	0730	294-91	164.000	1659.740	363.35
15/6/97	0735	515-91	183.720	1774.750	368.17
15/6/97	0735	516-91	183.510	1769.400	367.99
25/6/97	0700	329-91	125.480	1796.390	361.20
25/6/97	0700	330-91	138.840	1785.520	361.28
12/7/97	0745	27-91	138.030	1807.370	361.10
12/7/97	0745	28-91	135.380	1808.980	361.00
18/7/97	0830	1615-91	171.380	1749.330	355.37
18/7/97	0830	1616-91	168.340	1746.100	355.28
24/7/97	0830	4401-91	212.290	1800.510	360.57
24/7/97	0830	4402-91	211.620	1797.230	360.57
3/8/97	0730	4415-91	131.060	1790.800	359.06
3/8/97	0730	4416-91	133.670	1788.170	358.99
8/8/97	0830	161-91	143.560	1715.130	360.52
8/8/97	0830	162-91	140.640	1710.520	360.58
15/8/97	0900	341-91	171.530	1854.280	355.87
15/8/97	0900	342-91	170.430	1854.360	356.04
22/8/97	0830	4659-91	150.550	1805.640	362.56
29/8/97	0900	4661-91	105.200	1770.000	358.82
29/8/97	0900	4662-91	101.260	1770.550	358.87
12/9/97	0730	1927-91	139.610	1809.550	360.82
12/9/97	0730	1928-91	133.810	1811.140	361.06
19/9/97	0830	1198-91	138.060	1792.700	362.77
3/10/97	0830	517-91	122.170	1767.340	359.96
3/10/97	0830	518-91	121.740	1769.200	360.17
16/10/97	0730	1419-91	178.270	1789.350	367.40
16/10/97	0730	1420-91	176.910	1785.870	367.36
30/10/97	0730	379-91	116.280	1795.250	357.56
30/10/97	0730	380-91	114.580	1786.350	358.05
5/11/97	0830	645-91	138.010	1805.340	361.24
5/11/97	0830	646-91	138.640	1810.240	361.85
10/11/97	0730	473-91	177.870	1811.540	367.45

Table 7.3/ continued Measured background concentrations of greenhouse gases (EPD)

Date	**Time**	**Sample**	**CO/ppb**	**CH_4 / ppb**	**CO_2 /ppm**

10/11/97	0730	474-91	178.290	1816.640	367.86
20/11/97	0730	153-91	132.050	1829.340	360.19
20/11/97	0730	154-91	130.720	1825.680	360.25
25/11/97	0730	329-91	117.190	1824.410	362.24
25/11/97	0730	330-91	117.690	1820.480	362.58
3/12/97	0730	1483-91	191.020	1794.840	364.23
3/12/97	0730	1484-91	192.640	1798.350	364.45
10/12/97	0730	113-91	167.680	1758.860	367.22
10/12/97	0730	114-91	169.070	1754.240	367.45
18/12/97	0830	369-91	172.880	1785.640	365.55
18/12/97	0830	370-91	174.340	1780.540	365.24
22/12/97	0830	423-91	237.240	1775.240	364.28
22/12/97	0830	424-91	235.720	1769.240	365.05
29/12/97	0830	608-91	178.850	1794.350	365.58
29/12/97	0830	609-91	178.850	1787.540	365.86

For the purpose of elucidating trends, it is better to look at the data in Table 7.3 in the context of earlier collected data. Figures 7.1, 7.2 and 7.3 represent in graphical form data on these GHGs from Malta since 1993. Figure 7.1 shows the trends for carbon dioxide from October 1993 to December 1997. A cyclical seasonal variation in carbon dioxide levels can be seen quite clearly with higher levels of carbon doxide occuring during the spring/summer months and lower values occuring in the winter months. These seasonal variations are related to differences in the rate of plant photosynthesis and respiration: higher levels of photosynthesis coincide with lower carbon dioxide levels during the sunny summer months while during winter, the respiration/photosynthetic rate ratio is generally higher than that for the summer months leading to an increased atmospheric carbon dioxide concentration.

Figure 7.2 shows levels of methane in air for the period August 1994 to December 1997. In this case the trend is not as clear as that for carbon dioxide, although a 5-10% difference between peak and troughs exists. Fluctuations in methane concentrations would result from variation in air concentrations of atmospheric oxidants but other factors may also be involved.

Figure 7.3 displays the carbon monoxide trends from October 1993 to December 1997: significantly higher CO concentrations occur during the winter months than during the summer months. Carbon monoxide in air results both from direct emission (e.g. combustion of fossil fuels) and from oxidation of methane and other hydrocarbons in the presence of oxidising species.It must be stressed that the value of such data as presented in Table 7.3 is a function of the continuity of measurements taken over periods of several years. It is only through continuous long term measurements that useful data sets for climate change studies may be obtained. The long term trends cannot be studied in isolation since the situation is also influenced by atmospheric mixing caused by the transfer of GHGs generated in one particular geographical area to another. Thus, the information from Malta is useful only in the context of regional and, indeed, global measurements.

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Figure 7.1 Concentration data for Carbon Dioxide

Annex A

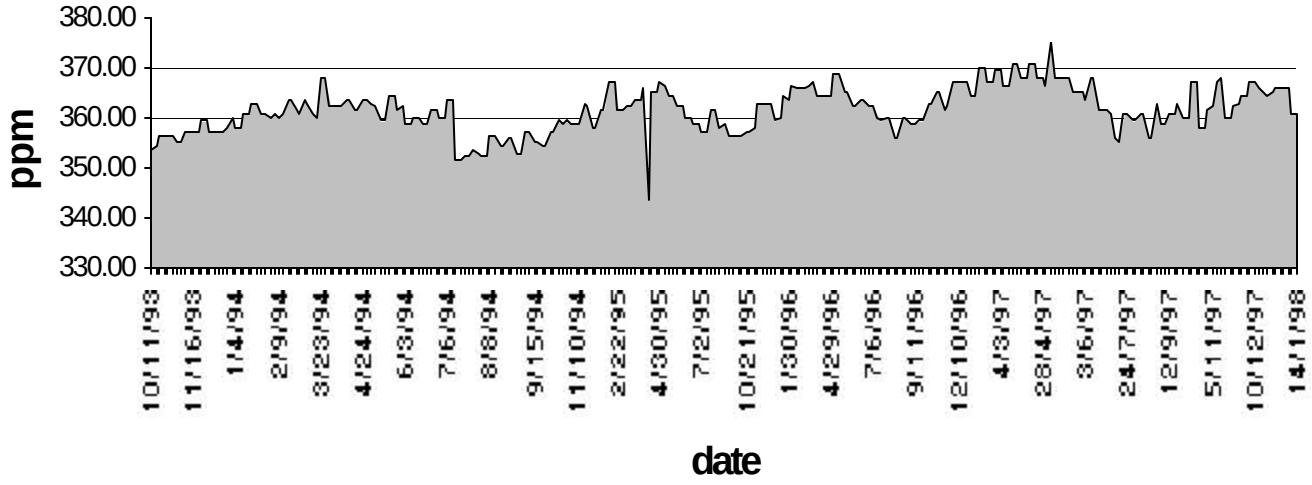


Figure 7.2 Concentration data for Methane (CH_4)

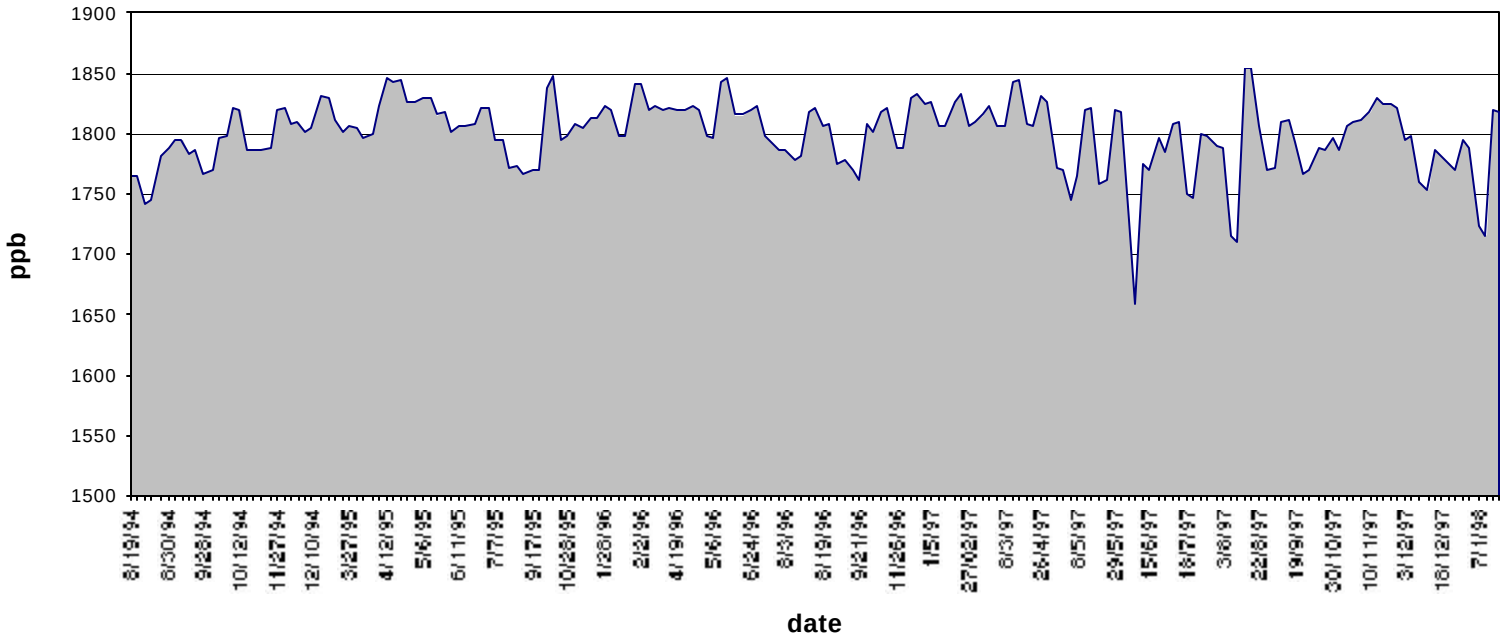
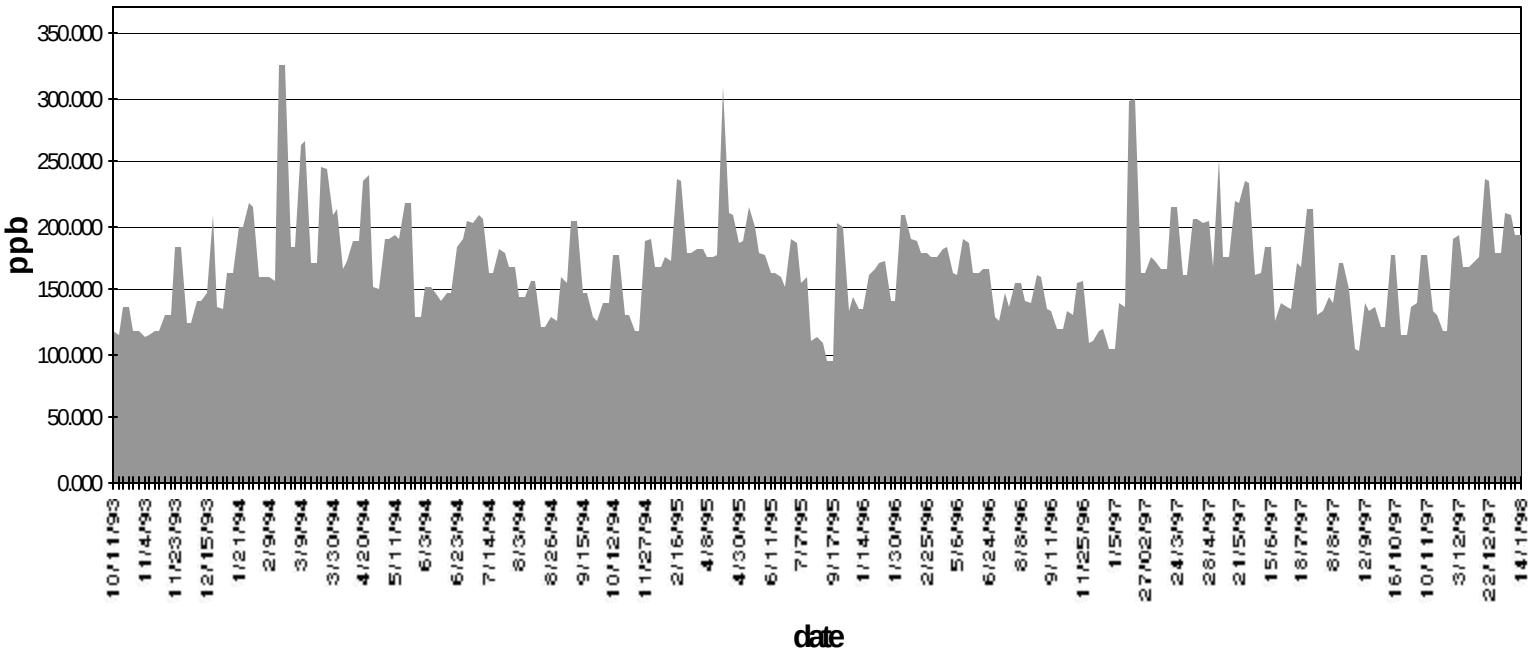


Figure 7.3 Concentration data for Carbon Monoxide (CO)



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15/1/97	0830	252-91	137.690	1806.000	364.20
3/2/97	0815	4153-91	297.430	1826.300	369.93
3/2/97	0815	4154-91	298.250	1832.720	369.86
27/2/97	0825	609-91	163.850	1805.770	366.93
27/2/97	0825	610-91	164.350	1809.140	367.05
4/3/97	0900	841-91	173.930	1815.320	369.12
4/3/97	0900	842-91	172.970	1822.610	369.04
8/3/97	0900	829-91	165.900	1805.060	366.48
8/3/97	0900	830-91	165.670	1806.000	366.41
24/3/97	0900	1193-91	214.610	1841.740	370.52
24/3/97	0900	1194-91	214.570	1844.900	370.60
18/4/97	0900	541-91	162.270	1807.070	367.97

Table 7.3/ continued Measured background concentrations of greenhouse gases (EPD)

Date	Time	Sample	CO/ppb	CH_4 / ppb	CO_2 /ppm

18/4/97	0900	542-91	161.210	1806.090	367.91
26/4/97	0815	1463-91	206.670	1829.970	370.99
26/4/97	0815	1464-91	206.190	1826.070	370.99
28/4/97	0800	269-91	201.730	1770.650	368.11
28/4/97	0800	270-91	203.210	1768.560	368.06
8/5/97	0915	605-91	168.430	1743.810	366.63
8/5/97	0915	606-91	252.840	1765.120	375.02
17/5/97	0815	537-91	174.560	1819.650	367.82
17/5/97	0815	538-91	174.770	1821.010	367.88
21/5/97	0735	589-91	220.270	1758.470	367.57
21/5/97	0735	590-91	217.310	1761.300	367.54
29/5/97	1000	57-91	234.010	1819.570	364.99
29/5/97	1000	58-91	233.580	1816.490	364.89
3/6/97	0730	293-91	161.790	1727.940	365.27
3/6/97	0730	294-91	164.000	1659.740	363.35
15/6/97	0735	515-91	183.720	1774.750	368.17
15/6/97	0735	516-91	183.510	1769.400	367.99
25/6/97	0700	329-91	125.480	1796.390	361.20
25/6/97	0700	330-91	138.840	1785.520	361.28
12/7/97	0745	27-91	138.030	1807.370	361.10
12/7/97	0745	28-91	135.380	1808.980	361.00
18/7/97	0830	1615-91	171.380	1749.330	355.37
18/7/97	0830	1616-91	168.340	1746.100	355.28
24/7/97	0830	4401-91	212.290	1800.510	360.57
24/7/97	0830	4402-91	211.620	1797.230	360.57
3/8/97	0730	4415-91	131.060	1790.800	359.06
3/8/97	0730	4416-91	133.670	1788.170	358.99
8/8/97	0830	161-91	143.560	1715.130	360.52
8/8/97	0830	162-91	140.640	1710.520	360.58
15/8/97	0900	341-91	171.530	1854.280	355.87
15/8/97	0900	342-91	170.430	1854.360	356.04
22/8/97	0830	4659-91	150.550	1805.640	362.56
29/8/97	0900	4661-91	105.200	1770.000	358.82
29/8/97	0900	4662-91	101.260	1770.550	358.87
12/9/97	0730	1927-91	139.610	1809.550	360.82
12/9/97	0730	1928-91	133.810	1811.140	361.06
19/9/97	0830	1198-91	138.060	1792.700	362.77
3/10/97	0830	517-91	122.170	1767.340	359.96
3/10/97	0830	518-91	121.740	1769.200	360.17
16/10/97	0730	1419-91	178.270	1789.350	367.40
16/10/97	0730	1420-91	176.910	1785.870	367.36
30/10/97	0730	379-91	116.280	1795.250	357.56
30/10/97	0730	380-91	114.580	1786.350	358.05
5/11/97	0830	645-91	138.010	1805.340	361.24
5/11/97	0830	646-91	138.640	1810.240	361.85
10/11/97	0730	473-91	177.870	1811.540	367.45

Table 7.3/ continued Measured background concentrations of greenhouse gases (EPD)

Date	**Time**	**Sample**	**CO/ppb**	**CH_4 / ppb**	**CO_2 /ppm**

10/11/97	0730	474-91	178.290	1816.640	367.86
20/11/97	0730	153-91	132.050	1829.340	360.19
20/11/97	0730	154-91	130.720	1825.680	360.25
25/11/97	0730	329-91	117.190	1824.410	362.24
25/11/97	0730	330-91	117.690	1820.480	362.58
3/12/97	0730	1483-91	191.020	1794.840	364.23
3/12/97	0730	1484-91	192.640	1798.350	364.45
10/12/97	0730	113-91	167.680	1758.860	367.22
10/12/97	0730	114-91	169.070	1754.240	367.45
18/12/97	0830	369-91	172.880	1785.640	365.55
18/12/97	0830	370-91	174.340	1780.540	365.24
22/12/97	0830	423-91	237.240	1775.240	364.28
22/12/97	0830	424-91	235.720	1769.240	365.05
29/12/97	0830	608-91	178.850	1794.350	365.58
29/12/97	0830	609-91	178.850	1787.540	365.86

For the purpose of elucidating trends, it is better to look at the data in Table 7.3 in the context of earlier collected data. Figures 7.1, 7.2 and 7.3 represent in graphical form data on these GHGs from Malta since 1993. Figure 7.1 shows the trends for carbon dioxide from October 1993 to December 1997. A cyclical seasonal variation in carbon dioxide levels can be seen quite clearly with higher levels of carbon doxide occuring during the spring/summer months and lower values occuring in the winter months. These seasonal variations are related to differences in the rate of plant photosynthesis and respiration: higher levels of photosynthesis coincide with lower carbon dioxide levels during the sunny summer months while during winter, the respiration/photosynthetic rate ratio is generally higher than that for the summer months leading to an increased atmospheric carbon dioxide concentration.

Figure 7.2 shows levels of methane in air for the period August 1994 to December 1997. In this case the trend is not as clear as that for carbon dioxide, although a 5-10% difference between peak and troughs exists. Fluctuations in methane concentrations would result from variation in air concentrations of atmospheric oxidants but other factors may also be involved.

Figure 7.3 displays the carbon monoxide trends from October 1993 to December 1997: significantly higher CO concentrations occur during the winter months than during the summer months. Carbon monoxide in air results both from direct emission (e.g. combustion of fossil fuels) and from oxidation of methane and other hydrocarbons in the presence of oxidising species.It must be stressed that the value of such data as presented in Table 7.3 is a function of the continuity of measurements taken over periods of several years. It is only through continuous long term measurements that useful data sets for climate change studies may be obtained. The long term trends cannot be studied in isolation since the situation is also influenced by atmospheric mixing caused by the transfer of GHGs generated in one particular geographical area to another. Thus, the information from Malta is useful only in the context of regional and, indeed, global measurements.

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Figure 7.2 shows levels of methane in air for the period August 1994 to December 1997. In this case the trend is not as clear as that for carbon dioxide, although a 5-10% difference between peak and troughs exists. Fluctuations in methane concentrations would result from variation in air concentrations of atmospheric oxidants but other factors may also be involved.

Figure 7.3 displays the carbon monoxide trends from October 1993 to December 1997: significantly higher CO concentrations occur during the winter months than during the summer months. Carbon monoxide in air results both from direct emission (e.g. combustion of fossil fuels) and from oxidation of methane and other hydrocarbons in the presence of oxidising species.

It must be stressed that the value of such data as presented in Table 3 is a function of the continuity of measurements taken over periods of several years. It is only through continuous long term measurements that useful data sets for climate change studies may be obtained. The long term trends cannot be studied in isolation since the situation is also influenced by atmospheric mixing caused by the transfer of GHGs generated in one particular geographical area to another. Thus, the information from Malta is useful only in the context of regional and, Indeed, global measurements.

Figure 7.1 Concentration data for Carbon Dioxide

Annex A

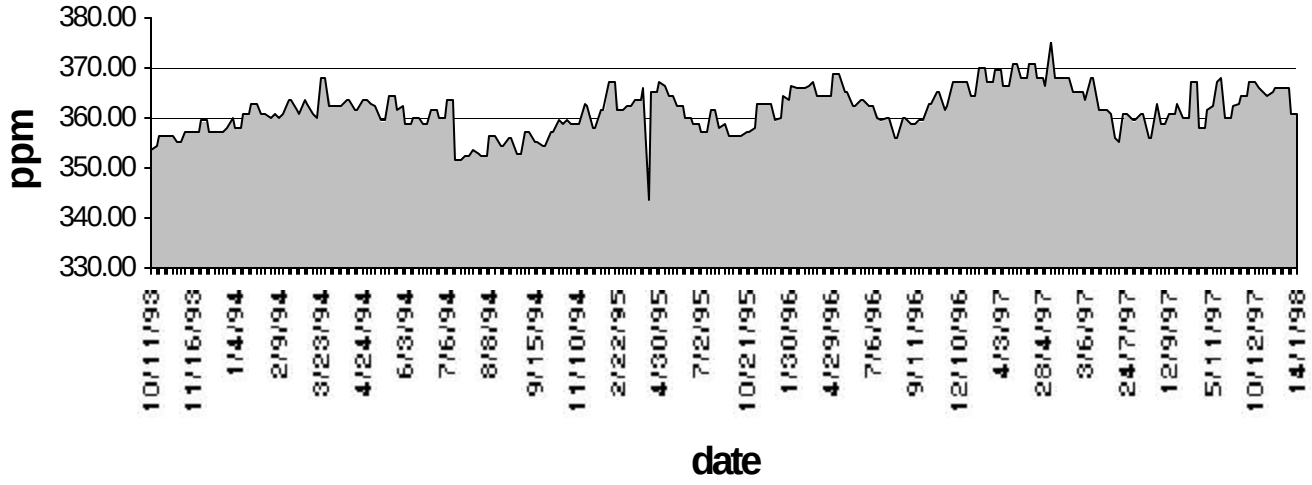


Figure 7.2 Concentration data for Methane (CH_4)

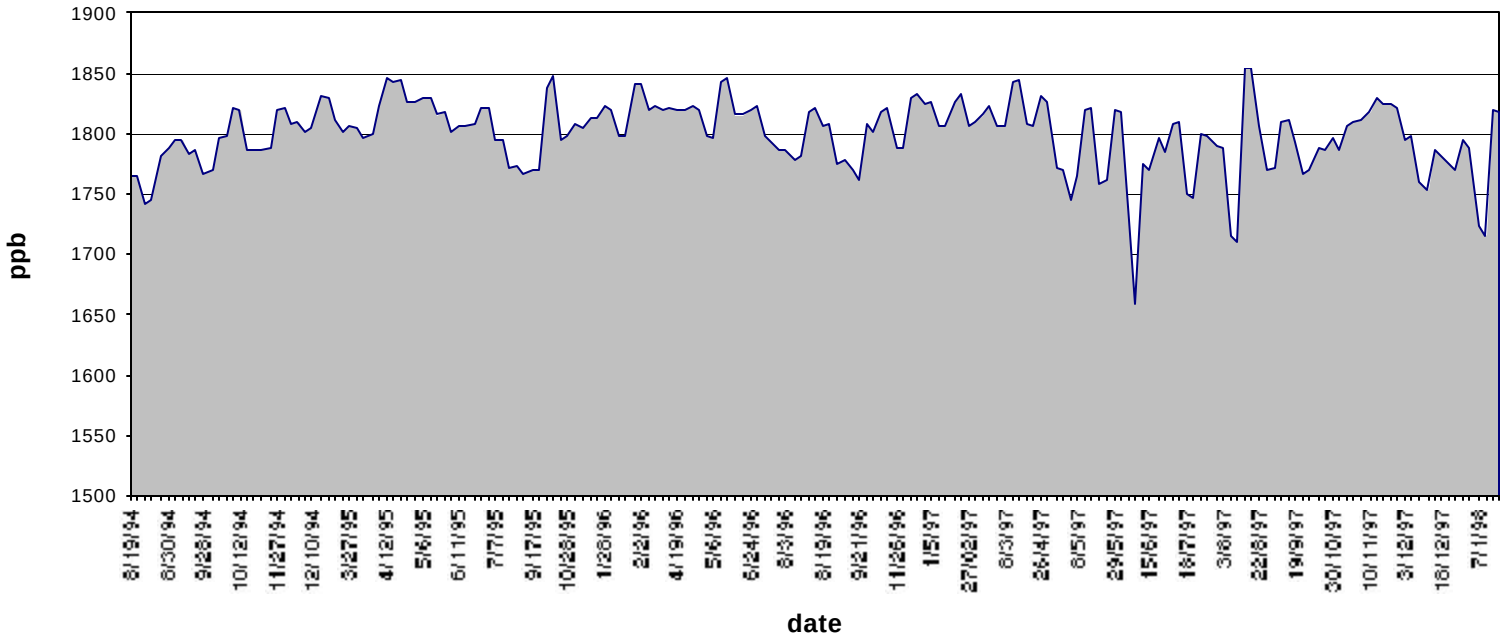
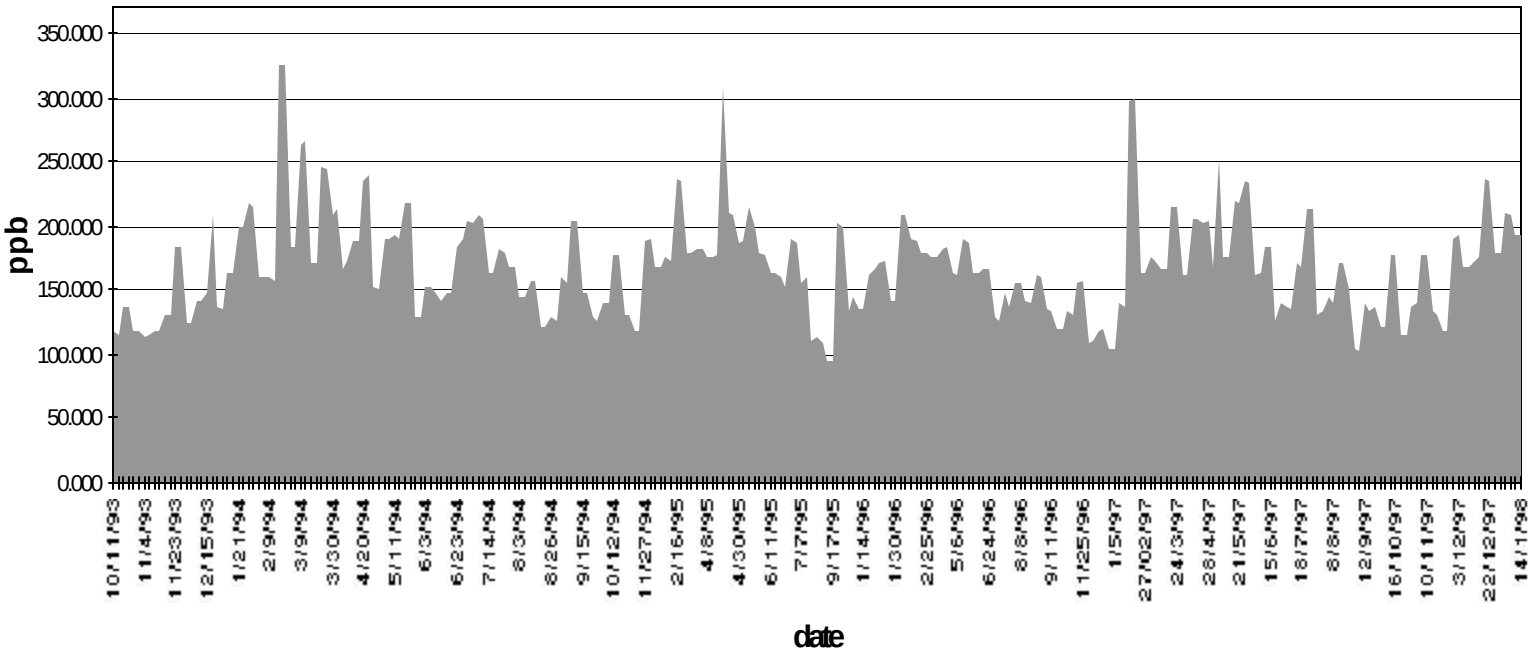


Figure 7.3 Concentration data for Carbon Monoxide (CO)



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7.7 Ozone Depleting Substances

Following the concern by the scientific community expressed during the 1970s and 80s resulting from the accelerated depletion of the ozone layer brought about by the widespread use of halogenated alkanes, the Vienna Convention for the Protection of the Ozone layer was adopted in 1985. In order to restrict usage of ozone depleting substances (ODS`s) the Convention was further elaborated through the 1987 Montreal Protocol which embodied a definite 'timetable' for the phase-out of the consumption and production of ODS`s together with restrictions on their manufacture, export and import. However as further scientific data revealed that the ozone depletion process was even more serious than previously supposed, further amendments to the Montreal Protocol were introduced by the London (1990) and the Copenhagen (1992) Amendments.

Malta acceded to the Vienna Convention and ratified the Montreal protocol in 1988. Following this ratification, the PCCU formulated an action plan to identify quantities of imported ODS`s together with end user distributed quantities, thus creating a comprehensive database for the annual consumption of ODS`s. The PCCU currently monitors the import and use of ODS`s , through *(i)* the investigation of import licenses by importers of ODS and *(ii) in situ* inspections of imported substances and surveillance of chlorofluorocarbons (CFC) trade movements.

The Montreal Protocol classifies ODS in three lists in Annexes A, B and C. Annexes A and B substances have to be phased out most rapidly.

Malta imports the following ODS:

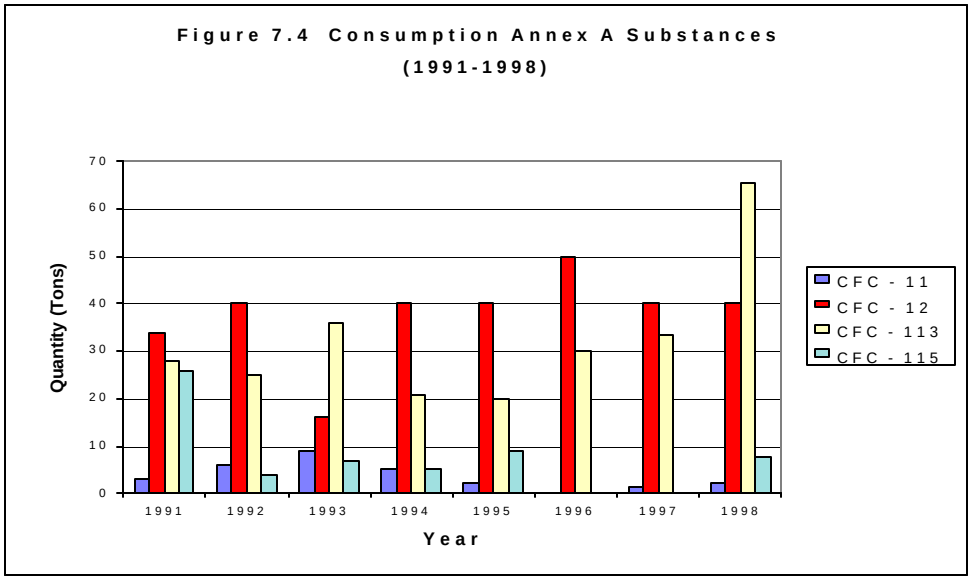
Annex A: CFC 11, CFC 12, CFC 113, CFC 115, Halon 1211, Halon 1301
Annex B: Methyl chloroform
Annex C: HCFC 22, HCFC 141b, Methyl Bromide

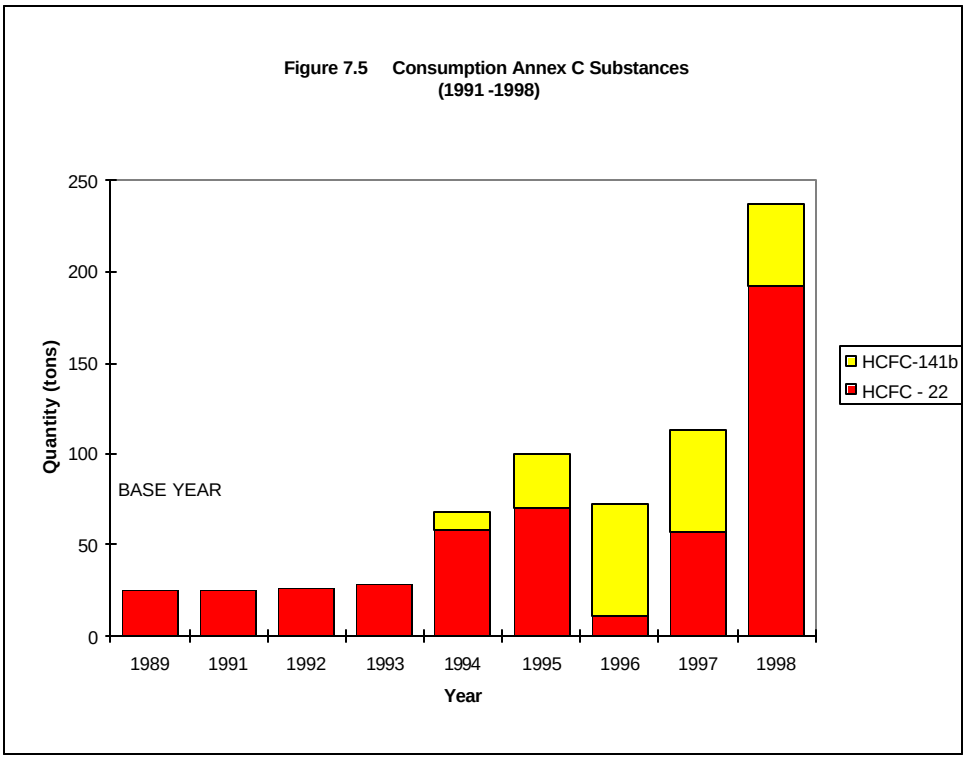
Table 7.4 gives the quantities of imported ODS for 1997:

Table 7.4: Imports of ODS for 1997

ODS	Chemical Formula	Application	Quantity Imported /kg
Annex A			
R-113	$CClF_2CCl_2F$	Cleaning/ Degreasing	40,000
R-12	CCl_2F_2	Refrigeration	36,129
R-11	CCl_3F	Refrigeration	7,700
Halon 1211	CF_2ClBr	Fire extinguishers	26.61
Halon 1301	CF_3ClBr	Fire Extinguishers	27.90
CFC 115		Air-conditioning Refrigeration	1,515
Total Quantity			85433.51
Annex C			
R-22	$HCClF_2$	Air-conditioning, Dehumidification	57,609
R-141b	CH_3CCl_2F	Foam production	55,435
Methyl Bromide	CH_3Br	Agriculture	5,729
Total Quantity			118,773

Figures 7.4 and 7.5 illustrate in graphical format data on the consumption volume for Annexes A and C substances from 1991 to 1998 (estimated).





Annex A substances: It may be seen from Figure 7.4 that whilst the level of consumption of Annex A ODS has not decreased since 1991 (except for CFC-11), their consumption has leveled out, meaning that in spite of an increased market demand, a phaseout is successfully being implemented since the demand has not

been met with increased ODS imports. In the case of CFC 12, the estimated 1998 consumption level is not due to increased import but to the tapping of existing stockpiles of the chemical.

The planned phase-out of Annex C substances is slower due to their lesser ozone destruction capacity. In line with a phase-out of more harmful ODS, the quantity of imported Annex C substances has steadily increased since December 1993 (see Figure 7.5). From Figure 7.5 it can be seen that 1997 levels have tripled with respect to 1993 levels and are set to double as can be seen from the 1998 estimate. This is a move in the correct direction since more widespread use of such ODS will support a faster phase-out of Annex A ODS`s.

Phase-out Timetable for ODS Malta will be following the line of the `Developing Countries` ODS phase-out schedule`, as agreed by the Parties to the Montreal Protocol at their 9th Meeting (Montreal , 15-17 September 1997). The obligations Malta will be facing are summed up in Table 7.5 below:

Table 7.5 Timetable for a phase-out of ODS in Developing Countries

Date	Phase-out Obligation
1 July 1999	Freeze of Annex A CFCs at 1995-97 average levels
1 January 2002	Freeze of halons at 1995-97 average levels; freeze of methyl bromide at 1995-98 average levels.
1 January 2003	Reduction by 20% of 1998-2000 consumption figures of Annex B CFCs; freeze in methyl chloroform at 1998-2000 average levels.
1 January 2005	50% reduction of Annex A CFCs with respect to 1995-97 average levels; 50% reduction of halons with respect to 1995-97 average levels; 85% reduction of carbon tetrachloride with respect to 1998-2000 average levels; 30% reduction of methylchloroform with respect to 1998-2000 levels
1 January 2007	85% reduction of Annex A CFCs with respect to 1995-97 average levels; 85% reduction of Annex B CFCs with respect to 1998-2000 average levels
1 January 2010	CFCs, halons, carbon tetrachloride phased out; 70% reduction of methyl chloroform from 1998-2000 average levels
1 January 2015	Methyl chloroform and methyl bromide phased out
1 January 2016	Freeze of HCFCs at baseline figure of year 2015 average levels
1 January 2040	HCFCs phased out/complete phase-out

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7.8. Air Emission Inventories

Air emission inventorying is a calculation-based methodology used to estimate the total quantities per unit time of various air pollutants emitted into the atmosphere.

To date, the PCCU unit within EPD and Enemalta Corporation have completed the following detailed inventories: *(i)* Greenhouse Gas Inventory Report for the base year 1990 (Table 7.6a); and *(ii)* CORINAIR emission inventory for 1990 and 1994: this inventory considers emissions of anthropogenically generated gases and particulate matter from various emitting sources.

Greenhouse gas inventory
Data for 1997 is available for the greenhouse gas inventory. Compilation of this inventory is required to satisfy part of Malta`s obligations following the ratification of the Convention on Climate Change on 14 March 1994. The methodology used in the completion of this inventory is based on IPCC guidelines and includes the calculation of yearly emissions of $CO_2$, $CH_4$, $NO_x$, CO, $N_2O$, non-methane VOC`s from electricity generation as well as from the industrial, commercial, residential and transport sub-sectors.

Table 7.6b below gives greenhouse gas emissions from the various sub-sectors for 1997.

The calculated amounts shown in the table represent only emitted gases resulting from locally used fuels and do not include potential emissions from the use of fuels which were bunkered during 1997. This is in line with calculations of strict country-localised emissions. It should be noted that the emissions have not been broken down into the level of detail that is exhibited in Appendix 1 for the 1990 emissions since relevant statistics which permit this detail were not yet available at the time of writing.

Table 7.6a: Greenhouse Gas Emissions from the Energy Sector for 1990 (EPD)

	CH_4 /Mg	**NOx/Mg**	**CO/Mg**	**N_2O/Mg**	**NMVOCs/Mg**	**CO_2 /Gg**
Electricity Generation						
Coal	3.790	5413.097	88.429	5.053	N/A	585.575
Fuel Oil	6.917	1986.274	148.229	19.764	29.646	756.889
Diesel	2.158	71.047	12.307	N/A	N/A	26.949
Sub Total 1	12.865	7470.418	248.965	24.817	29.646	1369.413
Industrial						
Fuel Oil 200	0.179	9.676	1.027	0.150	0.180	5.600
Fuel Oil 450	0.350	18.530	1.930	0.270	0.350	10.280
Fuel Oil 750	0.660	33.670	3.420	0.470	0.660	17.280
Diesel	0.528	52.940	6.651	0.710	1.367	25.541
Kerosene	2.469	17.635	7.054	0.705	1.058	24.966
LPG	0.035	1.514	0.322	N/A	N/A	2.0110
Sub Total 2	4.221	133.965	20.404	2.305	3.615	85.678

Table 7.6a/continued: Greenhouse Gas Emissions from the Energy Sector for 1990 (EPD)

	CH_4 /Mg	**NOx/Mg**	**CO/Mg**	**N_2O/Mg**	**NMVOCs/Mg**	**CO_2 /Gg**
Commercial						
Fuel Oil 200	0.030	3.350	0.470	0.970	N/A	2.126
Fuel Oil 450	0.220	21.290	2.730	6.230	N/A	12.362
Diesel	1.122	11.967	2.992	2.936	N/A	13.711
Kerosene	1.255	8.967	3.587	0.359	0.538	12.695

LPG	0.088	3.773	0.803	N/A	N/A	5.012
Sub Total 3	2.715	49.347	10.582	10.495	0.538	45.906
Residential						
Kerosene	0.377	2.269	1.076	0.108	0.161	3.808
LPG	0.588	25.121	5.345	N/A	N/A	33.371
Sub Total 4	0.965	27.390	6.421	0.108	0.161	37.179
Transport						
Sea	0.199	144.872	19.603	0.314	6.426	7.687
Land Petrol	84.292	1821.600	23871.841	4.220	4344.866	179.911
Land Diesel	5.216	830.994	770.471	6.008	185.473	124.288
Sub Total 5	89.707	2797.466	24661.915	10.542	4536.765	311.886
Total	110.473	10478.586	24948.287	48.267	4570.725	1850.062

Table 7.6b: 1997 Synoptic Greenhouse Gas Emission Inventory (EPD)

Fuel	*Generated Air Pollutants*				
	CO_2/Gg	**CH_4/Mg**	**N_2O/Mg**	**NOx/Gg**	**CO/Gg**
Leaded petrol	170.750	79.896	3.982	1.727	22.625
Unleaded petrol	56.379	26.373	1.315	0.570	7.470
Gas Oil	398.424	18.474	20.104	2.244	1.639
Heavy Fuel Oil	1401.723	14.641	47.582	3.607	0.275
Kerosene	0.0432	0.004	0.001	<0.001	<0.001
Jet A1	284.143	28.100	8.028	0.201	0.083
Av. Gas	0.410	0.041	0.012	<0.001	<0.001
LPG	44.842	0.790	NA	0.034	0.007
Propane	0.267	0.005	NA	<0.001	<0.001
Totals	2356.981	168.324	81.024	8.383	32.099

A comparison of the total quantities of greenhouse gases generated from fuels in 1997 with that in 1990 shows that the total quantity of emitted carbon dioxide during 1997 has increased by 27% over the 1990 value. Methane emissions have increased by 58% mainly from increased petrol consumption concomitant with the numerical increase of the car fleet. Dinitrogen oxide increased by 68% and this is largely due to electrical energy production at Delimara Power Station (especially that using gas turbines) and the increase in the vehicle fleet.

NOx emissions decreased by 20% in 1997 compared to the 1990 values. The main reason for this trend reversal would appear to be that due to the changeover from coal to heavy fuel oil combustion for electricity generation. Coal has a significantly higher emission factor for NOx emission when compared with fuel oil thus: 0.8-0.9 tons NOx/TJ for coal combustion to approximately 0.2 tons NOx/TJ for heavy fuel oil.

Carbon monoxide emissions increased by 29% over the 1990 values. This is due to the increased size of the car fleet from 1990 to 1997.

CORINAIR Inventory

The Corinair Inventory of air pollutants consists of a database system which categorises emission sources and allows for the calculation of several air pollutants in mass emitted /year. Initially only the following air pollutants were calculated using this software programme: SO_2, NOx, NMVOC, CH_4, CO, CO_2, N_2O and ammonia, NH_3. A more recent version of Corinair is capable of calculating emissions of heavy metals (lead, cadmium, mercury) and persistent organic pollutants (POPs), substances which are known to cause deleterious effects on human health and ecosystems. The Corinair inventory is now regarded internationally as the standard method of emissions estimation.

Corinair inventories for 1990 and 1994 are available (EPD) and are included in this report as Table 7.7 and 7.8 respectively.

Sulphur dioxide emissions during 1994 increased by a factor of 2.6 with respect to the 1990 value and the main reason for such a drastic increase was due to an increase in electricity generation resulting from the then newly operational Delimara power plant. This was accompanied by a concomitant rise in carbon dioxide emissions.

NOx emissions from power generation decreased slightly during 1994 with respect to 1990 emissions and the reason for this decrease was due to the replacement of coal with heavy fuel oil as the energy source for electricity generation.

The emissions of non methane VOCs increased in 1994 mainly due to a greater use of solvents in the industry sector.

Table 7.7 Pollutants emitted during the calendar year 1990 (Tons/year) (EPD)

Group Name	SO_2	NOx	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
Public Power Co-generation Plants	2,152	7,459	0	13	248	1,411000	5	0
Comm/Res/Inst Combustion. Plants	193	79	0	1	13	84,000	4	0
Industrial. Combustion	464	145	0	2	13	91,000	1	0
Production Processes	0	8	148	0	5	4,000	0	0
Extraction/ Distribution of fossil fuels	0	0	0	0	0	0	0	0
Solvent Use	0	0	1,653	0	0	0	0	0
Road Transport	256	3,559	2,640	92	20,974	351,000	11	2
Other mobile sources/ machinery	3,002	5,634	0	191	1,800	267,000	11	0
Waste treatment/ disposal	0	0	0	7,264	0	0	12,775	0
Agriculture	0	0	15	1,478	0	0	44	5,485
Nature	0	0	0	0	0	0	0	0
Total	6,067	16,884	4,456	9,041	23,053	2,208000	12,851	5,487

Table 7.8 Pollutants emitted during the calendar year 1994 (Tons/year) (EPD)

Group Name	SO_2	NOx	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
Public Power Cogeneration Plants	11,987	6,667	17	16	296	1,572000	33	0
Comm/Res/Inst Combustion. Plants	196	90	1	4	20	101,000	11	0
Industrial. Combustion	331	116	3	4	20	86,000	2	0
Production Processes	4	12	288	0	5	4,000	0	0
Extraction/ Distribution of fossil fuels	0	0	0	0	0	0	0	0
Solvent Use	0	0	2,437	0	0	0	0	0
Road Transport	253	3544	2640	156	20974	351000	11	2
Other mobile sources/ machinery	3,025	5,868	0	389	2,183	273,000	11	0
Waste treatment/ disposal	0	0	120	5,524	210	0	12,895	0
Agriculture	0	0	14	3,315	0	0	43	6,368
Nature	0	0	0	0	0	0	0	0
Total	15798	16297	5520	9408	23708	2387000	13006	6370

The data for road transport for 1994 appear dubious: considering that 20,000 more vehicles were on the road in 1994 when compared to 1990, pollutant emissions would not be expected to remain practically unchanged from 1990 values. Rather, based on petroleum fuel sales for '94 when compared to '90, one would expect an approximate 20% increase of all emissions from road transport for 1994.

Dinitrogen oxide and ammonia emissions are largely generated by waste treatment/disposal and agriculture. In 1994, the only significant change in emissions of these pollutants was a 14% increase in ammonia emission from agriculture.

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7.9. Inside air quality: radon

In 1997, the results of a preliminary study on the concentration of radon in inside air of homes in Malta and Gozo was published[1]. Radon-222 is a product of radioactive decay of uranium and thorium: lung cancer cases have been attributed to exposure to alpha particles emitted by radon. A synergistic effect has been observed between exposure to radon and to cigarette smoke. The results of the local study indicate that radon levels are dependent on various factors which include floor location, type of underlying geological formation and ventilation. The measured values were within the safety limits recommended by WHO and varied from 20 to 104 Bq m^{-3}; the range of average radon levels in European dwellings varies from about 7 to 140 Bq m^{-3}.

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[1] Mifsud I, Amato Gauci AJ, Licari L and Sammut M, 1997, Preliminary investigation on radon levels in local dwellings, *Xjenza*, v 2(1) 34-38.

7.10. Why monitor air pollution? Regulations, standards and control

As stated in the introduction, the quality of Malta's ambient air in 1997 was largely unknown since no monitoring of any of the priority air pollutants was practiced. The collection of data on air quality is not an end in itself: rather, the information obtained through monitoring is used to provide a sound scientific basis for developing specific policies and strategies for controlling emissions and hence improving the quality of the air and that of the environment in general. It allows policy makers and planners to make informed environmental management decisions. Monitoring also permits an objective assessment of the efficacy of any control strategies and systems and establishes whether enforcement action is required to allow national air quality objectives to be attained. In this regard, it is to be noted that neither air quality objectives nor a regulatory framework covering major activities which have an impact on air quality were in place in 1997.

Regulation and enforcement have significant resourcing implications and these need to be addressed along with the resourcing of an air monitoring programme. There is no point in spending money on air monitoring activities if the generated data is not acted upon profitably.

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