Monitoring of PM2.5
- Experience in Japan

Technology Transfer Project of PM2.5 Monitoring under the Integrated Programme on Better Air Quality (IBAQ)

ACAP

Asia Center for Air Pollution Research

Japan Environmental Sanitation Center

Introduction

Particle pollution is a mixture of microscopic solids and liquid droplets suspended in air. This pollution, also known as particulate matter, is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, soil or dust particles, and allergens (such as fragments of pollen or mold spores).

Fine particle pollution or $PM_{2.5}$ describes particulate matter that is 2.5 micrometers in diameter and smaller - 1/30th the diameter of a human hair.
Fine particle pollution can be emitted directly or formed secondarily in the atmosphere. Examples Sulfates are a type of secondary particle formed from sulfur dioxide emissions from power plants and industrial facilities. Nitrates, another a type of fine particle, are formed from emissions of nitrogen oxides from power plants, automobiles, and other combustion sources.
The chemical composition of particles depends on location, time of year, and weather.

Health studies have shown a significant association between exposure to fine particles and premature death from heart or lung disease. Fine particles can aggravate heart and lung diseases and have been linked to effects such as: cardiovascular symptoms; cardiac arrhythmias; heart attacks; respiratory symptoms; asthma attacks; and bronchitis. These effects can result in increased hospital admissions, emergency room visits, absences from school or work, and restricted activity days. Individuals that may be particularly sensitive to fine particle exposure include people with heart or lung disease, older adults, and children. (referred from the website of US-EPA)

The Ministry of the Environment, Japan (MOEJ) has been taking actions against $PM_{2.5}$, including establishment of environmental quality standard, assessment of automated measuring equipment having equivalence to the standard measuring method, promotion of conduct of monitoring in cooperation with local governments, and studies on the guidelines for raising an alert. In the future, the EANET participant countries are also to discuss reinforcement of monitoring of $PM_{2.5}$, so summarizing and communicating the approaches and experience in Japan will have significant meaning for the EANET participant countries.

Aiming at possible practical application in the future training for EANET participant countries, and other opportunities, the approaches adopted so far in Japan for $PM_{2.5}$ are summarized.

Contents

1 Background to establishing the Environmental Quality Standards (EQSs) [1)]

The United States had established air quality standards for fine particulate matter ($PM_{2.5}$) in 1997, and these standards were revised in September 2006. The World Health Organization (WHO) also released the 2005 edition of guidelines on target values for the Environmental Quality Standards (EQSs) in October 2006, which laid out air quality guidelines and provisional target values for $PM_{2.5}$. In the European Union, an EU directive concerning the upper limit for the concentration of $PM_{2.5}$ was announced in June 2008.

In light of these movements around the world, the Ministry of the Environment, Japan (MOEJ) began to conduct a study on the impact of exposure to fine particular matter in 1999 with the objective of elucidating the relationship between exposure to $PM_{2.5}$ in the general air environment and its impact on health. The results of this study were summarized and published in July 2007. Based on findings gathered in Japan and abroad, a study committee to assess the health impact of fine particulate matter was set up in May 2007 with the objective of conducting a professional review on assessments on the health impact of fine particular matter on respiratory and circulatory systems. The results of the study were summarized in a report in April 2008. According to this report, epidemiological and toxicity findings supported the hypothesis that PM2.5 on the whole has a certain level of impact on human health, and the report asserted the need to conduct a careful review on the methods of quantitative risk assessment in order to establish target values for EQSs.

Consequently, in June 2008, MOEJ established a special committee on the risk assessment methods for fine particulate matter under the Air Environment Subcommittee of the Central Environmental Council, with the aim of deliberating on quantitative risk assessment methods for $PM_{2.5}$. The committee summarized and published its findings in a report in November the same year.

In December 2008, MOEJ consulted the Central Environmental Council about the establishment of EQSs for $PM_{2.5}$, prompting the establishment of a special committee for EQSs for fine particulate matter under the Air Environment Subcommittee of the Central Environmental Council. This special committee studied guideline values for the establishment of EQSs, taking into consideration the characteristics of $PM_{2.5}$ and its behavior in the human body, ambient concentration in air, qualitative and quantitative assessment on health impact, and conducted investigations and deliberations into assessments on the achievement status for EQSs. In August 2009, it made a comprehensive decision

based on scientific findings from Japan and abroad, and came up with guideline values for the establishment of EQSs for $PM_{2.5}$ that give consideration to providing adequate protection to the health of population groups in the regions.

Based on this, the Central Environmental Council reported on the establishment of EQSs for $PM_{2.5}$, and the EQSs were announced and enforced in September 2009. (Table 1)

EQSs are established as standards that should ideally be maintained for the protection of human health, in line with the Basic Environment Act. The environmental quality standard for $PM_{2.5}$ is as follows.

- The environmental quality standard for fine particulate matter ($PM_{2.5}$) is stipulated as an annual average that is less than or equal to 15.0μg/m^3, and a 24-hour average that is less than or equal to 35μg/m^3.
- In places that have proven ability to appropriately identify a state of air pollution caused by fine particulate matter, measurement is taken using mass measurement with filter sample collection, or through an automated measuring equipment that has proven ability to obtain an equivalent value as the mass concentration measured using the measurement method described above.
- Fine particulate matter is defined as airborne particles that pass through a size-selective inlet with a 50% efficiency cut-off at 2.5μm aerodynamic diameter.

Table 1　Background to the establishment
of the Environmental Quality Standards (EQSs)

Year/month	Event
July 1997	Establishment of National Ambient Air Quality Standard (NAAQS) for $PM_{2.5}$ by US-EPA
1999-2006	Studies on the impact of exposure to fine particulate matter
September 2006	Revision of NAAQS by US-EPA
October 2006	Establishment of WHO Air Quality Guidelines
May 2007	Additional resolution to the "Amendment Act on Reduction of Total Amount of Nitrogen Dioxide and Particulate Matters Originating from Automobiles in Designated Areas" (Strengthening of measures)
July 2007	Release of outcomes of studies on exposure impact of fine particulate matter
May 2007 – April 2008	Study committee to assess the health impact of fine particulate matter
June 2008	Public announcement of EU EQSs
June 2008 – November 2008	Special committee on the risk assessment methods for fine particle matter
December 2008	Inquiry about establishment of the EQSs of fine particulate matter
February 2008 – August 2009	Special committee for the EQSs for fine particulate matter
September 2009	Announcement of the Environmental Quality Standards

2 Assessment methods and assessment results of equivalence between the automated $PM_{2.5}$ measuring equipment and the standard measuring method (filter sample collection method)

2.1 Measuring method of $PM_{2.5}$

The announcement stipulates that the measuring method of $PM_{2.5}$ is "a mass concentration measuring method by filter sample collection or a method using automated measuring equipment recognized to produce values equivalent to the mass concentration values gained through the former method." This measuring method was discussed by the Particulate Matter 2.5 ($PM_{2.5}$) Measuring Method Advisory Committee of the Air Environmental Section in the Central Environment Council, and the discussion process is described in the report of said Committee. After the discussion, the filter sample collection method, which has been in use in the US and Europe, was adopted as the standard measuring method in Japan. However, the problem with the filter sample collection method is the manpower required to prepare, install, collect, and weigh filters, and also that measured values thus gained are merely 24-hour averages and are not gained in real time. For this reason, for observations conducted to assess the environmental quality standard, it is recognized that measurement using automated measuring equipment is more useful[2)]。

Meanwhile, as the announcement states, an automated measuring equipment is required to produce values equivalent to those gained from the filter sample collection method, so the Ministry of the Environment, Japan (MOEJ) conducted equivalence assessment tests on automated measuring equipment entered by domestic and overseas manufacturers that had made an application. The result was released in October 2010 and in October 2011, and throughout Japan MOEJ has been conducting monitoring using the automated measuring equipment recognized to produce values equivalent to those gained from the standard measuring method.

This chapter will discuss the filter sample collection method for measuring $PM_{2.5}$ and conditions required for automated measuring equipment and its features, as well as the equivalence assessment method using the automated measuring equipment.

2.2 Conditions that the filter sample collection method needs to satisfy

As stated above, it has been stipulated that the filter sample collection method is

the standard measuring method of $PM_{2.5}$ in Japan. The method is to collect ambient fine particles in the air by suction filtration, and to weigh and determine the mass by means of a balance. The reason why this method was adopted in Japan as the standard method for measuring $PM_{2.5}$ is that physical quantity of mass concentration can be directly measured and that detailed provisions will make it possible to guarantee the precision and reproducibility of measurements. Conditions that the filter sample collection method should satisfy will be described below.

(1) Features of the particle size classifier

According to JIS Z 8851, the 50% sizing diameter should fall between 2.5±0.2 μm and the ratio of the 20% sizing diameter against the 80% sizing diameter should be 1.5 or smaller.

(2) Differences in temperature from the open air

The allowable differences in temperature between the filter-holding section and the open air should fall between ±5°C. This condition must always be kept until the collected samples have been gathered, in order to reduce the effect of the vaporization and adhesion of semi volatile substances even after the collection of samples.

(3) Material for the filter

PTFE (Polytetrafluoroethylene) must be used for the filter. Some of the commercially available products come with easily operable support rings.

(4) Suction flow rate

The actual flow should be controlled and displayed.

(5) Constant weight conditions and the sensitivity of a balance

For achieving constant weight of filters, the temperature should be within 21.5±1.5°C, the relative humidity should be within 35±5%, and the conditioning time should be 24 hours or over. A balance with a reciprocal sensitivity of 1 μg or less should be used for weighing. The conventional conditioning conditions of suspended particulate matter (SPM: Particles left after particles with aerodynamic diameter larger than 10 μm have been completely separated) used to be that the temperature should be 20°C, and the relative humidity 50%. However, for $PM_{2.5}$, the relative humidity for conditioning is lower, in order to eliminate as much of the effect as possible of the humidity.

(6) Concentration measuring range

2 μg/m^3 should be the lowest limit and a precision of at least 200 μg/m^3 should be secured for the higher concentration range.

2.3 Conditions that automated measuring equipment needs to satisfy

The Special Committee report describes the conditions that automated measuring equipment needs to satisfy, as follows.

(1) Relation between physical quantity and mass and between the standard measuring methods

It is necessary that the physical quantity to be measured and the mass have a definite relation, or that the correction relation between the physical quantity to be measured and the mass is clear. The measurement principle includes the Tapered Element Oscillating Microbalance (TEOM), the beta-ray absorption method, the light-scattering method, and a combination of other measurement principles. However, other types of principles are not to be excluded.

(2) Features of a particle size classifier

A particle size classifier shares the same features as the standard measuring method. Also, methods such as some of the light-scattering methods not using a particle size classifier need to deliver the same level of performance as the above-described particle size classifier.

(3) Averaging time (Temporal resolution)

The averaging time for automated measuring equipment should be 24 hours. At the moment, equivalence for an hourly value cannot be confirmed and the value should be treated as a reference value.

(4) Concentration measuring range

For the concentration measuring range, 2 – 200 μg/m^3 should be measurable as a 24-hour average.

(5) Inspection and calibration methods

Technical methods for inspection and calibration based on each measuring principle should have been established and the constancy of the measured value should be maintained through regular inspections.

(6) Equipment Differences

The differences in 24-hour averages should fall within a certain range when multiple pieces of automated measuring equipment of the same model are used simultaneously for measurement (parallel measurement).

(7) Suction flow rate

The actual flow should be controlled and displayed.

(8) Response to changes in the relative humidity

Automated measuring equipment should desirably have functions for suppressing changes in mass concentration caused by relative humidity, by equipping a dehumidifying system, etc.

Multiple pieces of automated measuring equipment based on the various measurement principles shown in (1) are commercially available and many of the manufacturers have adopted the beta-ray absorption method.

2.4 Equivalence assessment of an automated measuring equipment

It is stipulated in the announcement of the environmental quality standard that automated measuring equipment recognized to have equivalence to the standard measuring method should be used. The outline of the equivalence assessment test is described below.

It is advisable to conduct an equivalence assessment test for as broad a range as possible, covering both the low and high concentration ranges. Also, measurement of $PM_{2.5}$ is affected by the following phenomena: sulfate deliquesces if the relative humidity is 80% or higher, and nitrates evaporate at high temperatures. In consideration of these phenomena, it has been decided that periods and places shall be chosen which characterize factors affecting the measurements of $PM_{2.5}$. For this reason, it has been decided that the tests shall be conducted in summer and winter in urban and rural areas.

The equivalence assessment of automated measuring equipment and the standard measuring method should follow the assessment method based on the quality control techniques. The equivalence assessment is done by counting the number of the values outside the control limits drawn on both sides of the y=x diagonal in consideration of errors between the values gained from the standard measuring method and those from the automated measuring equipment among the values gained from the standard measuring method plotted on the x-axis and those gained from the automated measuring equipment plotted on the y-axis.

(Figure 1) The maximum tolerable number of the values outside the control limits is calculated based on single sampling inspection plans having desired operating characteristics by variables.

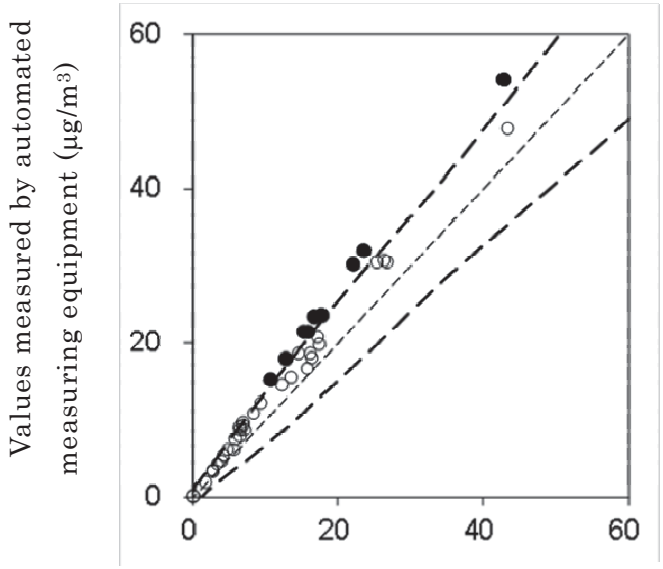

Figure 1　Image of equivalent test for automatic monitor
Bold broken lines show control limit area. Open and closed circles show data within and out of acceptable range, respectively.

As of November 2014, those listed in Table 2 below are automated measuring equipment recognized to produce values equivalent to those gained from the standard measuring method.

Table 2　List of equipment that equivalence with standard measurement method is confirmed* (As of November 20, 2014)

Model name	Manufacturer	Release date of the result
PM-712	Kimoto Electric	October 15,2010
PM-717	Kimoto Electric	October 15, 2010
FPM-377	DKK-TOA CORPORATION	October 15, 2010
APDA-375A	Horiba	October 15, 2010
FH62C14	Thermo Fisher Scientific	October 15, 2010
SHARP 5030	Thermo Fisher Scientific	October 15, 2010
MP101M	Environnement S.A	July 4, 2011
5014i	Thermo Fisher Scientific	July 4, 2011

＊　The sources are “The Results of Equivalent Test in Winter 2009 and Summer 2010 (October 15, 2010)”and “The Results of Equivalent Test in Summer 2010 and Winter 2010 (July 4, 2011)” released by the Air Environment Division, Environmental Management Bureau, MOEJ.

3 The processing standards for administrative affairs for continuous monitoring of air pollution based on the Air Pollution Control Law

In March 2010 the Ministry of the Environment, Japan (MOEJ) revised "The processing standards for administrative affairs for continuous monitoring of air pollution based on the Air Pollution Control Law" (hereinafter referred to as "Paperwork Standards"), which demonstrate the implementation methods of continuous monitoring of air quality, and the "Manual for Continuous Monitoring of Air Pollution" in response to the established environmental quality standard (EQSs) to state that continuous monitoring of $PM_{2.5}$ must be conducted as a legally prescribed transaction entrusted to a local municipality by individual prefectures and the cabinet-designated cities under the Air Pollution Control Law. The Paperwork Standards include description about accumulation of scientific knowledge about behaviors of $PM_{2.5}$ and its precursors in the atmosphere to seek effective countermeasures and implementation of component analysis as well as mass concentration measurement to estimate the contributing ratio of possible sources of $PM_{2.5}$. The sections referring to the description about $PM_{2.5}$ are reproduced below, providing specific example cases.

Proceeding Standard on Air Quality Monitoring Work Based on Air Pollution Control Law (Finally Revised on August 30, 2013) (Described only $PM_{2.5}$ Section)

Ⅲ Continuous Monitoring for $PM_{2.5}$ Mass Concentration

1. Monitoring Items

Fine particulate matter ($PM_{2.5}$), its environmental quality standards (EQSs) was established in September 2009, shoud be measured.

2. The number and allocation of monitoring stations

(1) The number of monitoring stations

In accordance with the examples [*1] referred to in II - 2. (1) of the Paperwork Standards.

*1 A facility, which incorporates the measurement devices for the monitoring objects listed in above 1 to continuously monitor the status of air pollution, is referred to as a monitoring station. The prefectures shall determine the standard for preferable number of monitoring stations for the monitoring items in the individual prefectures based on consultation with the cabinet-designated cities. The standard for preferable number of monitoring stations shall be determined by adding the required

number of monitoring stations from the nationwide perspective as specified in (A) below and the required number of monitoring stations from the regional perspective as specified in (B) below.

Note) The standard for preferable number of monitoring stations must be determined from the standpoint of protecting human health from any air pollution and preserving the human living environment. Therefore, it shall not include the number of those monitoring stations that are installed in areas or locations such as on the roadways, which are not associated with any normal human life and thus are not used for judgment on whether or not the EQSs are successfully met. In addition, it indicates the number of monitoring stations to help identify the status of air pollution in the entire area concerned and thus, it shall not include the number of those monitoring stations intended for the specific purposes listed below.

・ Identification of unexpected and highly concentrated pollution caused by any specific sources

(A) Determination of the required number of monitoring stations from the nationwide perspective

(i) Determination based on population and habitable area

The EQSs, guideline values, and other indicators for air pollutants (hereinafter referred to as "EQSs, etc.") have been established from the standpoint of protecting human health. Therefore, the number of monitoring stations determined for a prefecture on the basis of the indicator of human exposure to air pollutants, namely population or habitable area standards (calculated by subtracting the areas of forests and lakes from the gross area) listed below, whichever is smaller, is defined as the baseline number of monitoring stations for the prefecture.

(a) One monitoring station per population of 75,000

(b) One monitoring station per habitable area of 25 km^2

In practice, the number of monitoring stations may be adjusted as appropriate by regional division established by subdividing a prefecture into several regions according to the situation of pollution sources, population distribution, weather conditions, and other

factors.

(ii) Adjustment of the number of monitoring stations according to the level of environmental concentration among the monitoring stations installed in all prefectures, there is identified the monitoring station that has recorded the highest value for a given monitoring item on the basis of the applicable EQSs or other performance index in the past three years or so, and the highest value is labeled as shown below. Then, the number of monitoring stations for each monitoring item shall be selected as follows: The number of monitoring stations determined in (i) is selected for the prefectures having the monitoring stations falling under "High," the number of monitoring stations corresponding to about one-half of that determined in (i) is selected for the prefectures having the monitoring stations falling under "Medium," and the number of monitoring stations corresponding to about one-third of that determined in (i) is selected for the prefectures having the monitoring stations falling under "Low."

"High": Does not meet the EQSs, etc., otherwise successfully meets the EQSs, etc. but exceeds 70% of the standard value.

"Medium": Successfully meets the EQSs, etc., although ranges from 30% to 70% of the standard value.

"Low": Successfully meets the EQSs, etc. and does not exceed 30% of the standard value.

In practice, the number of monitoring stations may be adjusted as appropriate to correspond to the environmental concentration levels by regional division established by subdividing a prefecture into several regions according to the situation of pollution sources, population distribution, weather conditions, and other factors.

Note) Where some monitoring stations are to be relocated, streamlined by merging and closing, or abolished as a result

of the adjustment, particular attention shall be paid to ensuring the continuity of measured data and the efficient monitoring to represent the specific characteristics of the regions concerned.

(iii) Adjustment of the number of monitoring stations to correspond to the characteristics of monitoring items

The number of monitoring stations shall be adjusted to that determined in (i) and (ii).

[Informative Commentary]

The required number of monitoring stations from the nationwide perspective referred to in 2. (1) (A) is determined for Niigata Prefecture and Niigata City as examples.

Example 1: In the case of Niigata City

(i) Determination on the basis of population and habitable area

(a) (Total population = 812,034) [3)]÷75,000＝10.8

(b) (Habitable area = 726.10) [3)]÷25＝29.0

Since 10.8＜29.0, the required number of monitoring stations from the nationwide perspective is found to be 10.8.

(ii) Adjustment of the number of monitoring stations according to the environmental concentration level

Based on the officially released results in Niigata Prefecture [4) to 6)], the annual average performance index* over the past three years is found not to exceed the EQSs, although the 24-hour average performance index* exceeds the EQSs in some places (Table 3). However, comparison of the highest values for performance indices with 70% of the reference values provides the results shown below.

Annual average: 15×0.7＝10.5<13.9 (Shirone Station in FY2012)

24-hour average: 35×0.7＝24.5<37.5 (Kameda Station in FY2013)

* Annual average and 24-hour average performance indices refer to the 98 percentile value of annual average and 24-hour average, respectively. For further information about calculation methods, refer to “7. Handling and assessment of measured values” in the Paperwork Standards.

Table 3　$PM_{2.5}$ Mass Concentration at Niigata City[4)~6)]

Unit: μg/m^3

	Evaluation target value of annual average			Evaluation target value of daily average		
Station name / Year	2011	2012	2013	2011	2012	2013
Kameda	12.1	11.9	12.8	30.5	31.7	**37.5**
Ohyama	-	13.8	12.4	-	32.8	36.4
Tarodai	-	-	12.8	-	-	35.8
Shirone	-	**13.9**	11.9	-	34.5	35.7
Higashi-yamanoshita	-	-	12.7	-	-	32.7

Bold: maximum concentration in each category

Niigata City is a cabinet-designated city, having the monitoring stations falling under “High” and thus, it requires the monitoring stations in the number determined in (i), or 10.8 ≒11. In Niigata City, all the monitoring stations are labeled as “High.”

Example 2: In the case of Niigata Prefecture

(i) Determination on the basis of population and habitable area

(a) (Total population = 2,395,139) [3)]÷75,000＝31.9

(b) (Gross area 12583.72×Proportion of habitable area 0.356) [3)]÷25＝179.1

Since 31.9<179.1, the required number of monitoring stations from the nationwide perspective is found to be 31.9, and 21.1 monitoring stations, obtained by subtracting 10.8, or the required number for Niigata City, from 31.9, are required for all areas within the prefecture other than Niigata City.

(ii) Adjustment of the number of monitoring stations according to the environmental concentration level

Also in Niigata Prefecture, similarly as in Niigata City, the annual average performance index over the past three years is found not to exceed the EQSs, although the 24-hour average performance index exceeds the EQSs in some places (Table 4). In addition, all the performance indices are found to be equal to or higher than 70% of the EQSs values. Consequently, Niigata Prefecture is found to be a prefecture having monitoring stations falling under “High” and therefore it requires monitoring stations in the number determined in (i) or 21.1≒21.

Table 4 $PM_{2.5}$ concentration in Niigata Prefecture (Except for Niigata City) [4)~6)]

Unit: μg/m³

	Evaluation target value of annual average			Evaluation target value of daily average		
Station name/ Year	2011	2012	2013	2011	2012	2013
Shibata	-	11.3	12.1	-	27.0	31.9
Johoka	12.8	12.3	13.1	30.6	28.4	37.4
Fukaya	-	-	**14.1**	-	-	**39.2**

Bold: maximum concentration in each category

(B) Determination of the required number of monitoring stations from the regional perspective

(i) Consideration of natural conditions

The required number of monitoring stations must be determined in consideration of topographic, meteorological, and other region-specific conditions listed below to meet the conditions.

(a) Topographic conditions

For those areas isolated from other areas by mountains, located adjacent to a valley or river/lake and thus exposed to complicated atmospheric currents, or located on the seaside and subject to higher wind velocities, in which the atmospheric environments are independent from those in the other areas, it will not be adequate to apply the results of monitoring in one city to represent the conditions of atmosphere in another city.

(b) Meteorological conditions

Atmospheric environments vary with air temperature, wind direction, wind velocity, duration of sunshine, seasonal changes, and other factors.

(ii) Consideration of social conditions

The number of monitoring stations must be determined in consideration of the social usefulness of continuous monitoring in the context of making provisions for air pollutant sources, responding to the needs of communities concerned, identifying the status of fulfillment of regulations and planned arrangements, planning future development, and practical application to various research efforts and investigations.

(a) Making provisions for air pollutant sources

For stationary sources of air pollution, the distribution, scale, and emission point heights of factories and neighboring wind direction can affect the atmospheric environment.

Especially in areas where factories are densely packed, it should be noted that quick response is essential in the event of accident or other unusual conditions. In addition, measured values of substances under continuous monitoring allow estimation of the trend in emission of any air pollutants other than the substances under monitoring, and therefore continuous monitoring is also helpful for monitoring the entire air contaminants.

For mobile sources of air pollution, the arrangements or planned changes of roads and also the structure of roads, traffic volume by vehicle type, vehicle running speed, roadside conditions, and other factors can affect the atmospheric environment.

In urban areas congested with high- and medium-rise buildings, the atmospheric currents and waste heat from the buildings can affect the atmospheric environment.

(b) Making provisions against possible effects of trans-boundary pollution from the neighboring and/or other prefectures

Monitoring stations must be allocated in consideration of possible effects on the involved prefecture and/or areas of any trans-boundary pollution from neighboring and/or other prefectures, which would be caused by seasonal and/or weather conditions.

(c) Responding to the needs of communities concerned

Where there exists an agreement with or request by the community concerned and/or other social demand for allocation of monitoring stations, a general consensus must be built.

(d) Identifying the status of fulfillment of regulations and planned arrangements

Continuous monitoring has an additional role of providing means to complement the environmental surveillance conducted by factories, etc. on a voluntary basis and help the government agencies to perform final verification of proper compliance with regulatory

requirements. Furthermore, in environmental pollution control, port and harbor planning, and various other programs, continuous monitoring is actively positioned as a means to check if the programs are proceeded as planned.

(e) Planning future development

Where large-scale development is planned, prior measurement of atmospheric environments is essential.

(f) Practical application to various research efforts and investigations

The data accumulated in every monitoring station have been practically applied as basic inputs to research and as scientific data such as average exposure in the health impact assessment in the vicinity of monitoring stations, thus playing an important role. Especially in a case where monitoring station data are practically applicable to any environmental impact assessment, it contributes to increased efficiency in the assessment and enhanced quality of the assessment by virtue of its advantages of allowing clarification of changing trends over time and resultantly achieving precision improvement in forecast evaluation.

(iii) Consideration of the background to date

The monitoring stations that have been installed for a considerably long time and involved consistently in measurement have crucial significance for understanding the changes in atmospheric environments over time. In addition, monitoring stations have often been regarded highly by the local residents for their usefulness and accepted as given to the communities. Consequently, the existing monitoring stations should be continuously maintained by fully reviewing the background to date and being included in the standard for preferable number of monitoring stations.

(2) Allocation of monitoring stations

In accordance with the examples referred to in II - 2. (2) *2 of the Paperwork Standards, measuring equipment shall be installed in existing monitoring stations as a rule to meet the need for comparison of nitrogen oxides, suspended particulate matters, and other items. In practice, however, proper installation position shall be selected taking into consideration the requirements for installation of sampling inlets described in Section 5.

*2 The number of monitoring stations determined based on the provisions in (1) refer to the preferable total number of monitoring stations in each prefecture. Specific points for allocation of the monitoring stations shall be properly selected by individual prefectures and cabinet-designated cities based on the nationwide and regional points of view, which have been applied for determination of the number of monitoring stations. The monitoring stations may be grouped into two types listed below and then, appropriate type of stations shall be installed for the actual conditions of individual regions, giving consideration to the description provided below.

(i) Ambient air quality monitoring station

This monitoring station is intended for continuous monitoring of the status of air pollution. All the monitoring stations other than the roadside air quality monitoring stations referred to in (ii) below are called ambient air quality monitoring stations. The ambient air quality monitoring stations shall be allocated to efficiently attain the purposes of continuous monitoring, including continuous understanding of the status of air pollution in a certain area, identification of contribution of emissions from sources to pollution and heavily polluted areas, and understanding of the effectiveness of solutions taken for prevention of air pollution.

(ii) Roadside air quality monitoring station

A monitoring station intended to continuously monitor the status of air pollution at an intersection, over a road, or on the roadside resulting from emissions from running vehicles is referred to as a roadside air quality monitoring station. The roadside air quality monitoring stations shall be properly allocated in consideration of the conditions of road and traffic volume to allow efficient monitoring of air pollution due to exhaust gases from motor vehicles.

At the properly allocated monitoring stations, monitoring shall be continued consistently at the same spot as a rule to help identify any changes over time.

(3) Phased improvement

For the monitoring stations, the number of which has been determined based on the provisions in (1), improvements shall be carried out, taking

about three years from FY2010.

3. Frequency of monitoring

Monitoring shall be carried out consistently as a rule throughout the year.

4. Height of sampling inlets

(1) Basic concept

Air samples shall be taken as a rule at a height at which people live their normal lives and breathe.

(2) Based on the basic concept, specific height for sampling for monitoring of $PM_{2.5}$ shall be in accordance with the examples referred to in II - 4. (2) to (4) of the Paperwork Standards for suspended particulate matter (SPM)*3.

*3 (2) Based on the basic concept, the specific height of sampling inlets shall be 3 m or more and 10 m or less above the ground for the suspended particulate matter to eliminate possible effects such as sand and earth blown up in the air from the ground.

(3) When the height in (2) is found inappropriate as a result of careful investigation of the actual conditions based on the basic concept due to the situation where many people are living at height of 10 m or more above the ground such as in a high-rise collective residential building, proper height shall be selected as appropriate for the actual situation.

(4) Where the provisions in both (2) and (3) cannot apply or they are found inappropriate due to unavoidable circumstances such as difficulty in securing proper installation sites, the best possible effort should be made to establish a sampling inlet that meets both of the requirements listed below.

(A) The height of sampling inlet does not exceed 30 m; and

(B) Compared to the results of monitoring conducted at a neighboring spot continuously for one month or more at the same height of sampling inlet as specified in (2), any average difference in the 24-hour average of hourly values does not exceed 1/10 of the lower limit of air quality standard.

In practice, in order to identify any effects of seasonal changes, the

concurrently conducted monitoring shall be repeated at least four times a year in the four different seasons.

5. Requirements for installation of sampling inlets

In order to prevent possible loss of $PM_{2.5}$ due to adsorption and/or other reasons, the sampling inlet and the particulate collection section shall be connected with each other through a vertical tube, and the distance between the sampling inlet and the particulate collection section shall be limited to 5 m and the distance between the outlet of particle size classifier and the particulate collection section limited to 1.5 m. Where a sampler is installed in the inside of a monitoring station, the sampling tube shall be installed through the ceiling of the station.

In addition, around the sampling inlet, sufficient open space shall be maintained. Where any other sampling inlets, sampling equipment, and/or other installations exist in the surroundings, the sampling inlet shall preferably be located at least 1 m distant from the installations, in order to avoid possible effects

[Informative Commentary]

Figure 2 shows concept of 4.(2) and 5..

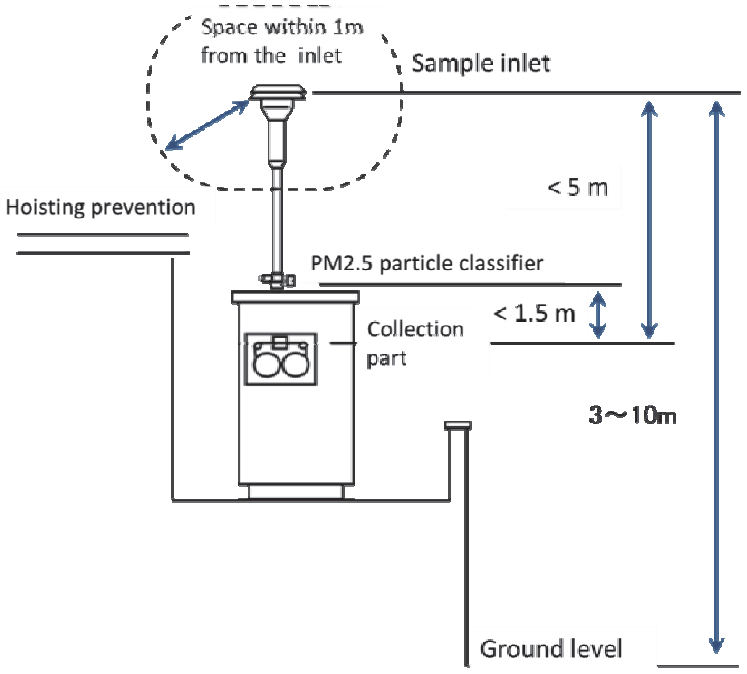

Figure 2 Installation requirements for $PM_{2.5}$ automatic monitor (Example for outdoor installation)[7)]

6. Measuring methods

The standard measuring method or automated measuring equipment recognized to provide equivalent values to mass concentration measured by the standard measuring method shall be used. For any other measuring methods and the specifications and configuration of measuring equipment, reference shall be made to the "Manual for Continuous Monitoring of Air Pollution"

7. Handling and assessment of measured values

(1) Measured values not subject to assessment

(A) Measured values obtained in the monitoring stations located in exclusive industrial districts specified by the City Planning Law (including the exclusive industrial districts designated by the former City Planning Law), harbor/port areas specified by the Port and Harbor Law, and vehicle running sections of roads, reclaimed lands, wastelands, volcanic regions, and other areas and locations where people may not live normally.

(B) Any measured values which are verified not to accurately reflect the status of air pollution in the area concerned due to reasons caused by the measuring equipment, etc.

(C) 24-hour average obtained with measurement of such average missed for a total of four hours or more in a day (24 hours). Annual average calculated with the number of days of valid measurement not reaching 250 days.

[Informative Commentary]

Figure 3 shows concept of calculation in 7.(1)(c).

Annual average shall be calculated by using data from 1st April through 31st March.

1-hour average of a certain hour is defined as the average value from the beginning of the previous hour to the beginning of that hour[8]. Daily average shall be calculated as the average of 1-hour average from 0 to 24 o'clock[8].

Day/ Month/ Year	1	2	3	～	22	23	24	24 hour average
1/4/2014	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5
2/4/2014	10.5	10.5	10.5	10.5	lack	10.5	10.5	10.5
～								
30/3/2015	lack	lack	lack	10.5	lack	lack	10.5	Missing
31/3/2015	lack	lack	lack	10.5	lack	10.5	10.5	10.5
Annual average	-	-	-	-	-	-	-	10.5

When there are four or more missing 1-hour averages, daily average shall be missing.

When the number of day with valid data is less than 250, annual average shall be missing.

Figure 3 Calculation method of daily and annual averages

(2) Assessment of results of continuous monitoring

In accordance with both the long-term guidelines for normal reduction of the entire distribution of particulate matter 2.5 ($PM_{2.5}$) exposure concentrations and the short-term guidelines for reduction of occurrence of higher concentrations in the distribution of exposure concentrations, long-term assessment shall be conducted.

Assessment in accordance with the long-term guidelines compares the annual average of measured results with the long-term guidelines (annual average).

Assessment in accordance with the short-term guidelines selects the annual 98 percentile value of 24-hour average of measured results as a representative value for comparison with the short-term guidelines (24-hour average). The assessment shall be conducted for each monitoring station. For judgment on whether or not the EQSs are met, assessment in accordance with the long-term and short-term guidelines is individually conducted and then the stations found to satisfy both guidelines are defined as meeting the EQSs.

[Informative Commentary]

Figure 4 and Table 5 show concept of 98 percentile value and an example of achievement of EQSs.

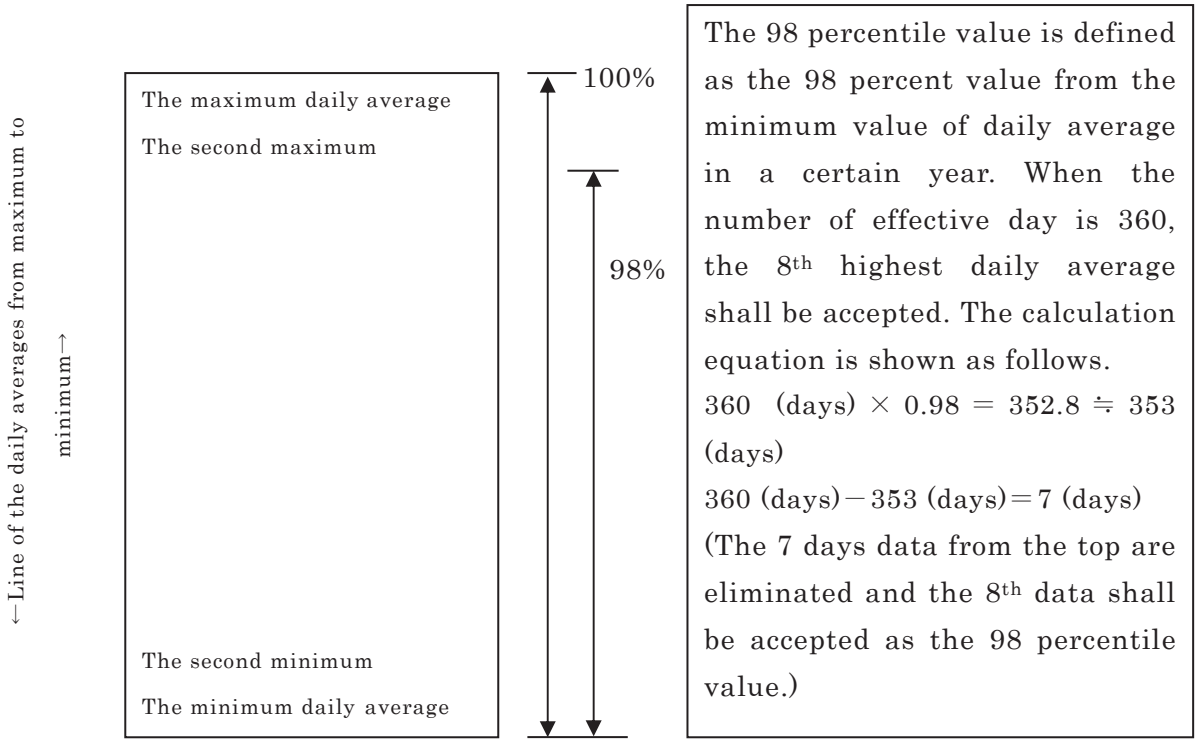

Figure 4 Concept of 98 percentile value

Table 5 Example for judgment on Environmental Quality Standards (EQSs)

	Annual average	98 percentile value of daily average	Judgment on EQS
A	15.0	35.0	Achievement
B	15.1	35.0	Non-achievement
C	15.0	35.1	Non-achievement

8. Component analysis

(1) Purpose

Component analysis is carried out in addition to measurement of mass concentration in order to amplify knowledge for contribution to surveys on possible health impact of $PM_{2.5}$ and seek more efficient solutions based on the accumulated scientific knowledge about the causative substances through understanding of the status of emission, development of emission inventory, and clarification of behavior in the air and mechanisms for secondary products formation.

(2) Systems for implementation

Component analysis must be adopted systematically on a nationwide scale and therefore it should be conducted successively based on the guidelines established separately to determine the role sharing between the central government and the prefectures, the methods for selection of the (number of) points for analysis, and the timing and methods of investigation.

9. Quality assurance/quality control (QA/QC) and maintenance

For measurement with greater precision, a proper maintenance and management system shall be established and improved in accordance with the "Manual for Continuous Monitoring of Air Pollution" to ensure that appropriate daily, regular, and other inspections and maintenance are carried out for the measuring equipment and details of the inspection and maintenance are properly recorded.

10. Reporting of results

Reporting of the results of continuous monitoring in accordance with the Air Pollution Control Law shall be completed before the specified date based on the method specified independently by the Ministry of the Environment.

4 Distribution of $PM_{2.5}$ monitoring stations in Japan

Since establishment of environmental quality standard in September 2009, the number of $PM_{2.5}$ monitoring stations and the number of sites conducting component analysis in Japan have been increasing year by year.

4.1 Changes in the number of $PM_{2.5}$ monitoring stations

The total number of $PM_{2.5}$ monitoring stations, including National Kitanomaru roadside air quality monitoring station (hereinafter referred to as "roadside monitoring station"), one of the stations exempted from application of environmental quality standard, and the monitoring stations using the measuring equipment without any equivalence, reached 73 as of the end of FY2010 (45 ambient air quality monitoring stations and 28 roadside monitoring stations) [9] and 310 as of the end of FY2011 (223 ambient air quality monitoring stations and 87 roadside monitoring stations) [10], showing an about four-fold increase at the end of FY2011 from the end of FY2010 (about five-fold increase in the number of ambient air quality monitoring stations and about three-fold increase in the number of roadside monitoring stations). As of the end of FY2012, the number of monitoring stations amounted to 596 (429 ambient air quality monitoring stations and 167 roadside monitoring stations) [11], showing an about eight-fold increase from the end of FY2010 (about ten-fold increase in the number of ambient air quality monitoring stations and about six-fold increase in the number of roadside monitoring stations). However, the target number of monitoring stations determined based on the guidelines provided in the Paperwork Standards is 1,292[1] and therefore, the number of the actually installed monitoring stations is found to be far short of half of the target number, even when including the measuring equipment without equivalence.

Distribution of $PM_{2.5}$ monitoring stations in each fiscal year by measuring equipment with and without equivalence is provided in Figure 5.

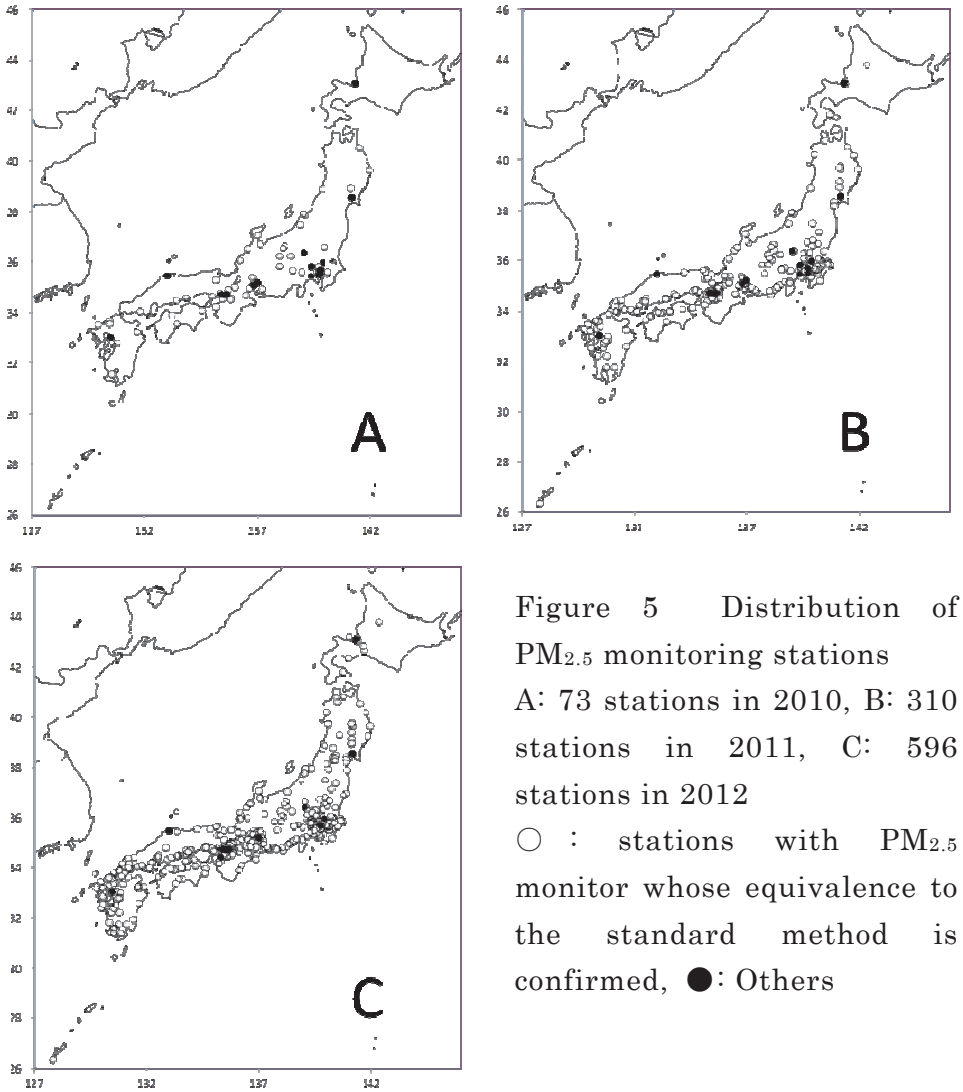

Figure 5 Distribution of $PM_{2.5}$ monitoring stations
A: 73 stations in 2010, B: 310 stations in 2011, C: 596 stations in 2012
○ : stations with $PM_{2.5}$ monitor whose equivalence to the standard method is confirmed, ●: Others

4.2 Changes in the number of sites conducting the component analysis of $PM_{2.5}$

Component analysis was once implemented by the Ministry of the Environment, Japan (MOEJ) up to FY2010 as the "Particulate Matter 2.5 ($PM_{2.5}$) Exposure Impact Assessment" at a total of 14 sites throughout the country, but it was discontinued during that fiscal year. In FY2011 MOEJ and local governments newly incorporated component analysis in the continuous monitoring in accordance with "The processing standards for administrative affairs for continuous monitoring of air pollution based on the Air Pollution Control Law" referred to in Chapter 3. The number of investigation spots increased as of the end of FY2012 compared to the end of FY2011, similarly as with the number of automated monitoring stations. Table 6 provides the number of monitoring sites by type of site [12), 13)]. The figures in parentheses in the table represent the

number of sites at which monitoring was conducted for a duration of two weeks or so in each of the four seasons throughout the fiscal year in accordance with the Guideline for Component Analysis described (hereinafter referred to as "four-season monitoring"). As can be seen from the table, the number of monitoring sites was increased from 35 to 52 for the ambient air quality monitoring stations, showing an about 1.5 times increase, from 15 to 24 for the roadside monitoring stations, showing an about 1.6 times increase, and from 8 to 12 for the background monitoring, showing a 1.5 times increase. For the sites at which the four-season monitoring was conducted, the total number was more than doubled, to 67 from 31.

Regarding the sites at which component analysis is conducted, the Guideline for Component Analysis states that sample collection points should be selected basically from (i) continuous monitoring stations of $PM_{2.5}$ and then (ii) the sites with higher $PM_{2.5}$ concentration and the sites allowing identification of background concentration. However, the Guideline also states that (iii) it is not mandatory to carry out component analysis in the background. Monitoring in the ambient air and roadside monitoring stations is almost all conducted under the responsibility of local governments, but at eight of a total of 12 background sites in FY2012, the MOEJ is involved in the monitoring (Nonodake, Ogasawara, Shionomisaki, Tsushima, Goto, Oita Kuju, Yakushima, and Hedomisaki) and only the remaining four sites rely on the local governments.

Table 6 Number of station performing components analysis in each classification [10), 11)] (The number of station performing 4 season's analysis)

Classification	2011	2012
Ambient	35 (18)	52 (44)
Roadside	15 (11)	24 (19)
Background	8 (2)	12 (4)
Total	58 (31)	88 (67)

5 Types and the actual number of pieces of automated measuring equipment in operation in Japan

As mentioned in Chapter 2 “Assessment methods and assessment results of equivalence between the automated $PM_{2.5}$ measuring equipment and the standard measuring method (filter sample collection method),” in Japan, in order to evaluate whether or not the environmental quality standard (EQS) is met, the automated measuring equipment recognized to provide measured results equivalent to those gained from the standard measuring method must be used for measurement of $PM_{2.5}$. In actuality, however, in some sites, including the national air pollution monitoring stations, there exist automated measuring equipment without equivalence, which was introduced before establishment of EQS, and so their measured values are released as reference data. Table 7 provides the working situations of automated measuring equipment.

Table 7 Operational status of automated $PM_{2.5}$ equipment[*1]

Model	Equivalent test	Manufacturer	2010	2011	2012
PM-712	Passed	Kimoto Electric	0	67	140
PM-717	Passed		0	0	0
FPM-377	Passed	DKK-TOA CORPIRATION	6	111	240
APDA-3750A	Passed	Horiba	21	26	33
FH62C14	Passed	Thermo Fisher Scientific	0	53	131
SHARP5030	Passed		25	33	36
5014i	Passed		0	0	0
MP101M	Passed	Environnement S.A	0	0	0
TEOM1400, etc.	Failed	Others	22	20	16
—	—	Total	74[*2]	310	596

*1 This table is completed by the interview survey to local governments after referring “The report of air pollution monitoring results in 2012” (MOEJ, July 2014) and “Data about monitoring stations (status over Japan in 2012)” on the NIES Environmental Numerical Database.

*2 The number of monitoring station is 73 (Figure 5) in 2010, however, the number of equipment is 74 because parallel monitoring was carried out at National Osaka Air Quality Monitoring Station. The parallel monitoring had been continued after 2011 at the station, however, since the aggregation of the number of station had been done equipment basis in the source reports after 2011, same numbers as Figure 5 are shown in this table.

6 Methods for releasing monitoring data

The Basic Environment Act stipulates implementation of research efforts and provision of information, and the Air Pollution Control Law stipulates continuous monitoring and releasing of results by local governments as summarized below. Under these laws, local governments make it obligatory by the municipal ordinances to implement research efforts and submit reports. As examples, some provisions of the ordinances of Niigata Prefecture and Niigata City are extracted below.

In recent years, the expansion of Internet accessibility has enabled the release of preliminary figures and/or report documents through websites. Typical contents released by the Ministry of the Environment, Japan (MOEJ) and local governments (Niigata Prefecture and Niigata City as examples) are reproduced later in this chapter.

The Basic Environment Act

(Provision of Information)

Article 27 The State shall make efforts to appropriately provide necessary information on environmental conservation including the state of the environment, so as to promote the education and learning provided for in Article 25 and to contribute to the activities voluntarily conducted by the private bodies etc., provided for in the preceding Article, in consideration of the protection of the rights and benefits of individuals and legal entities.

(Implementation of Researches)

Article 28 The State shall conduct surveys on the state of the environment, researches on forecast of environmental changes and other studies for formulation of policies with regard to environmental conservation.

Air Pollution Control Law

(Continuous Monitoring)

Article 22 Prefectural governors shall continuously monitor the status of air pollution (air pollution caused by radioactive materials not included; the same applies for paragraph 1 of Article 24) in accordance with an Ordinance of the Ministry of the Environment.

2. Prefectural governors shall report the results of the continuous monitoring under the preceding paragraph to the Minister of the Environment in accordance with an Ordinance of the Ministry of the Environment.

(Public Announcements)

Article 24 Prefectural governors shall make public the status of air pollution within the prefecture in accordance with an Ordinance of the Ministry of the Environment.

(Affairs Handled by Mayors of Cities Specified by Cabinet Order)

Article 31 A part of the affairs that are under the authority of a prefectural governor pursuant to the provisions of this Act may be undertaken by the mayor of a city (including special wards; the same shall apply hereinafter) specified by a Cabinet Order pursuant to the provisions of a Cabinet Order.

Enforcement Order of the Air Pollution Control Law

(Affairs Handled by Mayors of Cities Specified by Cabinet Order)

Article 13 2. Of the administrative affairs under the authority of a prefectural governor pursuant to the provisions of the Law, (...) the administrative affairs related to monitoring pursuant to the provisions of Article 20 of the Law, the administrative affairs related to requests pursuant to the provisions of paragraph 1, Article 21 of the Law and related to statements of opinion pursuant to the provisions of paragraph 2, Article 21 of the Law, the administrative affairs related to continuous monitoring pursuant to the provisions of paragraph 1, Article 22 of the Law and related to reporting pursuant to the provisions of paragraph 2, Article 22 of the Law, and the administrative affairs related to public announcements pursuant to the provisions of Article 24 of the Law (...) shall be undertaken by the mayor of a city ○○, (...) (hereinafter referred to as "mayor of a cabinet-designated city").

Niigata Prefecture Basic Environment Ordinance

(Annual Reporting)

Article 8 The Prefectural Governor shall submit annually to the Prefectural Assembly a report on the state of the environment and the policies with regard to environmental conservation and release the report.

(Implementation of Study and Research, etc.)

Article 17 The Prefecture shall, in order to establish and properly implement the policies for conservation of the environment, make efforts to collect information, implement studies and research efforts, and develop technologies and spread the products of the technology development regarding the matters related to control of environmental pollution, preservation of the natural environment, and conservation of the global and other environments.

(Improvement of Systems for Monitoring, etc.)

Article 18 The Prefecture shall make efforts to establish systems of monitoring, measurements, examinations, and inspections, etc. in order to ascertain the state of the environment and properly implement the policies with regard to environmental conservation.

Niigata City Basic Environment Ordinance

(Annual Reporting)

Article 7 The Mayor shall submit an annual report on the state of the environment and the policies with regard to environmental conservation and release the annual report.

(Identification of the Status of Environment, etc.)

Article 18 The City shall make efforts to collect information and implement studies and research efforts in order to ascertain the state of the environment and properly implement the policies with regard to environmental conservation.

2 The City shall make efforts to establish systems of monitoring and measurements, etc. in order to ascertain the state of the environment and properly implement the policies with regard to environmental conservation.

6.1 Ministry of the Environment, Japan (MOEJ)

6.1.1 Release through written reports

MOEJ has been publishing annually the "Annual Report on the Environment, the Recycling-oriented Society and the Biodiversity in Japan" since FY2009 to make public the results including the entire environmental administration in Japan with regard to air pollution, water contamination, and waste treatment in conjunction with the results of the policies for establishment of recycling-oriented society and conservation of biodiversity. Before FY2009, the Annual Report had been published in the form of "White Paper on Environmental Pollution" (FY1969 to FY1971), "White Paper on Environment" (FY1972 to FY2006), and "White Paper on the Environment and the Recycling-oriented Society" (FY2007 and FY2008).

In addition to the Annual Report, the "Report on the State of Air Pollution" is published annually as a specific report relating to continuous monitoring of air pollution and distributed to organizations concerned such as individual local governments to report the results of continuous monitoring of the status of air pollution all over the country. This Report contains the rate of compliance with the environmental quality standards (EQSs) for individual monitoring items, annual average, changes over time, and other statistics in Part 1 "Results of continuous monitoring of the status of air pollution" and also the valid measurement time at individual monitoring stations (the number of days during which valid measurements could be obtained for $PM_{2.5}$), annual average, and the annual averages over the past ten years in Part 2 "Reference Data."

6.1.2 Release through website

There is a website listing real time data of air pollutant concentrations measured throughout the country for public announcement (Atmospheric Environmental Regional Observation System (AEROS), Figure 6). This site provides information on a 24-hour basis by compiling not only the data of continuous monitoring from MOEJ and local governments but also the data from the national acid rain observatories (only those registered for EANET), which is not included in the continuous monitoring, and yellow sand (DSS) observation data obtained through the telemetered network. The data on $PM_{2.5}$ and other air pollutants is presented by regional division in Japan (Figure 7), and the distribution of hourly concentration values in each region may be viewed retroactively to 168 hours ago (seven days). In addition, a summary of

hourly values for all the monitoring items by monitoring station and the time-series plot graphs for individual monitoring items may also be accessible, being traced back to 168 hours ago.

In actuality, however, the real time data on this website are updated with a delay of about two hours and so, for identifying the most recent data, it is necessary to visit the website of the local government concerned. The website of MOEJ contains a page offering a summary of information about $PM_{2.5}$ and listing the links to the above-described page providing the real time data, the page for modeling, the pages including topics, pages referring to The EQSs, and provisional guidelines for raising an alert, and an additional page providing a list of links to real time data for individual prefectures to provide the current status, which allows immediate access to the necessary local government websites (Figure 8).

Final fixed data are announced officially on the website of the National Institute for Environmental Studies (NIES) (Figure 9). The published data on $PM_{2.5}$ include hourly values, monthly averages, and annual averages by fiscal year since FY2009. In addition, for the continuous monitoring stations for ambient air quality, detailed information is compiled by fiscal year, and for $PM_{2.5}$, the information about whether or not the measurement was successfully completed, the type of measuring equipment used, and whether or not the measuring equipment has proper equivalence is contained. These files are downloadable from the website in the text file format. The data by fiscal year and the information about monitoring stations become downloadable once the report for the fiscal year concerned has been released on the website for public announcement. NIES publishes the nationwide distribution of annual values based on the final fixed data (Figure 10). Graphical representation on the website is provided on a scale of 1 to 200 km, which may be enlarged to a scale of 1 to 100 m, allowing detailed checkup of the status of surroundings. Data before FY2008 may be downloaded from the website of MOEJ (Figure 11), although the data include measured values with any missing data left unprocessed and therefore it should be treated as reference information.

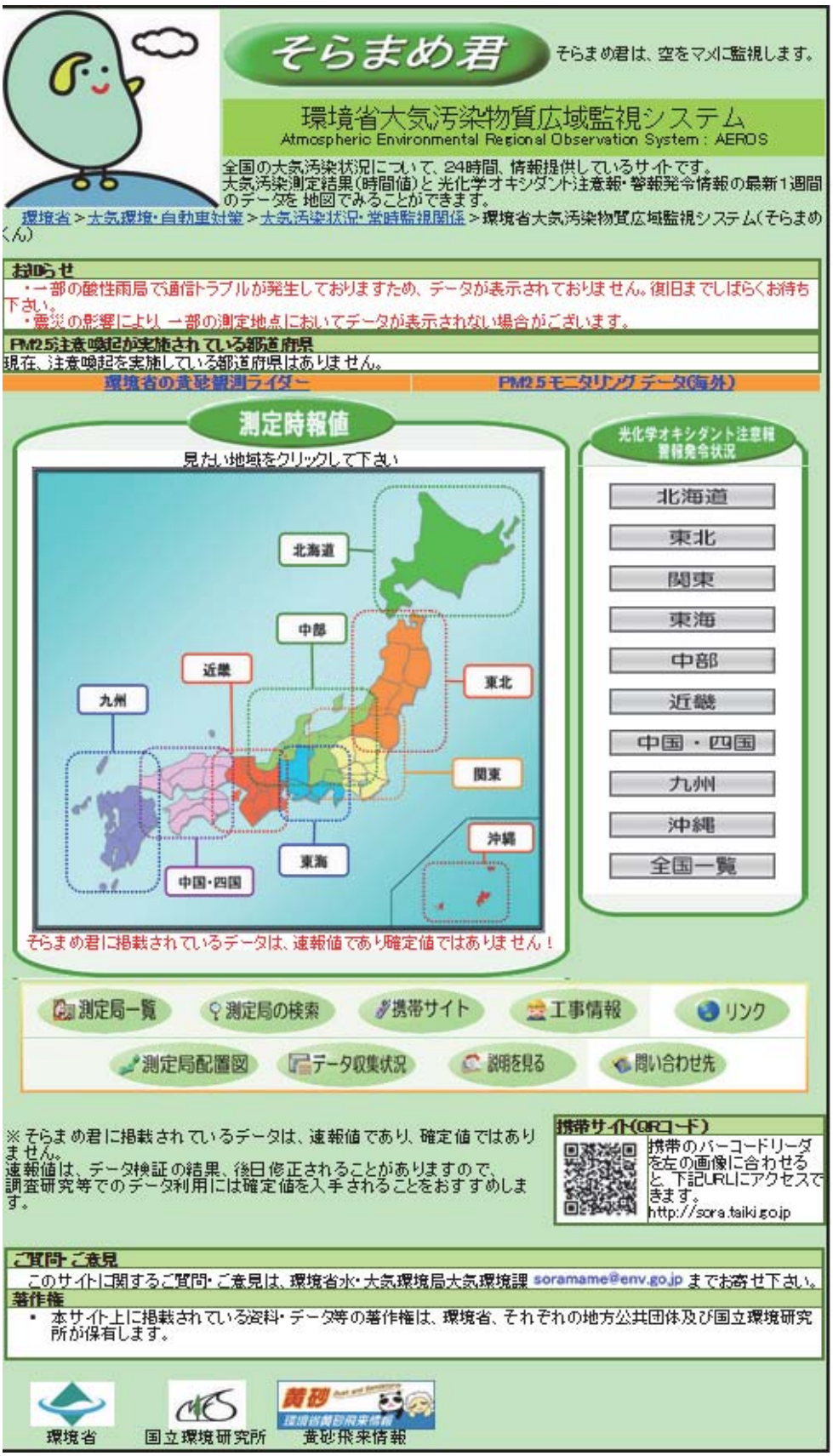

Figure 6 Front page of real time data provision site managed by MOEJ (access on September 5, 2014) http://soramame.taiki.go.jp/

Figure 7 An example of regional page (Kanto region) of real time data provision site (access on November 13, 2014) http://soramame.taiki.go.jp/DataMap.php?BlockID=03

Figure 8 Front page of "Information of $PM_{2.5}$" on the website of MOEJ (access on December 11, 2014) http://www.env.go.jp/air/osen/pm/info.html

4．現在の状況（各地の大気常時監視速報値掲載サイト等へのリンク）

- 現在、大気汚染防止法に基づき、地方自治体によって全国700カ所以上でPM2.5の常時監視が実施されています。
- PM2.5を始めとする大気汚染物質濃度の現在の状況については、環境省（大気汚染物質広域監視システム【そらまめ君】）や多くの都道府県等のホームページで速報値が公表されています。
- 常時監視結果については、各自治体がデータ確定作業を行った上で、測定された翌年度に一括して国へ報告されています。

■ 現在の状況【速報値】（都道府県のサイト）

北海道・東北地方

- 北海道(リンク)
- 青森県(リンク)
- 岩手県(リンク)
- 宮城県(リンク)
- 秋田県(リンク)
- 山形県(リンク)
- 福島県(リンク)

関東地方

- 茨城県(リンク)
- 栃木県(リンク)
- 群馬県(リンク)
- 埼玉県(リンク)
- 千葉県(リンク)
- 東京都(リンク)
- 神奈川県(リンク)

中部地方

- 新潟県(リンク)
- 富山県(リンク)
- 石川県(リンク)
- 福井県(リンク)
- 山梨県(リンク)
- 長野県(リンク)
- 岐阜県(リンク)
- 静岡県(リンク)

Figure 8 (Continued) Webpage of "Information of $PM_{2.5}$" on the website of MOEJ (linked to the webpage of local governments, access on December 11, 2014)

Figure 9 Front page of "Database of environmental numerical data" on the website of National Institute for Environmental Studies, Japan (NIES) (download site for final fixed data, access on September 5, 2014)
http://www.nies.go.jp/igreen/

Results of component analysis are downloadable from the website of MOEJ (Figure 11). From the "FY2010" to "FY2012" links on this website, the results of component analysis can be downloaded. For the results of component analysis, only the final fixed data are released.

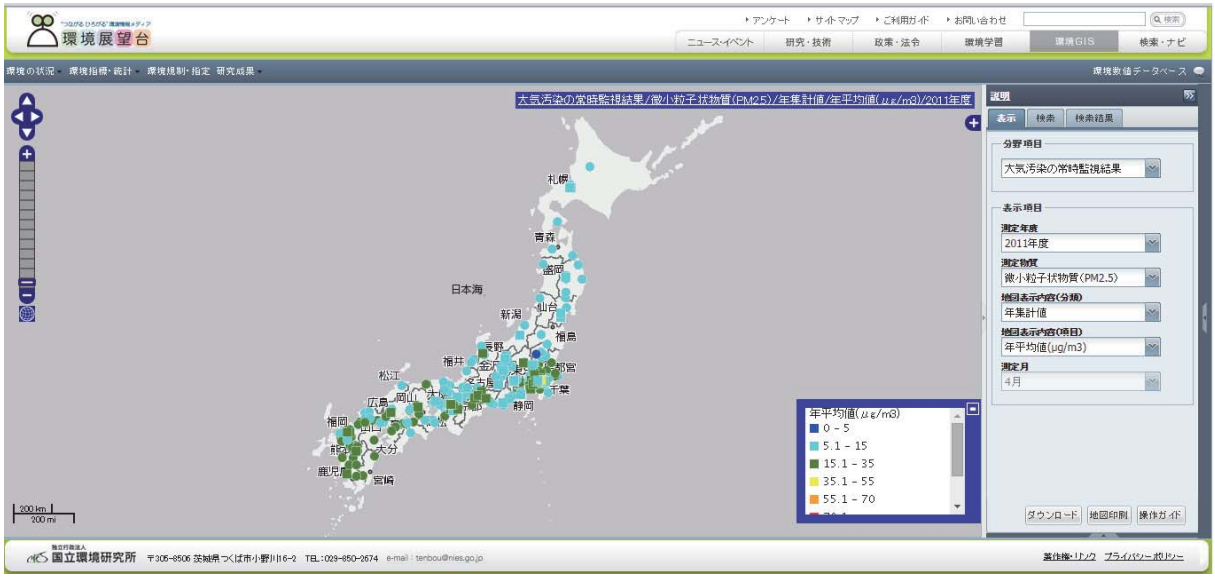

Figure 10 An output of continuous air pollution monitoring in the Environmental Geographic Information System on the website of NIES (distribution map of final fixed $PM_{2.5}$ data in 2011JFY, access on September 5, 2014) http://tenbou.nies.go.jp/gis/monitor/?map_mode=monitoring_map&field=2

Figure 11 Front page of "Measurement data of $PM_{2.5}$" on the website of MOEJ (access on December 11, 2014) http://www.env.go.jp/air/osen/pm/monitoring.html

The "Annual Report on the Environment, the Recycling-oriented Society and the Biodiversity in Japan" and the "Report on the State of Air Pollution" referred to in the preceding section are also downloadable from the website. However, Part 2 "Reference Data" of "Report on the State of Air Pollution" (annual values by monitoring station, etc.) are not posted on the website. Therefore, for acquisition of the data, it is necessary to submit a request to the MOEJ or download the data from the website of the NIES (Figure 9) in the form of a text file different from the original format.

6.2 Niigata Prefecture

6.2.1 Release through written reports

Similarly to MOEJ, Niigata Prefecture publishes annually “The Environment of Niigata Prefecture” (White Paper on Environment) and “Report on the Monitoring Results of Air Pollution.” The FY2014 edition of “The Environment of Niigata Prefecture” was issued on September 24, 2014 and the “Report on the Monitoring Results of Air Pollution” will be released at the end of the fiscal year.

6.2.2 Release through website

Niigata Prefecture also makes public the real time data (Figure 12: hourly value, Figure 13: 24-hour average) in addition to “The Environment of Niigata Prefecture” and “Report on the Monitoring Results of Air Pollution” mentioned in the preceding section. In addition, how any alerts are raised is made known to the public (Figure 14), and whether or not an alert is currently raised may be identified on the website listing real time data (Figure 12).

Meanwhile, the results of compliance with the EQSs in FY2012 are released, although the final fixed data of hourly values and 24-hour averages are left out of public announcement.

測定局名（所在地）	光化学オキシダント	二酸化硫黄	一酸化窒素	二酸化窒素	窒素酸化物	浮遊粒子状物質（SPM）	微小粒子状物質（PM2.5）
	ppm	ppm	ppm	ppm	ppm	mg/m^3	μg/m^3
注意報発令基準（参考）注）	0.12	0.5	---	0.5	---	2.0	---
村上（村上市塩町）	0.044						
中条（胎内市東本町）	0.041	0.001	***	***	***	***	
新発田（新発田市中央町）	0.039		0.001	0.003	0.004	***	***
杉谷内（聖籠町諏訪）	0.034	0.002	0.003	0.008	0.011	0.009	
次第浜（聖籠町次第浜）	0.043	0.002	0.001	0.002	0.003	***	
豊栄（新潟市北区朝日町）	0.040		0.002	0.006	0.008		
太郎代（新潟市北区太郎代）	0.047	0.002	0.000	0.002	0.002	0.015	14
松浜	0.043	0.001	0.001	0.004	0.005	0.017	

Figure 12　Front page of “Current status of atmospheric environment (real time data) in Niigata Prefecture” on the website of Niigata Prefecture, Japan (access on September 24, 2014) http://www.niigata-taiki.jp/

Figure 13 Front page of $PM_{2.5}$ real time data provision site managed by Niigata Prefecture, Japan (real time data of daily average, access on September 24, 2014)
http://www.pref.niigata.lg.jp/kankyotaisaku/1356750033048.html

Figure 14 Front page of "Measures for the high concentration event of $PM_{2.5}$" on the website of Niigata Prefecture, Japan (procedure for alert, etc., access on September 26, 2014)
http://www.pref.niigata.lg.jp/kankyotaisaku/1356753592105.html

6.3 Niigata City

6.3.1 Release through written reports

Similarly to Niigata Prefecture and MOEJ, Niigata City also publishes an annual report titled “The Environment of Niigata City,” releasing the state of the environment and the performance of the policies with regard to environmental conservation. However, such detailed data as disclosed in the “Report on the Monitoring Results of Air Pollution” are not published, but “The Environment of Niigata City (Summary Statistics)” is simply posted on the website for public announcement. The annual report is published usually around October and the Summary Statistics is released usually during the next fiscal year.

6.3.2 Release through website

In Niigata City, in addition to the annual report and the Summary Statistics mentioned in the preceding section, real time data (Figure 15: hourly value, Figure 16: 24-hour average) and concentration distribution map based on the real time data (Figure 17) are released. Real time data of hourly values may be traced back to the data in the past half-year for viewing. In addition, how any alert is raised is made known to the public (Figure 18), and the current status of alert is announced officially on the website.

新潟市の大気常時監視
Air Pollution Continuous Monitoring in Niigata City

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大気の現況（速報値）

新潟市内の最新の大気汚染状況（最近の7日間の速報値）をリアルタイムで提供しています。
データは速報値ですので、今後修正されることがあります。

測定日時: 2014 年 9 月 24 日 23 時 表示する
表示可能期間（2013年2月26日～）

測定日時　2014年09月24日 23時

種別	測定局名	二酸化硫黄 SO2 (ppm)	一酸化窒素 NO (ppm)	二酸化窒素 NO2 (ppm)	窒素酸化物 NOx (ppm)	光化学オキシダント Ox (ppm)	浮遊粒子状物質 SPM (mg/m3)	微小粒子状物質 PM2.5 (μg/m3)	一酸化炭素 CO (ppm)	非メタン炭化水素 NMHC (ppmC)	メタン CH4 (ppmC)	全炭化水素 THC (ppmC)	風向 WD (16方位)	風速 WS (m/s)
一般環	豊栄		0.000	0.003	0.003	0.039							CLM	0.0
	太郎代	0.001	0.002	0.043	0.045	0.019	0.022	14					E	2.0
	松浜	0.001	0.000	0.008	0.008	0.042	0.039			0.08	1.89	1.97	ENE	0.8
	大山	0.001	0.000	0.009	0.009	0.042	0.024	20		0.14	1.85	1.99	ESE	1.2

Figure 15　Webpage of real time air concentration data provision site managed by Niigata City, Japan (hourly average, access on September 24, 2014) http://taiki.city.niigata.lg.jp/newsflash.php


新潟市 Niigata City みなとまち。みらいまち。新潟市

音声読み上げ・文字拡大 multilingual 携帯サイト サイトマップ

検索について 検索

くらし・手続き | 子育て・教育 | 健康・医療・福祉 | 観光・文化・スポーツ | 産業・経済・ビジネス | 市政情報

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PM2.5の測定値について

更新日：2014年9月26日

新潟市では市内6ヶ所の大気汚染常時監視測定局でPM2.5（微小粒子状物質）の測定を行っています。

PM2.5速報値（1時間値）

新潟市内におけるPM2.5濃度の最新データ（1時間値）はこちらからご覧いただけます。

大気の現況（速報値）（新潟市の大気常時監視へのリンク）

PM2.5速報値（1日平均値）

PM2.5濃度（1日平均値）の表

測定日	測定結果（マイクログラム/立方メートル）					
	太郎代	大山	亀田	坂井輪	東山の下	白根
平成26年9月25日	6	7	5	4	6	7
平成26年9月24日	15	18	18	16	18	18
平成26年9月23日	10	12	10	9	10	12
平成26年9月22日	8	11	8	8	9	11
平成26年9月21日	13	12	10	7	10	11
平成26年9月20日	8	11	10	7	10	11
平成26年9月19日	6	6	6	5	6	8

大気環境

- PM2.5の測定値について
- PM2.5（微小粒子状物質）について
- 大気環境調査
- 悪臭防止対策
- 悪臭関係届出
- ボイラー・焼却炉等の届出と規制
- 大気汚染防止法に基づく届出様式一覧
- アスベスト対策
- 揮発性有機化合物（VOC）の排出抑制制度について

このページをみている人はこんなページもみています

- 迷子で保健所に保護されている犬
- 重要なお知らせ等
- 食育・花育センター講座情報
- 市民文化遺産を募集します（新潟市民文化遺産制度）
- 小瀬戸ARTプロジェクト2014 ワークショップ参加者大募集

情報がみつからないときは

Figure 16 Webpage of $PM_{2.5}$ measurement data provision site managed by Niigata City, Japan (daily average, access on September 24, 2014) http://www.city.niigata.lg.jp/kurashi/kankyo/seikatukankyo/taikikankyo/kankyo_pm2_5_result.html

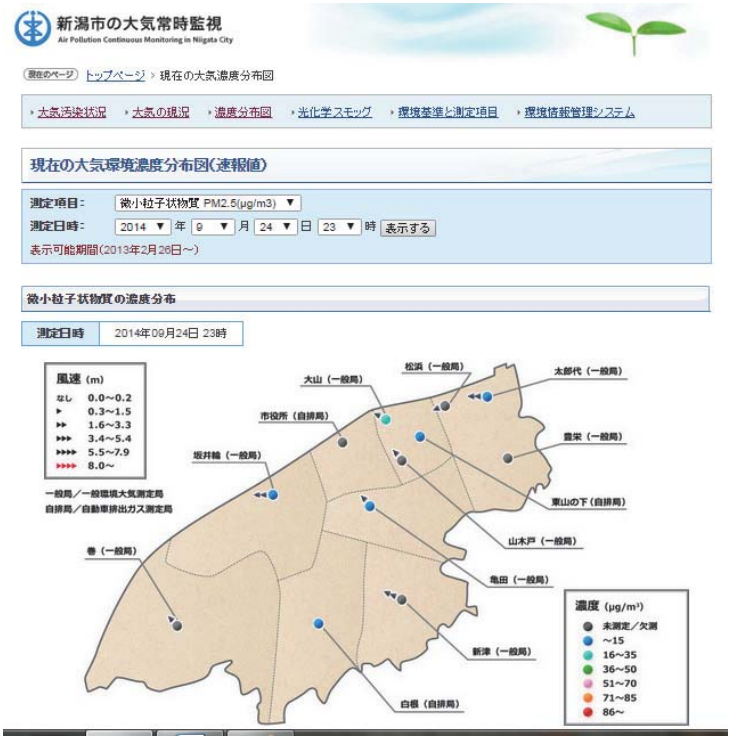

Figure 17 Webpage of "Distribution map of air pollutant concentrations (real time data)" on the website of Niigata City, Japan (hourly average of $PM_{2.5}$, access on September 24, 2014)

http://taiki.city.niigata.lg.jp/newsflash_kankyo.php

Figure 18 Webpage of "Information of $PM_{2.5}$" on the website of Niigata City, Japan (procedure for alert, etc., access on December 11, 2014) http://www.city.niigata.lg.jp/kurashi/kankyo/seikatukankyo/taikikankyo/kankyo_pm2_5.html

7 Provisional Guideline for Raising Alerts

7.1 Positioning of the guideline

Although there are limited findings in Japan and abroad about the health impact of $PM_{2.5}$ through short-term exposure, a wide range of studies have been carried out on its relationship with changes in cardiovascular and respiratory functions, changes in respiratory symptoms and respiratory functions, number of times of hospitalization/consultation at medical institutions, changes in outpatient emergency consultations, and death through respiratory/circulatory diseases.

Of these, the results of epidemiological research showing significant correlation between the 24-hour average concentration of $PM_{2.5}$ and hospitalization/consultation for respiratory/circulatory diseases showed that there was some form of health impact at the 98 percentile value of a 24-hour average of 69μg/m^3 amongst groups that included highly sensitive persons.

On the other hand, according to the results of tests conducted on volunteer healthy adults for acute exposure to $PM_{2.5}$, it was found that two hours of exposure to an average concentration of 72.2μg/m^3 caused changes to the blood biochemical index. However, there are also other findings where changes in blood pressure, heart rate, and other factors were not detected even after exposure to an average concentration of 190μg/m^3. Hence, a definite correlation has not been found between the exposure concentration of $PM_{2.5}$ and health impact.

The experts' meeting proposed a 24-hour average of 70μg/m^3 as a suitable value for the provisional guideline for raising alerts based on a comprehensive consideration of the following: epidemiological findings, findings about short-term exposure, and the fact that the United States' Air Quality Index (AQI) have established 65.5μg/m^3 and above as the concentration level at which $PM_{2.5}$ may possibly have some form of impact on human health for all people.

However, it is important to note that exposure to $PM_{2.5}$ at a concentration exceeding the 24-hour average of 70μg/m^3 may not necessarily have an impact on the health of all people.

Even when highly sensitive persons such as those with respiratory/circulatory diseases, young children, and the elderly, etc. are exposed to a 24-hour average of below 70μg/m^3, short-term impact on the health may still be detected.

7.2 Methods for determining the raising of an alert

An alert is raised in order to draw attention from the general society to reference information, and to allow the general public, including highly sensitive persons, to use the information as reference for their actions so that they may gain more opportunities to engage in outdoor activities during the day. Hence, it is considered appropriate to raise the alert at an early timeslot in the morning when many people commence their daily activities.

In addition, it is considered appropriate to make a decision to raise an alert when the $PM_{2.5}$ concentration for the day is expected to exceed the 24-hour average concentration of 70μg/m^3 at general ambient air monitoring stations.

It is appropriate to use the hourly value as the measurement for determining whether or not to raise an alert. However, although it has been proven that automated measuring equipment for $PM_{2.5}$ provides measurements of 24-hour average concentration that are equivalent to standard measuring methods, the equipment has not been proven to have the ability to produce the same degree of accuracy for hourly values. For that reason, when hourly values are used to determine whether or not to raise an alert, it is necessary to put extra effort into enhancing the accuracy of the hourly value. This can be achieved through methods such as computing the hourly average for several hours based on values collected from multiple monitoring stations, or obtaining the median value.

Using data obtained from general ambient air monitoring stations in all parts of Japan for two years (FY2010 and FY2011), a study was carried out to elucidate the relationship between the 24-hour average value and the hourly average for 5:00 a.m., 6:00 a.m., and 7:00 a.m. of the same day. The results of the study are shown in Figure 19. Based on this regression formula, the hourly value that corresponds with the 24-hour average of 70μg/m^3 was estimated to be approximately 85μg/m^3.

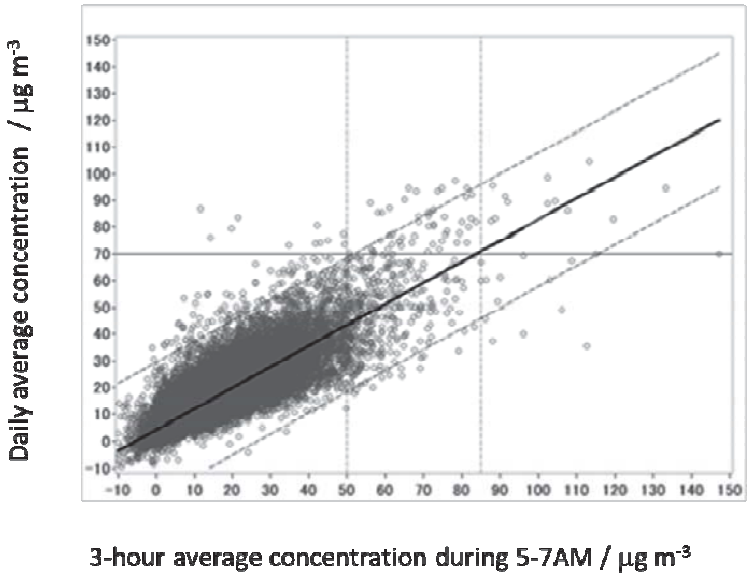

Figure19　Results of regression analysis between the 24-hour average values and 3-hour (5-7AM) average values of the same day
The bold line represents the regression famula that shows the relationship between the 24-hour average value and 3-hour averages. The broken lines show the 95% prediction limits.

Then later, after several local governments requested response to the rise in concentration in the daytime, in November 2013 considerations were added for activities to be conducted in the afternoon. Upon considering the possibility of making reassessment after noon using regression analysis of the 24-hour average and the average of hourly values, 80 μg/m^3, the average of hourly values taken between 5 o'clock in the morning and noon was determined as the criterion.

In December 2014, the following two points were revised. Firstly, the method of determining whether to lift an alert was added so that the residents do not have to continuously stay indoors in the case where the concentration of $PM_{2.5}$ has significantly improved in the daytime. Specifically, if the hourly value of $PM_{2.5}$ concentration has consecutively fallen below 50 μg/m^3 at all monitoring stations in a single area where the concentration has exceeded the criterion for raising an alert, it was deemed appropriate to determine whether to lift the alert in consideration of the density transition at the relevant monitoring stations as well as neighboring monitoring stations. Secondly, the values used for determining whether to raise an alert in earlier hours of the morning was changed in order to reduce the chance of "overlooking" the value exceeding the provisional indicator value before an alert is raised. This means that whether or not to raise an alert is determined by "the second largest value in a single area"

rather than “the median in a single area,” which used to be regarded appropriate. Also, raising an alert is something that should be determined daily, so it was additionally decided that an alert should not be continuously used after midnight.

With regard to the above-described criterion, it is to be noted that forecast precision is still limited, in that a certain number of cases are overlooked and that there are still problems with precision of the automated measuring equipment concerning the hourly value. For this reason, it is appropriate to determine whether to raise and lift an alert after taking comprehensive account of weather conditions, characteristics of pollution sources, etc. in the area, observation data of neighboring monitoring stations and those in neighboring prefectures, the latest simulation results released by research institutions, etc.

7.3 Provisional guideline for raising alerts

In view of the above, it was considered appropriate to establish the following as the provisional guideline for raising alerts (Table 8).

Table 8　Provisional guideline for raising alerts

Level	Provisional guideline value	Guideline for activities	Value for assessing whether or not to raise an alert [*3]	
			Assessment in the early hours of the day	Assessment in preparation for activities after noon time
			5:00 – 7:00	5:00 – 12:00
	24-hour average ($\mu g/m^3$)		Hourly value ($\mu g/m^3$)	Hourly value ($\mu g/m^3$)
Ⅱ	Above 70	As far as possible, reduce the incidence of non-urgent outings and strenuous exercises outdoors. (Highly sensitive persons[*2] should take even greater care with their activities in consideration of the physical condition of their bodies.)	Above 85	Above 80
Ⅰ	Below 70	While there is no particular need to restrict activities, highly sensitive persons should pay attention to changes in the physical condition of their bodies as health impact may be observed.	Below 85	Below 80
Environmental Quality Standard	Below 35[*1]			

＊1　The short-term environmental quality standard is a 24-hour average of $35\mu g/m^3$, which is assessed at the 98 percentile value of 24-hour values for a year.

＊2　Highly sensitive persons includes those who suffer from respiratory/circulatory diseases, young children, and the elderly.

＊3　The 24-hour average that serves as the provisional guideline is the value used to assess the situation in early hours of a day.

7.4　Enforcement methods

In principle, the implementing entity for raising alerts is the municipality. This is in consideration of factors such as the possibility that a rise in $PM_{2.5}$ concentration may occur over a relatively wide area, and the ability of local government bodies to utilize knowhow about emergency measures based on the Air Pollution Control Act.

Furthermore, as it is necessary to bear in mind the possibility of a wide-area phenomenon and the accuracy of measuring equipment, it is appropriate to make a decision about raising an alert using data for several hours obtained from

multiple monitoring stations.

After raising an alert, if significant improvements are observed in the $PM_{2.5}$ concentration levels, use the level of 50μg/m^3 as shown in Figure 19 as a guideline for notifying residents about the improvements.

References

1) Japan Environmental Sanitation Center (JESC) “Essential Basic Knowledge about $PM_{2.5}$” (May 2013)
2) MOEJ “Particulate Matter 2.5 ($PM_{2.5}$) Measuring Method Advisory Committee Report under Air Environmental Section, Central Environment Council” (September 2009)
3) Niigata Prefecture website “1. Topography and Population” http://www.pref.niigata.lg.jp/tokei/1249502654105.html 1. Topography and Population (Excel format 38 KB) (access in November 10, 2014)
4) Niigata Prefecture Department of Civil Life and Environment, Environment Control Section “FY2011 Report on the Monitoring Results of Air Pollution” (December 2012)
5) Niigata Prefecture Department of Civil Life and Environment, Environment Control Section “FY2012 Report on the Monitoring Results of Air Pollution” (February 2014)
6) Niigata Prefecture website “The status of achievement of environmental quality standard for particulate matter 2.5 ($PM_{2.5}$) (FY2013)” http://www.pref.niigata.lg.jp/kankyotaisaku/1356750033048.html (access in November 10, 2014)
7) JICA FY2014 “Project for Capacity Development of Planning for Pollution Control of Ozone (O_3) and $PM_{2.5}$ in Atmosphere,” a material for presentation in the training for attendees visiting Japan “Monitoring techniques and methodologies for ozone and $PM_{2.5}$” (documented by Mr. Hajime Mikasa, Japan Environmental Technology Association (JETA))
8) MOEJ Environmental Management Bureau “Manual for Continuous Monitoring of Air Pollution Sixth Edition” (March 2010)
9) MOEJ “FY2010 Report on the State of Air Pollution” (February 2012)
10) MOEJ “FY2011 Report on the State of Air Pollution” (July 2013)
11) MOEJ “FY2012 Report on the State of Air Pollution” (July 2014)
12) MOEJ “FY2011 Report on the State of Air Pollution – Particulate Matter 2.5 ($PM_{2.5}$) Component Measurement Results -” (July 2013)
13) MOEJ “FY2012 Report on the State of Air Pollution – Particulate Matter 2.5 ($PM_{2.5}$) Component Measurement Results -” (July 2014)

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