Air Qual Atmos Health
DOI 10.1007/s11869-010-0131-2

Global review of national ambient air quality standards for PM_{10} and SO_2 (24 h)

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Received: 5 January 2010 / Accepted: 28 December 2010

Abstract Literature comparing national ambient air quality standards (AAQSs) globally is scattered and sparse. Twenty-four hour AAQSs for particulate matter <10 μm in aerodynamic diameter (PM_{10}) and sulfur dioxide (SO_2) in 96 countries were identified through literature review, an international survey, and querying an international legal database. Eighty three percent, of the 96 countries with information on the presence or absence of AAQSs, have 24-h AAQSs for either PM_{10} or SO_2. Slightly more countries have 24-h AAQSs for SO_2 (76 countries) than PM_{10} (69 countries). The average 24-h AAQSs for PM_{10} and SO_2 are 95 μg/m^3 (95% confidence interval [CI], 82–108 μg/m^3, n=68) and 182 μg/m^3 (95% CI, 158–205 μg/m^3, n=73). The population-weighted average AAQS for PM_{10} is 98 and 155 μg/m^3 for SO_2. The average AAQS for both PM_{10} and SO_2 are substantially higher than the recommended World Health Organization Air Quality Guideline (WHO AQG) value. Several countries have promulgated AAQSs at the WHO AQG value for PM_{10}, but none for SO_2. Further examination in selected countries found that air quality monitoring data, existing AAQSs in other countries, environmental epidemiology studies, and the WHO AQGs are considered the most often in establishing or revising AAQSs.

Keywords World Health Organization · Air Quality Guidelines · Air pollutants · Particulate matter · Sulfur dioxide

Introduction

Considerable resources are devoted to developing and implementing ambient air quality standards (AAQSs), but few systematic investigations appear to have been conducted to review AAQSs globally or explore the evidence used to establish and revise AAQSs. Although there are publications that list the AAQSs in one region (Maggioria and Silva 2006; Schwela et al. 2006), in urban areas (Archer and Davidson 1996; Schwela et al. 2006) or in selected countries as part of a larger analysis of air quality management (International Union of Air Pollution Prevention Associations 1991; Elsom and Longhurst 2004), a comprehensive global analysis of AAQSs does not seem to have been conducted.

This paper reviews the 24-h national AAQSs for particulate matter less than ten micrometers in aerodynamic diameter (PM_{10}) and sulfur dioxide (SO_2) globally.[1] In addition to tabulating AAQSs, we attempt to determine the type of scientific evidence considered by an agency when

Electronic supplementary material The online version of this article (doi:10.1007/s11869-010-0131-2) contains supplementary material, which is available to authorized users.

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[1] Given time and resource constraints and the variety of averaging times for AAQSs, it was not feasible to conduct a comprehensive review of the national AAQSs for every pollutant in every country. Instead, this review was limited to daily (24-h averaging time) AAQSs for PM_{10} and SO_2. This averaging time was selected because preliminary research indicated that 24-h is the most common averaging time for both pollutants. PM_{10} was selected instead of $PM_{2.5}$ (particulate matter <2.5 μm in aerodynamic diameter) because preliminary results indicated that a larger proportion of countries have AAQSs for PM_{10} than $PM_{2.5}$.

Published online: 18 January 2011

establishing or revising AAQSs, specifically the use of the World Health Organization Air Quality Guidelines.

In 2006, the World Health Organization (WHO) published global air quality guidelines (AQGs) for PM_{10}, SO_2, NO_2 and ozone (WHO 2006; Krzyzanowski and Cohen 2008). Thus far, there have been four versions (WHO 1987, 2000a, b, 2006) of the World Health Organization Air Quality Guidelines (WHO AQGs). The guidelines which provide an international reference that countries, particularly those without the resources to conduct their own assessment, can use to develop AAQSs.

The 2006 WHO AQGs are composed of a single guideline value and interim targets (ITs). The interim targets provide a stepwise approach to achieving the air quality guideline value. The guideline values can be used by developed countries, with the capacity to implement a strict AAQS, while developing countries, with higher levels of air pollution, could select an interim target level achievable based on their own air quality management infrastructure, and progress towards the AQG value at their own pace.

Methods

This research focuses on both *national* AAQSs, which are legally binding, and voluntary ambient air quality guidelines (AAQGs). Although AAQSs and AAQGs are substantially different, when examining how they are implemented and enforced, these topics are not the focus of this review. As a result, both AAQSs and AAQGs are referred to as AAQSs unless explicitly stated otherwise. When available the type of AAQS, i.e., guideline, standard or directive, is indicated in the supplemental materials.

Literature review

The review was limited to countries recognized by the United Nations (UN). The AAQSs (standards) for 75 countries were acquired, from internet searches, legal databases, and secondary sources; of which 57 were from internet and legal database search engines. Web-based searches were limited to information from government websites (e.g., The Ministry of Environment), peer-reviewed journals, or reports produced by a governmental, international or regional organization (e.g., the European Union or Food and Agriculture Organization). AAQS in 18 additional countries were acquired from secondary sources (Maggioria and Lopez-Silva 2006; Schwela et al. 2006).

Survey

Information on and the evidence used to establish AAQSs in 24 countries were gathered from respondents to surveys sent to the Ministry of Environment in 153 countries through the postal service and email in September and October 2007, and May 2008. The contact information of each agency was acquired from the Ministry of Environment or equivalent website for each country, the Clean Air Initiative—Asia Center, The National Association of Clean Air Agencies, the United Nations Environmental Programme, and the Global Environmental Facility website. A pre-addressed, postage-paid international business reply envelope was included with each paper survey. The surveys were sent to self-identified developing countries, defined here as members of the G77 (group of 77) or G24 (group of 24) within the UN, and European countries that were not members of the European Union (EU) in 2007. Although Iraq and Afghanistan fulfilled the inclusion criteria; surveys were not sent to either.

Each survey was sent with a cover letter requesting that the survey be completed by a representative who was responsible for drafting or revising their national ambient air quality standards (see supplemental materials for a copy of the survey). The exact role of the survey respondent in the AAQS revision process was not confirmed.

The 31 question survey covered three broad topics: background information on AAQSs; awareness of the WHO AQGs and their role in determining AAQSs; and the standard setting process, specifically the evidence-base used to establish or revise AAQSs. In some circumstances, agencies were asked to answer questions based on information projected into the future. For example, if an agency did not have AAQSs for PM, but they were in the process or had plans to establish them, then they were asked to answer a question such as *"Who are the participants involved in setting the AAQSs?"* based on the type of participants that they *expected* to be involved in future standard setting.

Results

AAQS

Information regarding the presence or absence of national daily AAQSs for PM_{10} and SO_2 was found for 96 out of 192 UN member countries (50%). These countries contain 5.6 billion people, or 84% of the world population. Eighty (83%) of the 96, have a 24-h AAQS for either PM_{10} or SO_2. Slightly more countries have a 24-h AAQS for SO_2 (n=76; 79%) than for PM_{10} (n=69; 72%).

The average 24-h AAQS for PM_{10} and SO_2 is 95 μg/m^3 (95% confidence interval [CI], 82–108 μg/m^3, n=68) and 182 μg/m^3 (95% CI, 158–205 μg/m^3, n=73). The population-weighted average AAQS for PM_{10} is 98 and 155 μg/m^3 for SO_2, respectively. The average 24-h AAQS was established or last revised for PM_{10} in 2004 (95% CI 2003–2005, n=65) and SO_2 in 2004 (95% CI 2002–2005, n=64).

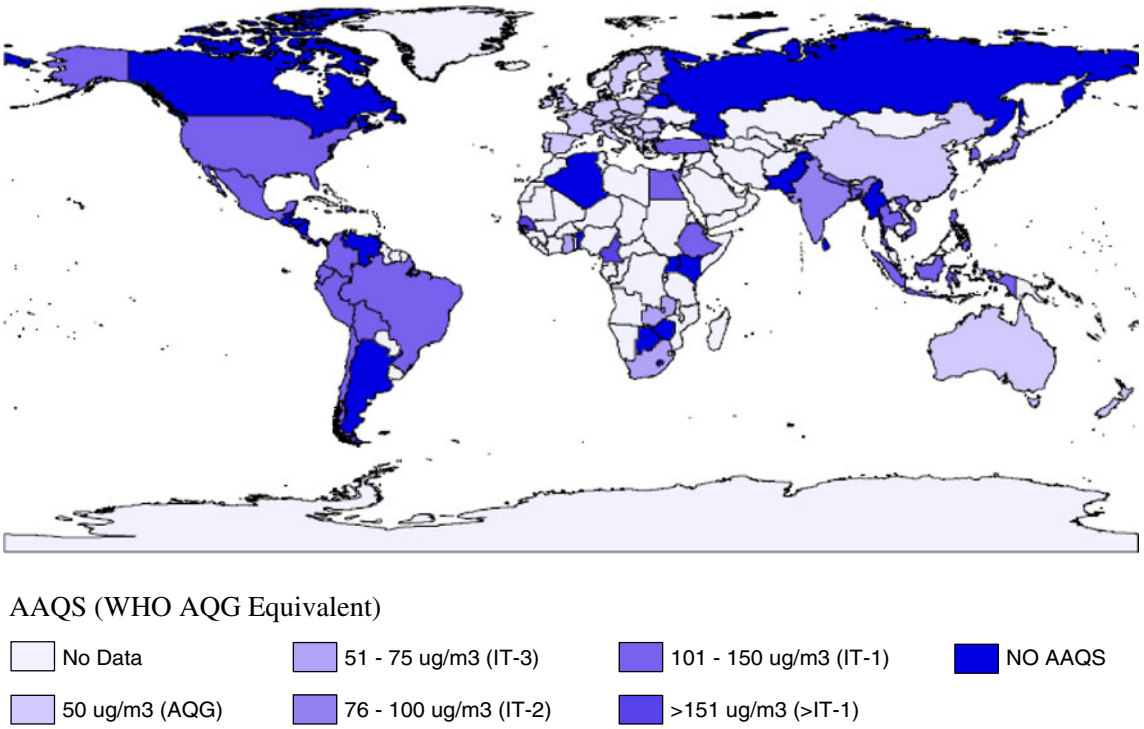

Fig. 1 Map of national 24-h AAQS for PM_{10} AAQS (WHO AQG equivalent)

Figures 1 and 2 present the range of AAQSs found in each country. A list of the AAQSs used to create Figs. 1 and 2 is provided in the Online Supplement. If a country has an AAQS, but the exact value is unknown, it was included in the >IT-1 category in both Figures.

Association between AAQS stringency and selected demographics

A statistical analysis (using STATA software) of the stringency of each AAQS comparing selected demographic

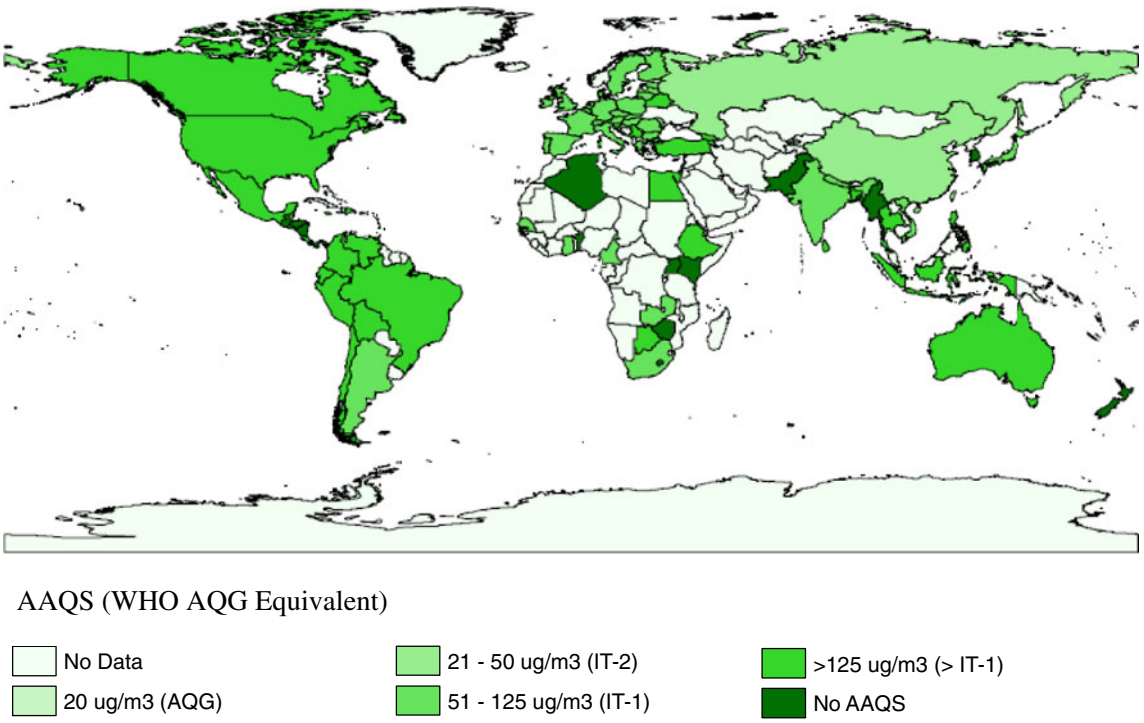

Fig. 2 Map of national 24-h AAQS for SO_2 AAQS (WHO AQG equivlent)

Table 1 Individual association between various demographics and PM_{10} AAQS

Demographic[a]	β	Confidence interval	R^2
Energy use per capita (kg of oil equivalent, 2007)	−35.61**	−46.47 to −24.76	0.40
Government expenditure (% of GDP, 2008)	−5.93**	−7.88 to −3.97	0.39
Health expenditure per capita ($US, 2007)	−16.86**	−23.19 to −10.53	0.30
PM_{10} (country level, ug/m,^{3} 2006)	44.55**	25.44 to 63.66	0.25
Population (2008)	7.68*	0.43 to 14.94	0.06

[a] The natural logarithm of the following variables was used in order to adjust for skewed distributions—health expenditure per capita, energy use per capita, population and average annual exposure to PM_{10}.

*$p<0.05$, **$p<0.01$

variables (population, urban population, gross domestic product per capita, energy use per capita, health expenditure per capita, average annual exposure to PM_{10}, and government expenditure; see Table 1 in the supplemental materials for details) yielded the results presented in Table 1 for PM_{10} AAQSs. The only variables with significant associations ($p<0.05$) to SO_2 AAQSs were government expenditure (β=−7.52, 95% confidence internal −12.02 to −3.02, $R^2=0.15$) and energy use per capita (β=−25.68, 95% confidence interval −51.18 to −0.17, $R^2=0.06$).

Participants involved in the AAQS process

The results presented in the following sections are based entirely on the survey discussed above. The geographical distribution and selected demographics of the survey respondents and non-respondents are summarized in the web supplement. The type of participants involved in the process of establishing or revising AAQSs were government or parliament scientists, followed by consultants, academic scientists, and government or parliament officials (see Table 2).

Table 2 The type of players involved in setting or revising the AAQSs

Type of participant	Percent countries where players involved ($n=18$)
Government parliament officials	100
Consultants	89
Academic scientists	89
Government parliament scientists	72
NGOs	67
Lawyers	50
Businesses	50
Economists	44
CBOs	44
Development organizations	17
Government institutions	6

NGO non-governmental organization, *CBO* community based organization

Evidence used to determine AAQSs

Air quality monitoring data, followed by environmental epidemiology studies, was used the most often to establish or revise AAQSs. Most agencies require the epidemiology studies used to set their AAQSs to be conducted in their own country (78%, $n=18$) and peer-reviewed (75%, $n=16$).

As shown in Table 3, most of the agencies also base their AAQSs on secondary evaluations of scientific evidence such as the AAQS in another country (71%, $n=21$—see Table 4) or the WHO AQGs (79%, $n=19$).

Large fractions of agencies require a risk assessment (61%, $n=18$) and an economic analysis (47%, $n=17$) to be conducted before setting an AAQS.

WHO AQGs

Prior to reading the questionnaire used in this research, almost all of the respondents (91%, $n=23$) were aware of at least one version of the WHO air quality guidelines. Awareness was slightly higher for the global AQGs (81%, $n=21$) than the European AQGs (79%, $n=19$). We found the Global or European AQGs have played a major role in the determination of AAQSs for PM or SO_2 in the majority of the respondent countries with AAQSs (79%, $n=15$). Most of the respondents (91%) also indicated that they now plan to use the WHO AQGs (2005) to revise or establish at least one of their AAQSs for either PM_{10}, $PM_{2.5}$, SO_2, NO_2 (nitrogen dioxide), or ozone ($n=22$). In addition, 17% of the countries that utilized one of the versions of the WHO AQGs referenced them in a legal act.

Discussion

Information regarding the presence or absence of 24-h AAQSs for PM_{10} and SO_2 was ascertained for 96 countries, which

Table 3 The type of evidence used to set or revise AAQS (n=17)

	Type of study or secondary evaluation	Number of countries
Primary data	Air quality monitoring data	17
	Environmental epidemiology	12
	Occupational epidemiology	5
	Controlled human exposure studies	3
	Toxicology studies	3
Secondary assessments	AAQSs from other Countries	14
	WHO AQGs	12
	NGO reports	5
	IARC[a] designation	3

[a] The International Agency for Research on Cancer (IARC) is a separate agency of the WHO that evaluates the carcinogenicity of a substance

represent 84% of the global population. Most countries (83%) had AAQSs for PM_{10} or SO_2 at the time of this research.

There are at least two numeric values for each AAQS that account for the majority of the AAQSs globally. AAQSs set at 50 and 150 μg/m^3 comprise 82% (n=68) of the PM_{10} AAQS. These coincide with the WHO AQG value (50 μg/m^3) and the US PM_{10} NAAQS (150 μg/m^3), which has not changed since 1997 (US EPA 2008). Standards set at 125 and 365 μg/m^3 represent 64% (n=73) of the AAQSs for SO_2—equivalent to the first WHO interim target (125 μg/m^3) for SO_2 and the US SO_2 NAAQS (365 μg/m^3). This suggests that the WHO AQGs and the US NAAQS have influenced the selection of AAQSs in numerous countries.

Table 4 Countries that based their AAQS on the AAQSs of another country or region (n=14)

Existing standard	Agencies that used the existing standard to determine their own AAQS
US NAAQS	Brunei Darussalam, Chile, Mexico, Egypt, Philippines, Thailand
EU directives	Republic of Serbia, Chile, Croatia
CARB standards	Switzerland, Thailand
Russia Federation	Georgia, Armenia
South Africa	Lesotho
Singapore	Brunei Darussalam
Senegal	Cameroon
Nigeria	Cameroon
Egypt	Cameroon
Asian countries and East Asian regions	Philippines
India	Nepal

US NAAQS United States National Ambient Air Quality Standards, *EU* European Union, *CARB* California Air Resources Board

Comparison to the WHO AQGs

Tables 5 and 6 provide a summary on the number of countries that have AAQGs that have reached each WHO IT for PM_{10} and SO_2. Most of the global population lives in a country that has not implemented an AAQS that meets the WHO AQG target for PM_{10} (72%) or SO_2 (100%). The average 24-h PM_{10} AAQS (95 μg/m^3) is slightly lower then WHO IT-2 (100 μg/m^3), out of three possible ITs, and almost twice the recommended WHO AQG (50 μg/m^3). The mean 24-h SO_2 AAQS (182 μg/m^3) is well above WHO IT-1 (125 μg/m^3), out of two possible ITs, and more than nine times the WHO AQG (20 μg/m^3) (WHO 2006). The population-weighted average AAQS for both PM_{10} and SO_2 is slightly different than the unadjusted averages, but within the same WHO IT range. The global average PM_{10} AAQS is much closer to the AQG value than the average SO_2 AAQS. This is because the European Union, which consisted of 27 countries at the time of this research, adopted the AQG value for PM_{10}, but the first interim target level (IT-1) for SO_2.

Association between AAQS stringency and selected demographics

As shown in Table 1, the stringency of AAQSs for PM_{10} is moderately associated with a number of national demographic indicators. Energy use, health/government expenditure, and country level PM_{10} concentration had the strongest association to PM_{10} AAQS stringency. Combining energy use and PM_{10} concentration into one model yielded slightly better results (R^2=0.46). Although, the low R^2 for each indicator signifies that the variability in each country's AAQS is largely attributed to other factors. These findings are line with the survey results, which identified air quality monitoring data, AAQS in other countries, environmental epidemiology studies, and the WHO AQGs as the primary determinants of a countries AAQS. However, since air quality monitoring data were a main determinant in the survey results one might expect country level PM_{10} to have

Table 5 Summary of PM_{10} AAQS and WHO targets (WHO, 2006)

WHO AQG equivalent	PM_{10} (ug/m^3)	Number of countries with AAQS in range[a]	Million people covered (2008)	Percent of global population (2008)
AQG	50	34	1870	28
IT-3	51–75	4	86	1
IT-2	76–100	3	1270	19
IT-1	101–150	25	1700	25
>IT-1	>151	2	31	<1
No AAQS		27	661	10
No data		95	1040	16

[a] Please note that this table excludes countries with AAQS, whose values are unknown (n=1)

a stronger association than observed. Government expenditure was associated to AAQS stringency for both pollutants.

The relationship between disability adjusted life years (DALYs) due to urban air pollution and AAQS stringency was not significant. However, the analysis was limited because data on DALYs are aggregated by region.

Evidence used to establish and revise AAQSs

The participants responsible for establishing or revising the AAQSs for each country encompassed a wide variety of professionals ranging from academic scientists to members of community based organizations. As expected, government or parliament officials participated in setting or revising the AAQSs in all of the respondent countries with a higher percentage relying on government or parliament officials (100%) than government scientists (72%). There was also an extremely high participation of consultants (89%), which was equal to that of non-government academic scientists. Approximately half of the participants were business representative (50%) or economist (44%). The extremely diverse nature of the participants suggests that science was not the only factor considered when determining an AAQS.

Air quality monitoring data (e.g., baseline air quality) were considered the most often when setting and revising AAQSs; followed by AAQSs in other countries, environmental epidemiology studies, and the WHO AQGs. This suggests that secondary assessments of the risk of air pollution are just a relevant as peer-reviewed literature. Most of the respondents (77%) indicated they only use epidemiology studies that have been conducted in their own country and require the epidemiology studies used for standard setting to be peer-reviewed (75%). This should be considered when funding projects in developing countries. The high weight given to monitoring data could signify the importance of ensuring AAQSs are feasible. Although, less than half of the respondents require an economic analysis to be conducted before an AAQS is set.

Toxicology studies were not considered nearly as much as epidemiology studies, they were only utilized by one fifth of the respondents and their importance rating was equal to NGO reports.

The US NAAQS, EU Directives, and the CARB air quality standards were utilized by other countries to set AAQSs regardless of the geographical region that the country is located in. It was common for an agency to base their standards on the AAQS of another country in their geographical region. However, the US NAAQS, EU Directives, and the CARB air quality standards were utilized by other countries to set AAQSs regardless of the geographical region that the country is located in.

The WHO AQGs

Almost all (91%, n=23) of the respondents were aware that the WHO publishes air quality guidelines that are globally applicable or for Europe. Most (79%, n=19) of the respondents used one of the four versions of the air quality

Table 6 Summary of SO_2 AAQS and WHO targets

WHO AQG equivalent	SO_2 (ug/m^3)	Number of countries with AAQS in range[a]	Million people covered (2008)	Percent of global population (2008)
AQG	20	0	0	0
IT-2	21–50	3	1470	22
IT-1	51–125	42	2050	31
>IT-1	>125	28	1640	24
No AAQS		18	379	6
No data		96	1090	16

[a] Please note that this table excludes countries with AAQS, whose values are unknown (n=3)

guidelines to determine their AAQSs, and significantly more (91%, n=22) of the respondents plan on using the most recent publication *Air Quality Guidelines: Global Update 2005* to set or revise their AAQSs. One of the two countries that did not plan to use the WHO AQGs currently has no AAQSs, and has no plans to establish any.

Most of the agencies that used one of the WHO AQGs documents to set or revise an AAQS evaluated the evidence in the document, compared it to their local conditions, and then decided on a standard. In the case of the PM standard, the more recent the WHO publication the more likely a country was to modify the WHO AQG for local conditions. This finding suggests it would be useful for the WHO to develop a method to aid agencies in evaluating how the WHO AQGs compare to country-specific characteristics in their next edition.

Limiting factors

There was a disproportionate lack of information about African, Middle Eastern, and Central European countries. Possible explanations for this could be a lack of actual AAQSs, a deficit in published information regarding AAQSs or language barriers—Arabic is difficult to translate with free online translation services. In addition, of course, the survey was printed in English.

A visual analysis of Figs. 1 and 2 indicates that there might be a spatial correlation in the AAQSs in particular regions. After more data are gathered, particularly in Africa and the Middle East, a spatial analysis might be warranted to test if there is an underlying trend of clustering. Until then, this review has produced a useful reference of 24-h PM_{10} and SO_2 AAQSs for policymakers in the developed and developing world.

Conclusion

In summary, most countries have 24-h AAQSs for both PM_{10} and SO_2. The average AAQS for both PM_{10} and SO_2 is substantially higher than the WHO AQG value. Several countries have promulgated AAQSs at the AQG value for PM_{10}, but not SO_2. Although AAQSs that pertain to 84% of the global population were identified, the global conclusions are limited by the lack of information in several regions. In the countries with data, however, air quality monitoring data seem to be considered the most frequently when setting and revising AAQS, followed by existing AAQSs in other countries, environmental epidemiology studies, and the WHO AQGs.

Relevance of findings

These findings, which cover 84% of the world population, have provided a set of benchmarks for evaluating the status of AAQSs. These benchmarks can provide policy makers with a broader perspective, when establishing and revising their own AAQSs. International organizations, such as the WHO, might also find these benchmarks useful when revising the AQGs. The information presented in this paper could also be utilized to advance econometric analyses of air quality regulations and economic and social indicators; and to promote further research on the implementation and enforcement of AAQSs.

Acknowledgments We thank Aaron Cohen and Michal Krzyzanowski for their guidance, the Brian and Jennifer Maxwell Endowed Chair at the School of Public Health for partial funding, and Maureen Lahiff for statistical support.

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Supplementary material for Vahlsing/Smith

A. Comparison of Survey Respondents and Non-Respondents

The geographical distribution and selected demographics of the survey respondents and non-respondents are summarized in Table 1 and 2.

Table 1: Number of respondents & Non – respondents in each Geographical Region

Region	Respondents	Non – Respondents	Total
Asia	10	22	32
Africa	6	43	49
Central Europe	3	13	16
South America	2	30	32
Middle East	1	16	17
North America	1	0	1
Western Europe	1	2	3
Scandinavia	0	3	3
Total	24	129	153

Asian countries represented the largest percent of the respondents (40 %), followed by African countries (25 %), Central European countries (12 %) and South American countries (8 %). The remaining 8 % of the respondents were from the Middle East, North America, and Western Europe. A statistical significant difference between medians was not observed between respondents and the non-respondents for any of the variables shown in Table 2.

Table 2: Selected Median of Demographics for Survey Respondents & Non – Respondents

Demographic	Median	
	Respondents (n = 24)	Non – Respondents (n = 129)
Population (2008)	1,000,000	6,200,000
Urban Population (% of Total, 2008)	53	49
GDP per capita (current $US, 2008)	3,400	2,800
Health expenditure per capita	130	150

(current US$ 2007)		
Energy Use (kg of oil equivalent per capita, 2007)	850	910
PM10 (population weighted ug/m3 2006)	51	37
SO2 Emissions (thousand metric tons 2000)	96	59
General Government Final Consumption Expenditure (% of GDP, 2008)	14	13
DALYS (attributed to urban air pollution, 2009)	1,000,000	930,000

*statistical significance difference (p>0.05) between respondent and non – respondents
GDP(Gross Domestic Product), DALYs (Disability Adjusted Life Years)
Source – World Bank, World Development Indicators, 2010

B. Ambient Air Quality Standards & Selected Demographics

Country Name (Source of AAQS[1])	AAQS Pollutant (ug/m3)		Year[2] AAQS Set or Revised		Population[3] (2008)	Urban population[4] (% of total, 2008)	GDP/capita[5] (current US$, 2008)	Health expenditure/capita[6] (current US$, 2006)	Energy use[7] (kg of oil equalent/capita, 2007)	PM10[8] (ug/m3, 2007)	General government final consumption expenditure[9] (% of GDP, 2008)	Type of AAQS**
	PM10	SO2	PM10	SO2								
Algeria (Kerbachi, 2006)	0	0	2007	2007	34,373,426	65	4,845	173	1,089	71	13	

[1] Secondary sources are listed. If no source is provided the AAQS data came from the survey results discussed in this paper.
[2] The most recent year each AAQS was revised or the year the AAQS was set, if has not been revised. For example, the AAQS or limit values in the EU were last considered for revision in 2008, despite the fact that they did not change from 1999 limit values set in 1999. If the country does not have AAQS then this is the date the most recent document was published stating that there are no AAQS.
[3] Source: World Bank, World Development Indicators, 2010, www.worldbank.org
[4] Source: World Bank, World Development Indicators, 2010, www.worldbank.org
[5] Source: World Bank, World Development Indicators, 2010, www.worldbank.org
[6] Source: World Bank, World Development Indicators, 2010, www.worldbank.org

Country Name (Source of AAQS[1])	AAQS Pollutant (ug/m3)		Year[2] AAQS Set or Revised		Population[3] (2008)	Urban population[4] (% of total, 2008)	GDP/capita[5] (current US$, 2008)	Health expenditure/capita[6] (current US$, 2006)	Energy use[7] (kg of oil equalent/capita, 2007)	PM10[8] (ug/m3, 2007)	General government final consumption expenditure[9] (% of GDP, 2008)	Type of AAQS**
	PM10	SO2	PM10	SO2								
Antigua & Barbuda[10] (Blacklane, 2011)	0	0	2007	2007	86,634	30	14,048	627		12	18	
Argentina (Maggioria, 2006)	0	70	2006		39,882,980	92	8,236	663	1,850	73	13	
Armenia (survey respondent)	0	yes[11]	2007	2004	3,077,087	64	3,873	133	926	59	12	
Australia (Aus. Gov., 1998)	50	209 (0.08 ppm)	1998	1998	21,431,800	89	47,370	3,986	5,888	15	1	
Austria (Council of EU, 2008)	50	125	2008	2008	8,336,926	67	49,599	4,523	3,997	33	18	D

[7] Source: World Bank, World Development Indicators, 2010, www.worldbank.org

[8] Particulate matter concentrations refer to fine suspended particulates less than 10 microns in diameter (PM10) that are capable of penetrating deep into the respiratory tract and causing significant health damage. Data for countries and aggregates for regions and income groups are urban-population weighted PM10 levels in residential areas of cities with more than 100,000 residents. The estimates represent the average annual exposure level of the average urban resident to outdoor particulate matter. The state of a country's technology and pollution controls is an important determinant of particulate matter concentrations (Source: World Bank, World Development Indicators, 2010, www.worldbank.org).

[9] General government final consumption expenditure (formerly general government consumption) includes all government current expenditures for purchases of goods and services (including compensation of employees). It also includes most expenditure on national defense and security, but excludes government military expenditures that are part of government capital formation. Source: World Bank, World Development Indicators, 2010, www.worldbank.org

[10] Although Antigua and Barbuda have no AAQS they use the WHO AQG when necessary

[11] If the survey respondent indicated that their country had AAQS for pollutant, but did not specify what the AAQS it was assumed that the country had the least stringent AAQS on the map, but the country was not included in average AAQA calculation.

Country Name (Source of AAQS[1])	AAQS Pollutant (ug/m3)		Year[2] AAQS Set or Revised		Population[3] (2008)	Urban population[4] (% of total, 2008)	GDP/capita[5] (current US$, 2008)	Health expenditure/capita[6] (current US$, 2006)	Energy use[7] (kg of oil equalent/capita, 2007)	PM10[8] (ug/m3, 2007)	General government final consumption expenditure[9] (% of GDP, 2008)	Type of AAQS**
	PM10	SO2	PM10	SO2								
The Bahamas[12] (Min, of Environment, 2006))	0	0	2008	2008	337,668	84		1,535				
Bangladesh (Govt. Bangladesh, 2005)	150	365	2005	2005	160,000,128	27	497	15	163	135	5	S
Barbados (EPD, 2004)	150		2004		255,203	40	14,426	932		40		S
Belarus (WHO, 2003)	0	200			9,680,850	73	6,230	302	2,891	6	17	M
Belgium (Council of EU, 2008)	50	125	2008	2008	10,708,433	97	47,085	4,056	5,366	22	23	D
Belize[13] (Law Rev. Com. 2003)	0	80	2003	2003	322,100	52	4,218	174		15	16	S
Benin (Min de l'Habitat, 2003)	0	0	2003	2003	8,662,086	41	771	32	343	46		
Bolivia (Maggioria, 2006)	150	365	1992	1992	9,694,113	66	1,720	69	571	94	13	S
Botswana (survey respondent)	0	300	2008	2001	1,921,122	60	6,982	372	1,068	67	20	S
Brazil* (Maggioria, 2006)	150	365	1990	1990	191,971,506	86	8,205	606	1,239	23	20	S
Brunei Darussalam* (survey respondent)	Yes	0	2007	2007	392,280	75		753	7,190	54		S
Bulgaria (Council of EU, 2008)	50	125	2008	2008	7,623,395	71	6,546	384	2,641	57	16	D

[12] The Bahamas has drafted AAQS (The Environmental Planning and Protection Act of 2005. Pollution Control and Waste Management Regulations (preliminary draft May 18, 2005), but they have not been adopted.

[13] Residential and rural SO_2 AAQS. The industrial and mixed use SO_2 AAQS is 120 ug/m^3 and the sensitive AAQS is 30 ug/m^3.

Country Name (Source of AAQS[1])	AAQS Pollutant (ug/m3)		Year[2] AAQS Set or Revised		Population[3] (2008)	Urban population[4] (% of total, 2008)	GDP/capita[5] (current US$, 2008)	Health expenditure/capita[6] (current US$, 2006)	Energy use[7] (kg of oil equalent/capita, 2007)	PM10[8] (ug/m3, 2007)	General government final consumption expenditure[9] (% of GDP, 2008)	Type of AAQS**
	PM10	SO2	PM10	SO2								
Cameroon (survey respondent)	260	125	2007	2007	19,088,385	57	1,226	54	391	62		S
Canada[14] (Health Canada, 2006)	0	301 (115 ppb)	2008	1998	33,311,400	80	45,070	4,409	8,169	17		
Chile (survey respondent)	150	250	2001		16,803,952	88	10,084	615	1,851	48	12	S
China (personal communication)	50	50	2000	2000	1,324,655,000	43	3,267	108	1,484	73	14	S
Colombia (Maggioria, 2006)	150	250	2006	2006	45,012,096	75	5,416	284	655	22	16	S
Costa Rica (Maggioria, 2006)	150	365	2002	2002	4,519,126	63	6,564	488	1,070	36	14	
Croatia (survey respondent)	50	125	2004	2004	4,434,000	57	15,637	1,009	2,101	30	19	S
Cyprus (Council of EU, 2008)	50	125	2008	2008	862,434	70	31,410	1,778	2,854	44	19	D
Czech Republic (Council of EU, 2008)	50	125	2008	2008	10,424,336	74	20,673	1,141	4,428	21	20	D
Denmark (Council of EU, 2008)	50	125	2008	2008	5,493,621	87	62,118	5,551	3,598	19	27	D
Dominican Republic (Maggioria, 2006)	150	150	2002	2002	9,952,711	69	4,576	224	804	20	8	S
Ecuador (Maggioria, 2006)	150	350	2003	2003	13,481,424	66	4,056	200	885	25	11	

[14] The maximum acceptable level was used in this research. The maximumtolerable level is 306 ppb.

Country Name (Source of AAQS[1])	AAQS Pollutant (ug/m3)		Year[2] AAQS Set or Revised		Population[3] (2008)	Urban population[4] (% of total, 2008)	GDP/capita[5] (current US$, 2008)	Health expenditure/capita[6] (current US$, 2006)	Energy use[7] (kg of oil equalent/capita, 2007)	PM10[8] (ug/m3, 2007)	General government final consumption expenditure[9] (% of GDP, 2008)	Type of AAQS**
	PM10	SO2	PM10	SO2								
Egypt (survey respondent)	150	150	2005		81,527,172	43	1,991	101	840	119	11	S
El Salvador (Maggioria, 2006)	150	365	2003	2003	6,133,910	61	3,605	206	800	33	9	S
Estonia (Council of EU, 2008)	50	125	2008	2008	1,340,675	69	17,454	837	4,198	13	19	D
Ethiopia (Etyemezian V, 2005)	150	365 (0.14 ppm)	2003	2003	80,713,434	17	317	9	290	68	10	G
Finland (Council of EU, 2008)	50	125	2008	2008	5,313,399	63	51,323	3,809	6,895	18	22	D
France (Council of EU, 2008)	50	125	2008	2008	62,277,432	77	44,508	4,627	4,258	13	23	D
The Gambia (Sarr, 2008)	50	125	1999	1999	1,660,200	56	489	22		86	16	
Georgia (survey respondent)	0	yes	2007	2003	4,307,011	53	2,970	191	767	47	14	S
Germany (Council of EU, 2008)	50	125	2008	2008	82,110,097	74	44,446	4,209	4,027	19	18	D
Ghana (survey respondent)	70	100	2000	2000	23,350,927	50	713	54	415	34	20	G
Greece (Council of EU, 2008)	50	125	2008	2008	11,237,094	61	31,670	2,679	2,875	36	17	D
Grenada (survey respondent)	0	0	2007	2007	103,538	31	6,162	416		20	16	
Guatemala (Maggioria, 2006)	0	0	2006	2006	13,686,128	49	2,848	186	620	62	9	
Honduras (Maggioria, 2006)	0	0	2006	2006	7,318,789	48	1,823	107	661	43	16	

Country Name (Source of AAQS[1])	AAQS Pollutant (ug/m3)		Year[2] AAQS Set or Revised		Population[3] (2008)	Urban population[4] (% of total, 2008)	GDP/capita[5] (current US$, 2008)	Health expenditure/capita[6] (current US$, 2006)	Energy use[7] (kg of oil equalent/capita, 2007)	PM10[8] (ug/m3, 2007)	General government final consumption expenditure[9] (% of GDP, 2008)	Type of AAQS**
	PM10	SO2	PM10	SO2								
Hungary (Council of EU, 2008)	50	125	2008	2008	10,038,188	68	15,408	1,019	2,658	19	9	D
India (Govt. of India, 2009)	100	80	2009	2009	1,139,964,932	30	1,017	40	529	65	12	S
Indonesia (Govt. of Indonesia, 1999)	150	365	1999	1999	227,345,082	51	2,246	42	849	83	8	S
Ireland (Council of EU, 2008)	50	125	2008	2008	4,425,675	61	60,460	4,556	3,457	16		D
Israel[15] [i] (Govt. of Israel, 1992)	150	280	1992	1992	7,308,800	92	27,652	1,893	3,059	31	25	
Italy (Council of EU, 2008)	50	125	2008	2008	59,832,179	68	38,492	3,136	3,001	27	20	D
Jamaica (Claude Davis, 2006)	150	365	2006	2006	2,687,200	53	5,438	224	1,852	43		S
Japan (Schwela, 2006)	100	105			127,704,000	66	38,455	2,751	4,019	30		S
Kenya[16] (Govt. of Kenya, 2009)	0	0	2004	2004	38,765,312	22	783	34	485	36	17	

[15] PM_{10} is defined as respirable particulate matter.

[16] Draft AAQS were promulgated. See reference.

Country Name (Source of AAQS[1])	AAQS Pollutant (ug/m3)		Year[2] AAQS Set or Revised		Population[3] (2008)	Urban population[4] (% of total, 2008)	GDP/capita[5] (current US$, 2008)	Health expenditure/capita[6] (current US$, 2006)	Energy use[7] (kg of oil equalent/capita, 2007)	PM10[8] (ug/m3, 2007)	General government final consumption expenditure[9] (% of GDP, 2008)	Type of AAQS**
	PM10	SO2	PM10	SO2								
Korea, Rep. (Schwela, 2006)	150				48,607,000	81	19,115	1,362	4,586	35	15	S
Latvia (Council of EU, 2008)	50	125	2008	2008	2,266,094	68	14,908	784	2,052	16	20	D
Lesotho (survey respondent)	0	0	2007	2007	2,049,429	25	791	51		41	27	
Lithuania (Council of EU, 2008)	50	125	2008	2008	3,358,115	67	14,098	717	2,740	19	18	D
Luxembourg (Council of EU, 2008)	50	125	2008	2008	488,650	82	109,903	7,439	8,790	15	16	D
Malta (Council of EU, 2008)	50	125	2008	2008	411,950	94		1,362	2,120			D
Mauritius (survey respondent)	100	200	1997	1997	1,268,854	42	7,345	247		18	13	S
Mexico (SEMARNAT, 2005) (Min. of Health., 1993)	120	341	2005	1994	106,350,434	77	10,232	564	1,750	36	10	S
Moldova (Cojocaru, 2008)	0	50	2008		3,633,369	42	1,694	127	910	36	21	M
Myanmar (survey respondent)	0	0	2007	2007	49,563,019	33		7	319	58		
Nepal (survey respondent; Sah, 2003)	120	70	2003	2003	28,809,526	17	438	20	338	34	10	S
Netherlands (Council of EU, 2008)	50	125	2008	2008	16,445,593	82	52,963	4,243	4,909	34	25	D
New Zealand (Min. for the Envir, 2004)	50	0	2004	2004	4,268,900	87	30,439	2,790	3,966	14		
Nicaragua (Maggioria, 2006)	0	0	2006	2006	5,667,325	57	1,163	92	621	28		

Country Name (Source of AAQS[1])	AAQS Pollutant (ug/m3)		Year[2] AAQS Set or Revised		Population[3] (2008)	Urban population[4] (% of total, 2008)	GDP/capita[5] (current US$, 2008)	Health expenditure/capita[6] (current US$, 2006)	Energy use[7] (kg of oil equalent/capita, 2007)	PM10[8] (ug/m3, 2007)	General government final consumption expenditure[9] (% of GDP, 2008)	Type of AAQS**
	PM10	SO2	PM10	SO2								
Pakistan (survey respondent)	0	0	2007	2007	166,111,487	36	991	23	512	120	12	
Panama (Maggioria, 2006)	0	0	2006	2006	3,398,823	73	6,793	396	845	35	11	
Peru (Maggioria, 2006)	150	365	2001	2001	28,836,700	71	4,477	160	494	54	9	
Philippines (survey respondent)	150	180	1999	1999	90,348,437	65	1,847	63	451	23	10	G
Poland (Council of EU, 2008)	50	125	2008	2008	38,125,759	61	13,845	716	2,547	37	19	D
Portugal (Council of EU, 2008)	50	125	2008	2008	10,622,413	59	22,923	2,108	2,363	23	21	D
Romania (Council of EU, 2008)	50	125	2008	2008	21,513,622	54	9,300	369	1,806	14	16	D
Russian Federation (Sakhalin Energy, 2005)	0	50	2008		141,950,000	73	11,832	493	4,730	18	17	M
Senegal (Govt. of Senegal, 2003)	260	125	2003	2003	12,211,181	42	1,087	54	225	95	10	S
Seychelles (survey respondent)	0	0	2007	2007	86,956	54	9,580	564			15	
Singapore (Schwela, 2006)	150	365			4,839,400	100	37,597	1,148	5,831	41	11	
Slovak Republic (Council of EU, 2008)	50	125	2008	2008	5,406,626	57	18,212	1,077	3,307	15	17	D
Slovenia (Council of EU, 2008)	50	125	2008	2008	2,021,316	49	27,019	1,836	3,632	30		D
South Africa (Rep. of South Africa, 2006)	75	125	2007	2004	48,687,000	61	5,678	497	2,807	21	20	G

Country Name (Source of AAQS[1])	AAQS Pollutant (ug/m3)		Year[2] AAQS Set or Revised		Population[3] (2008)	Urban population[4] (% of total, 2008)	GDP/capita[5] (current US$, 2008)	Health expenditure/capita[6] (current US$, 2006)	Energy use[7] (kg of oil equalent/capita, 2007)	PM10[8] (ug/m3, 2007)	General government final consumption expenditure[9] (% of GDP, 2008)	Type of AAQS**
	PM10	SO2	PM10	SO2								
Spain (Council of EU, 2008)	50	125	2008	2008	45,555,716	77	35,215	2,712	3,208	32	19	D
Sri Lanka (survey respondent)	0	Yes	2007	2003	20,156,204	15	2,013	68	464	82	16	S
Sweden (Council of EU, 2008)	50	125	2008	2008	9,219,637	85	51,950	4,495	5,512	12	26	D
Switzerland (survey respondent)	50	80	2007		7,647,675	73	64,327	6,108	3,406	26		S
Thailand (survey respondent)	120	300	1995	2001	67,386,383	33	4,043	136	1,553	71	12	S
Trinidad & Tobago (Rep. of Trinidad and Tobago, 2005; email communication, 2008)	75	125	2008	2008	1,333,388	13	18,108	785	11,506	101	11	G
Turkey (Rep. of Turkey, 1986)	150	150	1986	1986	73,914,260	69	9,942	465	1,370	40	13	
Uganda (Personal comm., 2003)	0	0	2003	2003	31,656,865	13	453	28		12	12	
United Kingdom (Council of EU, 2008)	50	125	2008	2008	61,414,062	90	43,541	3,867	3,464	15	22	D
United States (EPA, 2009)	150	365	2006	1996	304,060,000	82	46,350	7,285	7,766	21		S
Venezuela (Maggioria, 2006)	0	365	2006	1995	27,935,000	93	11,246	477	2,319	11	11	
Vietnam (Schwela, 2006)	150	125	2005	2005	86,210,781	28	1,051	58	655	55	6	
Serbia (survey respondent)	50	150	2000	2000	7,350,221	52	6,811	408	2,141		21	
Zambia (Govt. of Zambia, 1996)	70	125	1996	1996	12,620,219	35	1,134	57	604	40	9	G

Country Name (Source of AAQS[1])	AAQS Pollutant (ug/m3)		Year[2] AAQS Set or Revised		Population[3] (2008)	Urban population[4] (% of total, 2008)	GDP/capita[5] (current US$, 2008)	Health expenditure/capita[6] (current US$, 2006)	Energy use[7] (kg of oil equalent/capita, 2007)	PM10[8] (ug/m3, 2007)	General government final consumption expenditure[9] (% of GDP, 2008)	Type of AAQS**
	PM10	SO2	PM10	SO2								
Zimbabwe (Govt. of Zimbabwe, 2006)	0	0	2005	2005	12,462,879	37		79	759	27		
World (WHO, 2006)	50	20	2005	2005	6,697,254,041	50	9,042	809	1,819	50		G

*Sub-national AQS

** S = ambient air quality standard, G = ambient air quality guideline, M = maximum permissible concentration, D = EU air quality directive, blank values indicate the type of AAQS is unknown

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PARTICULADO PARA PARTICULAS SUSPENDIDAS TOTALES PST, PARTICULAS MENORES DE 10 MICROMETROS PM_{10} Y PARTICULAS MENORES DE 2.5 MICROMETROS $PM_{2.5}$ EN EL AIRE AMBIENTE COMO MEDIDA DE PROTECCION A LA SALUD DE LA POBLACION, PARA QUEDAR COMO NORMA OFICIAL MEXICANA NOM-025-SSA1-1993, SALUD AMBIENTAL.
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AAQS Survey

School of Public Health,
University of California, Berkeley, USA
September 2007
Survey on Air Quality Guidelines and Standards

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Please complete the following questionnaire. The questions of the most importance to us are in bold, if you are not able to complete the entire questionnaire, any attempt to answer the questions in bold would be much appreciated.

Country ☐
Name of respondent ☐
Title and agency ☐
Postal address for receiving final report of survey results and a complimentary copy of the *WHO Air Quality Guidelines, Global Update 2005*

☐

Section 1: Background Information on Air Quality Standards

1. Does your country have a law or act mandating the establishment of ambient air quality standards (AAQSs)?

☐ yes
- **a. What year did your country implement the law or act?** ☐
- **b. Please check the pollutants that your country has ambient air quality standards (AAQSs) for** ☐ **carbon monoxide** ☐ SO_x ☐ NO_2 ☐ **lead** ☐ **ozone** ☐ **Total PM** ☐ PM_{10} ☐ $PM_{2.5}$ ☐ **other** _____

☐ **no**
- **a. Does your country plan to establish AAQSs?** ☐ **yes** ☐ **no**

2. Is your country part of any regional air quality agreement, regulation, or standard?
☐ yes, please list _____
☐ no

3. Is the establishment of your countries ambient air quality standards (AAQS) tied to an international loan agreement or debt package with, for example, the World Bank?
☐ yes, please write the name of the development organization it is with _____
☐ no

4. What type of AAQSs does your country have? *(please check all that apply)*
☐ AAQSs for different land use practices, for example residential or industrial
☐ national AAQS ☐ state/municipal/local AAQS

5. Does your country use a Pollution Standards Index?
☐ yes
- a. Which standards are used to calculate the Pollution Standard Index? *(check all that apply)*
  - ☐ WHO Air Quality Guidelines
  - ☐ Standards from another country, Please specify the country _____
  - ☐ the national AAQS
  - ☐ other _____

☐ no

Section 2: WHO AQG

6. Before reading this questionnaire, were you aware that the World Health Organization (WHO) publishes
- **a. air quality guidelines for Europe?** ☐ **yes** ☐ **no**
- **b. air quality guidelines that are globally applicable?** ☐ **yes** ☐ **no**

7. Does your country have ambient air quality standards (legally binding) or guidelines (voluntary) for Particulate Matter (PM)?
☐ **yes, we have** *(please circle)* **standards guidelines**
- **a. What year were they established?** _____
- **b. When were they last updated?** _____

☐ **no (please go to question 11)**

8. What indicator of PM does your country have standards for? *(please check all that apply and write the concentration of the standard)*

Pollutant	**Standard (mass concentration) Annual**	**Daily**
☐ Total Suspended Particles (TSP)	_____ (ug/m^3)	_____ (ug/m^3)
☐ Thoracic particles	_____ (ug/m^3)	_____ (ug/m^3)
☐ PM_{10}	_____ (ug/m^3)	_____ (ug/m^3)
☐ $PM_{2.5}$	_____ (ug/m^3)	_____ (ug/m^3)
☐ other _____	_____ (ug/m^3)	_____ (ug/m^3)

9. Please check all of the following documents that have played a significant role in the deliberations for setting the AAQS for PM, and indicate how the evidence in the document was used.

Document	**Evidence in document evaluated, and accepted**	**Evidence in document evaluated, but not used**	**Evidence in document evaluated, and modified for local conditions**
☐ *Air Quality Guidelines for Europe* **(published by the WHO in 1987)**	☐	☐	☐
☐ *Air Quality Guidelines for Europe 2nd edition* **(published by the WHO in 2000)**	☐	☐	☐
☐ *Guidelines for Air Quality* **(published by the WHO in 2000, with a global focus)**	☐	☐	☐
☐ *Air Quality Guidelines: Global Update 2005* **(published by the WHO in 2006)**	☐	☐	☐

10. Have any of the documents checked in Question 9 been acknowledged in a legal act?
☐ **yes** ☐ **no**

11. The WHO has promulgated PM AQGs using different approaches that try to reflect in varying degree the growing scientific recognition that there are no clear thresholds, i.e., levels of pollution below which there is no effect. The figures below represent three of these methods.
(see the following page)

Method A: Risk Coefficients with no specific recommended concentrations (WHO, 2000)

Table 11. Summary of relative risk estimates for effects of long-term exposure to particulate matter on the morbidity and mortality associated with a 10 μg/m³ increase in the concentration of PM10 or PM2.5

Endpoint (reference)	Relative risk for PM2.5 (95% confidence interval)	Relative risk for PM10 (95% confidence interval.)
Mortality (26)	1.14 (1.04–1.24)	1.10 (1.03–1.18)
Mortality (715)	1.07 (1.04–1.11)	n.a.
Bronchitis (154)	1.34 (0.94, 1.99)	1.29 (0.96–1.83)
% change in FEV_1, children (155)	– 1.9% (– 3.1% to – 0.6%)*	– 1.2% (– 2.3% to – 0.1%)
% change in FEV_1, adults (157)		– 1.0% (n.a.)

Method B: Concentration Guidelines alone (WHO, 2006)

Guidelines	
$PM_{2.5}$:	10 μg/m³ annual mean 25 μg/m³ 24-hour mean
PM_{10}:	20 μg/m³ annual mean 50 μg/m³ 24-hour mean

Method C: Guidelines with Interim Targets and some risk information (WHO, 2006)

WHO air quality guidelines and interim targets for particulate matter: annual mean concentrations*

	PM_{10} (μg/m³)	$PM_{2.5}$ (μg/m³)	Basis for the selected level
Interim target-1 (IT-1)	70	35	These levels are associated with about a 15% higher long-term mortality risk relative to the AQG level
Interim target-2 (IT-2)	50	25	In addition to other health benefits, these levels lower the risk of premature mortality by approximately 6% [2–11%] relative to theIT-1 level
Interim target-3 (IT-3)	30	15	In addition to other health benefits, these levels reduce the mortality risk by approximately 6% [2–11%] relative to the -IT-2 level.
Air quality guideline (AQG)	20	10	These are the lowest levels at which total, cardiopulmonary and lung cancer mortality have been shown to increase with more than 95% confidence in response to long-term exposure to $PM_{2.5}$

Please indicate which approach *provides the most useful information* for setting the AAQSs for your country. Here, we are not asking you to judge the specific PM levels in the above examples, but rather to the judge the *utility of the method* used by WHO to present them

- ☐ Method A: Risk coefficients with no specific guidelines provided
- ☐ Method B: Guidelines with no risk coefficients provided
- ☐ Method C: Guidelines with Interim Targets (that provide a step-wise approach to air pollution management) with some risk information
- ☐ all three methods are necessary
- ☐ none of the three methods are useful
- ☐ another method, please explain _____

12. Please explain the reasons for your answer to the previous question. We urge you to take all the space you need as this is an important part of the survey. Please consider

- **scientific issues, for example whether a method better reflects physical reality in your opinion;**
- **regulatory concerns, for example whether a method would be easier to implement in regulation;**
- **policy issues, for example whether a method is easier explain to policy makers and the public.**

_____
_____
_____

13. Does your country have ambient air quality standards or guidelines for SO_2?

- ☐ yes, we have standards
- ☐ yes, we have guidelines
  - a. What year were they established? _____
  - b. When were they last updated? _____
- ☐ no (please go to question 18)

14. What averaging time is used for each SO_2 AAQS? *(please check all that apply and write the concentration of the standard)*

Pollutant	Standard (mass concentration)
☐ 24 hour average	_____ ug/m³
☐ 8 hour average	_____ ug/m³
☐ 10 minute average	_____ ug/m³
☐ annual average	_____ ug/m³
☐ other _____	_____ ug/m³

15. Please check the following documents if they have played a significant role in the deliberations for setting the AAQS for SO_2 and indicate how the evidence in the document was used.

Document	Evidence in document evaluated, and accepted	Evidence in document evaluated, but not used	Evidence in document evaluated, and modified for local conditions
☐ *Air Quality Guidelines for Europe* (published by the WHO in 1987)	☐	☐	☐
☐ *Air Quality Guidelines for Europe 2nd edition* (published by the WHO in 2000)	☐	☐	☐
☐ *Guidelines for Air Quality* (published by the WHO in 2000, with a global focus)	☐	☐	☐
☐ *Air Quality Guidelines: Global Update 2005* (published by the WHO in 2006)	☐	☐	☐

16. Have any of the documents checked in Question 15 been acknowledged in a legal act?
☐ yes ☐ no

17. Did you consider the secondary formation of particles when setting the AAQS for SO_2?
☐ yes ☐ no

18. Does your country *plan* to use the WHO AQG to set or update your AAQSs?

- ☐ yes
  - ☐ a. We plan to use them to *set* AAQSs
    For which pollutants? (please check) ☐PM ☐SO_2 ☐NO_2 ☐O_3
  - ☐ b. We plan to use them to *update* AAQSs
    For which pollutants? (please check) ☐PM ☐SO_2 ☐NO_2 ☐O_3
- ☐ no

19. What additional information do you want from the WHO in order to help set your AAQSs?

_____
_____

Section 3: The Evidence-base used to Determine AAQSs and the Standard Setting Process
(If you answered "yes" to either question 7 or 13 please continue. If you answered "no" to question 7 and 13 and have begun planning your AAQSs, please answer the following questions. If setting AAQSs is not a current priority, please skip to the comments section – Question 31 - at the end of the questionnaire.)

20. What types of studies are used to set the AAQSs in your country? *(please check all that apply)*
- ☐ **toxicology studies (animal studies conducted in a lab)**
- ☐ **epidemiology studies in natural settings (studies examining the causation between exposure to air pollution and health effects)**
- ☐ **epidemiology studies in occupational settings**
- ☐ **controlled human exposure studies (studies in which humans are exposed to air pollutants in a controlled lab environment)**
- ☐ **monitoring data on current pollution concentrations in your country**
- ☐ **reports from nongovernmental organizations (NGOs)**
- ☐ **other** _____

21. Please rate the importance of the studies you selected in the previous question when determining your AAQSs.

Type of Study	Important	Partially Important	Not important
toxicology studies	☐	☐	☐
epidemiology studies	☐	☐	☐
controlled human exposure studies	☐	☐	☐
Reports from NGOs	☐	☐	☐
other	☐	☐	☐

22. Do you require the epidemiology studies used to set your AAQSs to be conducted in your own country?
☐ **yes** ☐ **no**

23. Do epidemiology, toxicology and controlled human exposure studies have to be peer reviewed to be used to set the AAQSs in your country?
☐ yes ☐ no

24. Which of the following standards, if any, are your AAQSs based on (please check)
- ☐ **European Union air quality directives**
- ☐ **the United States air quality standards**
- ☐ **California's air quality standards**
- ☐ **the standards of another country in the region**
  If so, which country _____
- ☐ **International Agency for Research on Cancer (IARC) designation**

25. Who are the participants involved in setting the AAQSs? *(please check all that apply)*
☐ **government/parliament officials** ☐ **consultants** ☐ **development organizations**
☐ **academic scientists** ☐ **government/parliament scientists** ☐ **lawyers**
☐ **economists** ☐ **businesses** ☐ **environment or health NGOs**
☐ **community based organizations (CBOs)**
☐ **other** _____

26. Which of the following factors, if any, are *considered* when setting an AAQS? *(please check all that apply)*
☐ **health effects** ☐ **exposure duration** ☐ **number of people exposed**
☐ **cost** ☐ **feasibility** ☐ **non-health environmental effects**
☐ **concentration of air pollutant** ☐ **susceptible populations**
☐ **concentration of other pollutants that might affect the pollutant of interest**
☐ **the effect of the pollutant of interest on climate change**
☐ **other** _____
☐ **other** _____

27. Do you require a risk assessment to be conducted in your country on the pollutant of interest, before an AAQS is set?
☐ yes ☐ no

28. Which official or agency makes the final decision about each AAQS?
_____

29. Is an economic analysis done before or after the AAQSs are set?
☐ **before** ☐ **after** ☐ **neither**

30. Do you plan to include an evaluation of the how PM or SO_2 interact with gases that affect the climate in your next revision of the AAQSs?
☐ yes ☐ no

31. Comments/ Issues related to air quality standards (for example: Is there a source of information you find valuable that has not been mentioned above? What other information would be valuable, when setting your AAQS? What type of international assistance would you prefer? What other sources do you need? Any other suggestions that you want to share are welcome.)

Please make sure your contact information is noted at the beginning of the questionnaire so that you receive a copy of the final report and WHO publication.
If not using the addressed envelope please return to:

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Thank you very much for taking the time to complete this questionnaire. We appreciate your participation.

References

Air Quality Guidelines for Europe, 2nd Edition. Copenhagen,WHO Regional Office for Europe, 2000 (WHO Regional Publications, European Series, No 91).

Air Quality Guidelines for Europe: Global Update 2005. Copenhagen, WHO Regional Office for Europe, 2006.

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