

# **1. Air quality**

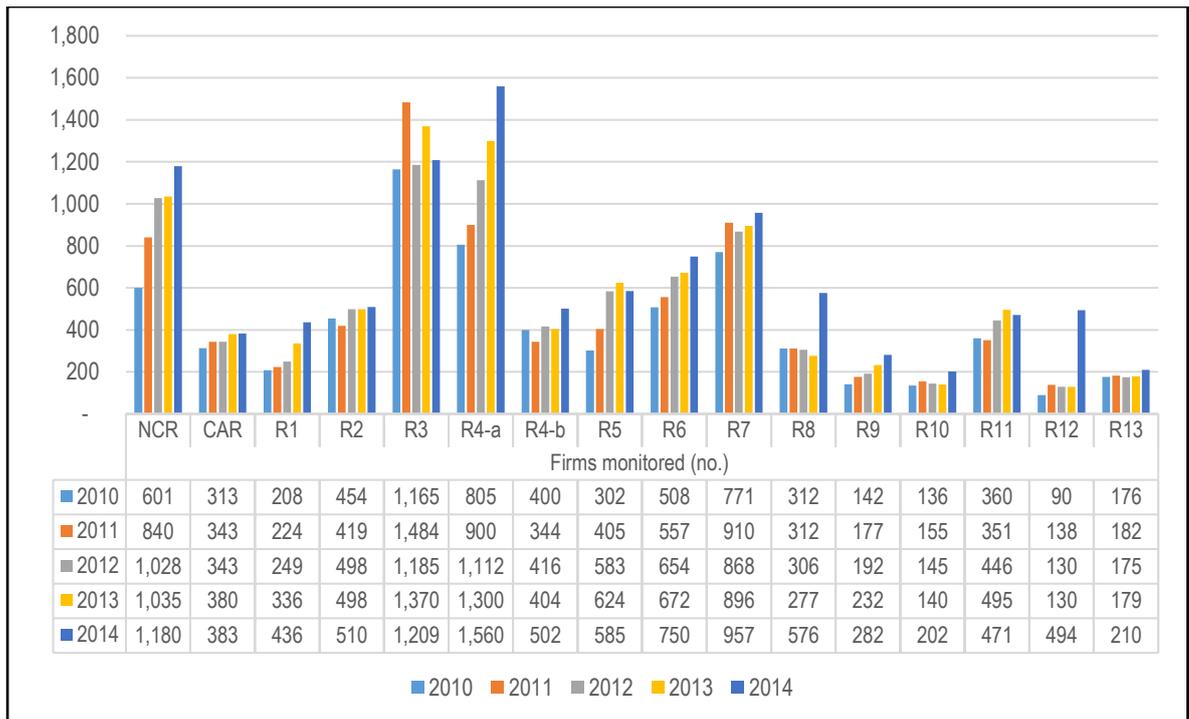
## **1.1 Sources of air pollution**

Air pollutants can come from both natural and anthropogenic sources, but anthropogenic air pollutants dominate the atmosphere of areas primarily undergoing industrialization. For management purposes, air pollution sources can be classified as stationary, mobile or area, as described in RA 8749.

### **1.1.1 Stationary sources**

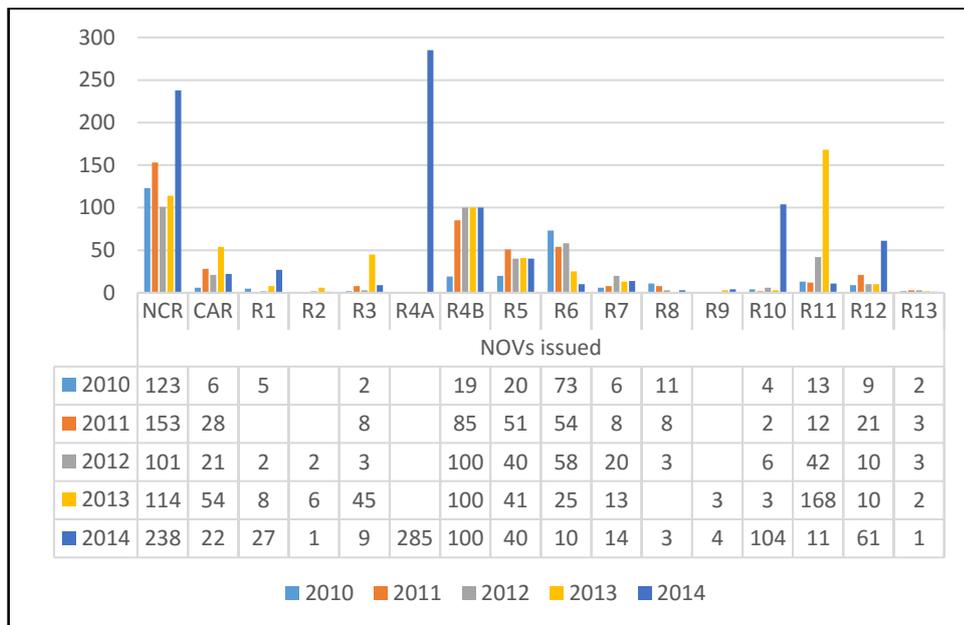
Stationary sources refer to any building or immobile structure, facility or installation which emits or may emit any air pollutant, and may be defined generally as individual points of air emissions (e.g. smokestacks). Under RA 8749, all industries classified as a stationary source should perform their own emissions monitoring and report the results to the DENR. All stationary sources of air emissions must comply with National Emission Standards for Sources Specific Air Pollution (NESSAP) and Ambient Air Quality Standard (AAQS) pertaining to the source. Upon compliance to standards, the DENR issues a Permit to Operate (PTO) to these industries prior to their operation.

Based on the grounds stated in Section 12 of DAO 2013-26, a Notice of Violation (NOV) may then be issued to industries with previously issued PTOs. In 2014, the DENR monitored a total of 10,307 firms. During the period 2010 to 2014, the number of firms monitored grew from 6,743 in 2010 to 10,307 in 2014 representing an increase of 53%. The most number of industries monitored are in Regions 3, 4A, 7 and NCR – areas in the country where the level of industrial growth is high. Also notable is the sudden increase in the number of monitored firms in Regions 8 and 12 in 2014. (See **Figure 1-1**).



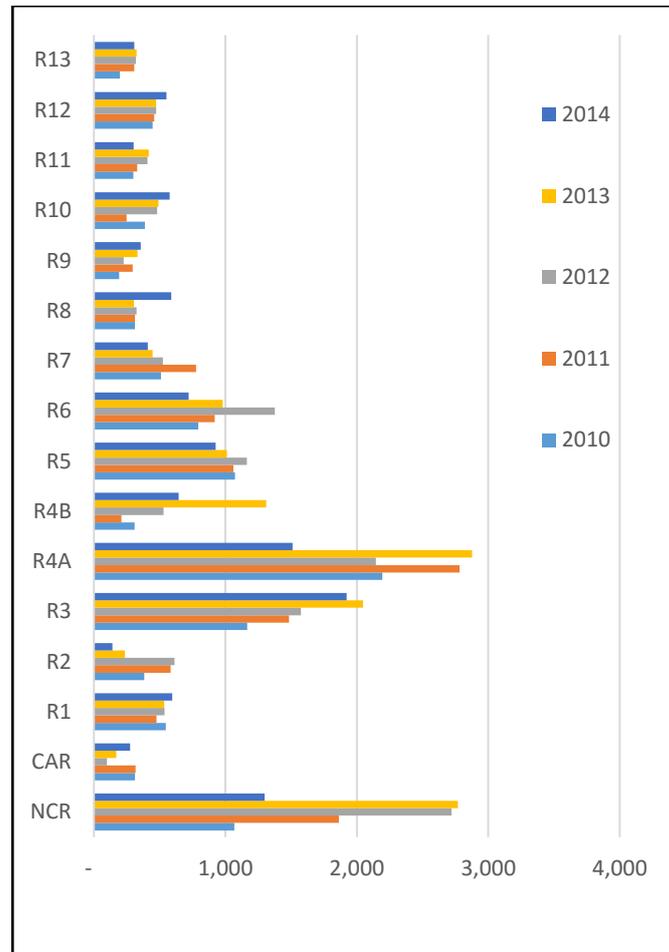
**Figure 1-1. Number of firms monitored By region, 2012-2014**

During the period 2010 to 2014, NOVs issued increased from 293 in 2010 to 930 NOVs in 2014 for an increase of more than 200%. (**Figure 1-2**) In 2014, the most number of NOVs recorded are in Region IVA (285), NCR (238), Region 10 (104) and Region 4B (100).



**Figure 1-2. Number of NOVs issued, 2010-2014**

From 2010 to 2014, the number of PTOs issued was 10,190 in 2010 to 11,129 PTOs in 2014 showing a slight increase of 9 percent. The most number of PTOs was issued in 2013 at 14,728 PTOs. This number abruptly decreased in 2014, exemplified by huge decreases in NCR, 4A and 4B, which explains the low rate of increase in the number of PTOs released during the five-year period. (See Figure 1-3)



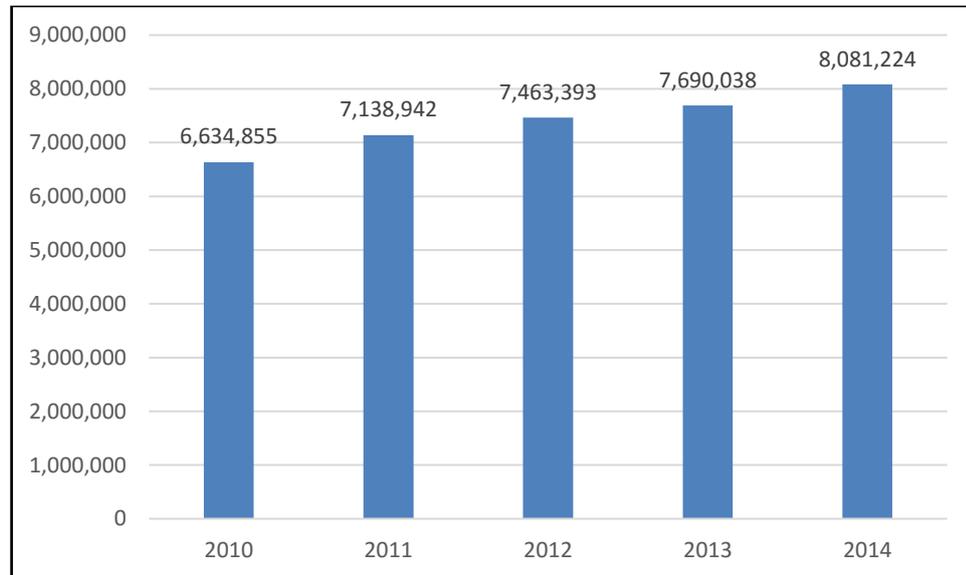
Source: EMB

**Figure 1-3. Number of PTOs issued, 2012-2014**

### 1.1.2 Mobile sources

Mobile sources are any vehicle propelled by or through combustion of carbon-based or other fuel, constructed and operated principally for the conveyance of persons or the transportation of property or goods. It has already been reported in the 1996 to 1999 Metro Manila Urban Transportation Integration Study (MMUTIS) that the sources of major atmospheric pollutants such as particulate matter and NOx come mostly from motor vehicle exhaust emissions mainly attributed to jeepneys, buses and taxicabs. However, the total volume of emissions of criteria pollutants attributed from the transport sector disaggregated as to the types of motor vehicles and areas of operation has not yet been fully studied and reported.

**Figure 1-4** shows the number of total registered motor vehicles (MVs) in the Philippines from 2010 to 2014. The number of registered vehicles has continuously increased in the country, increasing the number of mobile emissions. From 6,634,855 MVs in 2010 to 8,081,224 MVs in 2014 recorded by the LTO, the number of MVs grew by 22 percent during the five-year period.

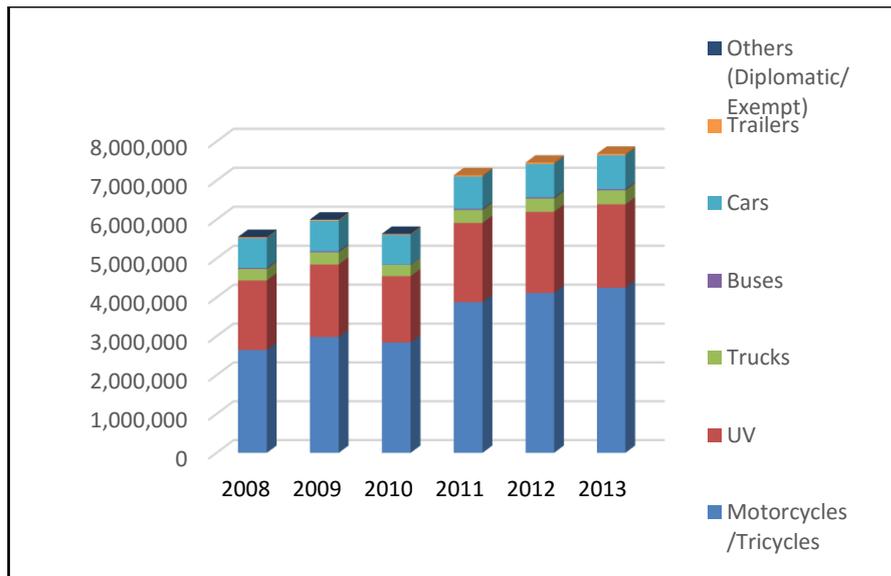


*Source: LTO, NSCB*

**Figure 1-4. Total number of registered motor vehicles in the Philippines from 2010-2014**

MVs are classified by the LTO for registration into seven groups: cars, utility vehicles (UV), sports utility vehicles (SUV), trucks, buses, motorcycles/tricycles (MC/TC) and trailers. For the period 2008 to 2013, LTO data have shown that all types of vehicles have steadily increased in number as can be seen in **Figure 1-5**.

Prior to 2005, registered UV outnumbered the other types of MV with an average share of 41.8%. From 2005 onwards however, the percentage of motorcycles and tricycles (MC/TC) increased until it overtook the UV share and became the dominant MV in the Philippines.



Source: LTO

**Figure 1-5. Number of registered motor vehicles by MV type, 2008-2013**

In general, increase in vehicle registrations is caused by the increase in population especially in urban centers to cater to the transport needs of the people. Although more national roads and bridges are being improved and built through the years, main roads remain heavily congested particularly during rush hours, prolonging vehicle emissions as travel time is increased. The increase in purchase and registration of motorcycles can be attributed to the thought that these MVs are faster, use less space and consume less fuel compared to cars. Those who can afford use cars because the mass transit system of the country is undeveloped, explaining the steady increase in car registrations as well.

The solution to heavy traffic is the improvement of the Philippines' mass transport system as less vehicles will be used, thus reducing mobile emissions. The DOTC has implemented and still continue to promote rationalization projects for public transit, especially for buses and jeepneys which dominate the roads in terms of numbers. On the other hand, the LTFRB LTO inspects motor vehicle emissions as per RA 8749. Compliance to standards is the requirement for new and renewal of registration while penalties are imposed to those who exceed the limit.

To reduce vehicular emissions, non-motorized transport (bicycle use) is being promoted as well as the use of 'cleaner fuels' such as liquefied petroleum gas (LPG) and compressed natural gas (CNG). In 2012, the transport sector accounted for the 38.72 kTOE (3.4%) of the total 1,146.41 kTOE LPG consumption of the country. Hybrid cars and electricity-powered vehicles are also gaining more support from the government, private and public sector.

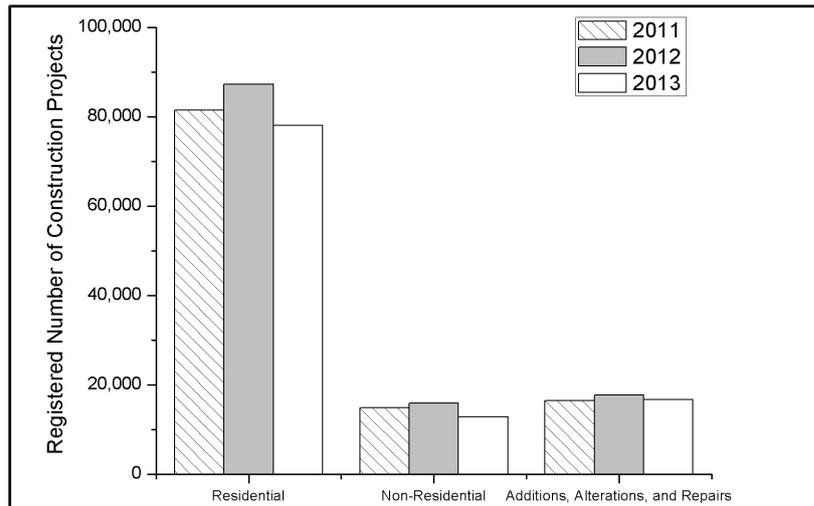
### **1.1.2 Area sources**

Area source is a source of air emissions that is not confined to a discrete point or points of emissions, examples of which (but not limited to) are construction activities (TSP or PM<sub>10</sub>), unpaved road ways (TSP or PM<sub>10</sub>), lagoons (photochemically reactive compounds and/or other emissions), industrial facilities with many small or generalized potential sources such as valves, seals, etc. (photochemically reactive compounds and/or other emissions); and common generally industrial, small, non-regulated point sources (e.g. dry cleaners and gasoline stations) where the point source(s) cannot feasibly or practically be measured.

Household cooking, meat curing and waste burning are also among the contributors to area sources. Pursuant to Part VII, Section 13 (d) of the RA 8749 IRR, open burning of materials such as plastic, polyvinyl chloride, paints, ink, wastes containing heavy metals, organic chemicals, petroleum related compound, industrial wastes, ozone depleting substances and other similar toxic and hazardous substances, is prohibited.

As specified in Section 24 of RA 8749, there is also a ban on smoking inside a public building or an enclosed public place including public vehicles and other means of transport or in any enclosed area outside of one's private residence, private place of work or any duly designated enclosed smoking area. Implementation of this policy seems lacking as a large part of the 17.3 million Filipino (aged 15 years old and above) smokers can be seen smoking every day in the streets and public vehicles.

Alongside the increase in urbanization rates and economic development, the number of construction activities has also increased during the past decade. The total number of new construction projects in 2011 was 112,881 and this increased by 6.75% in 2012 to 121,051 with the most number of constructions occurring in Region 4A at 27,729 projects (22.9%). From 2012, a 10.98% decrease to 107,765 construction projects was recorded in 2013 (**Figure 1-6**). From 2011 to 2013, the major type of construction was residential, comprising 70 to 75% of all approved construction projects.

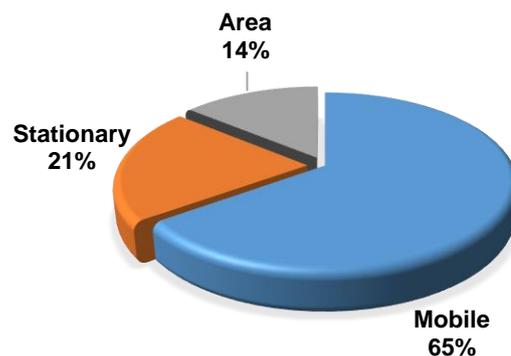


**Figure 1-6. Number of construction projects in the Philippines, 2011-2013**

#### 1.1.4 Emissions inventory

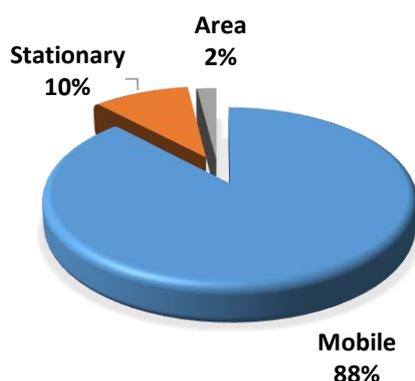
The EMB is required under RA 8749 to conduct an inventory of emissions once every three years. Emissions inventory estimates emissions coming from stationary, mobile and area sources.

Based on the latest National Emissions Inventory by source conducted in 2015, the majority (65%) of air pollutants came from mobile sources such as cars, motorcycles, trucks and buses. Almost 21 percent were contributed by stationary sources such as power plants and factories. The rest (14%) were from area sources such as construction activities, open burning of solid wastes and *kaingin* in the uplands. (See **Figure 1-7**).



**Figure 1-7. National Emissions Inventory, by source, 2015**

On the other hand, the Emissions Inventory for NCR in the same year revealed that mobile sources contributed an enormous 88 percent to total air pollution in the area compared to 10% from stationary sources and a mere 2% from area sources. (See **Figure 1-8**).



**Figure 1-8. NCR Emissions Inventory, by source, 2015**

## **1.2 Status of air quality**

### **1.2.1 Air quality monitoring**

Ambient Air Quality is defined by RA 8749 as the general amount of pollution present in a broad area, and refers to the atmosphere's average purity as distinguished from discharge measurements taken at the source of pollution. In order to monitor the ambient air quality of the country, EMB regional monitoring stations routinely take measurements of criteria air pollutants. In the existing National Air Quality Monitoring Set-up of the DENR EMB, there are sampling equipment located all over the Philippines classified according to type of monitoring and criteria pollutants monitored.

#### General Ambient and Roadside Ambient Air Quality Monitoring Program

General air pollution monitoring stations monitor the ambient air quality of a fixed area. Roadside air quality monitoring stations monitor the ambient air quality near roads with large traffic volumes and assess air pollution caused by motor vehicles.

The Quality Assurance/Quality Control of air monitoring network ensures that the ambient air quality monitoring equipment are operated, maintained and calibrated. The manual and real time stations are situated in highly urbanized cities and also rural areas nationwide. These are being managed by focal and alternate focal persons in the regional offices as mandated through EMB Special Order No. 219 Series of 2015. They are tasked to oversee day to day operation of the stations located in their respective territorial jurisdiction and submit a quarterly report of the stations operation. The AQMS central office manages the central depository system and acts as the overall section in charge of the operation and maintenance of the 93 stations nationwide. **(Table 1-1)**

**Table 1-1. Types of air quality monitoring systems in the Philippines and pollutants monitored, 2015**

Type	Quantity
Manual/Reference Method – PM <sub>10</sub>	27
Manual/Reference Method - TSP	22
Continuous Monitoring – DOAS (PM <sub>10</sub> , PM <sub>2.5</sub> , O <sub>3</sub> , SO <sub>2</sub> , NO <sub>2</sub> , CO & BTX)	14
Continuous Monitoring Van – 1 (Methane, O <sub>3</sub> , SO <sub>2</sub> , NO <sub>2</sub> & CO) & 2 (PM <sub>10</sub> )	3
Continuous Monitoring – PMS (PM <sub>10</sub> & PM <sub>2.5</sub> )	27
<b>Total Number of Stations</b>	<b>93</b>

Source: EMB

### 1.2.2 Criteria pollutants

Criteria pollutants are air pollutants for which National Ambient Air Quality Guideline Values have been established. These pollutants and their guideline values are shown in **Table 1-2**.

**Table 1-2. National Ambient Air Quality Guideline Values (NAAQGV) from RA 8749**

Parameter	Averaging Time	NAAQGV(µg/NCM)
TSP	Annual	90
	24-hour	230
PM <sub>10</sub>	Annual	60
	24-hour	150
PM <sub>2.5</sub>	Annual	35 (Until 31 Dec, 2015), 25 (By 1 January, 2016)
	24-hour	75 (Until 31 Dec, 2015), 50 (By 1 January, 2016)
Sulfur Dioxide (SO <sub>2</sub> )	Annual	80
	24-hour	180
Nitrogen Dioxide (NO <sub>2</sub> )	Annual	-
	1-hour	-
	24-hour	150
Ozone (O <sub>3</sub> )	8-hour	60
	1-hour	140
Carbon Monoxide (CO)	8-hour	10
	1-hour	35
Lead (Pb)	annual	1
	3 months	1.5

Notes: Notes for Table \_\_

\*NCM stands for 'normal cubic meter', assuming that the samples were collected under 'normal' conditions or at standard temperature and pressure

-SO<sub>2</sub> and Suspended Particulate matter (TSP and PM) are sampled once every six days when using the manual methods. A minimum of twelve sampling days per quarter or forty-eight sampling days each year is required for these methods. Daily sampling may be done in the future once continuous analyzers are

procured and become available.

-For short term values, maximum limits represented by ninety-eight percentile (98%) values not to exceed more than once a year.

-Annual values of TSP and PM<sub>10</sub> are reported as Geometric Mean. \*Geometric mean is used because the annual mean pollutant level in a year is dependent of the pollutant level from the previous year.

-Evaluation of the guideline for Lead is carried out for 24-hour averaging time and averaged over three moving calendar months. The monitored average value for any three months shall not exceed the guideline value.

Particulates or tiny particles of solid material or liquid aerosols can be present in the atmosphere and can be of pollution concern. Particle pollutants in the air can come from both natural and man-made sources such as smoke from forest fires and recreational sources, volcanic eruptions, vehicle exhaust emissions, industrial emissions, soil and road dust. Depending on the specific size, properties and environmental conditions, it may remain suspended in the air for a few seconds or indefinitely and travel from hundreds to thousands of kilometers.

*Total Suspended Particulates (TSP)* refer to all atmospheric particles in the atmosphere with diameters equal to or less than 100 micrometers. These relatively 'coarse' particles are mainly related to soiling and dust nuisance. On the other hand, particulates with diameters less than 10 micrometers are called Particulate Matter (PM) and are of greater health concern as they can penetrate deep into the lungs. PM with diameters less than 10 micrometers are specifically called PM<sub>10</sub> while PM with diameters less than 2.5 micrometers are called PM<sub>2.5</sub>.

*Sulfur dioxide (SO<sub>2</sub>)* is a colorless gas with a pungent smell at low concentrations. Fossil fuel combustion, power plants and other industrial facilities are the main sources of SO<sub>2</sub> in the atmosphere. In urban centers with high traffic volume, high SO<sub>2</sub> levels can be observed due to vehicular combustion of fuel with high-sulfur content. In the atmosphere, it can undergo chemical reactions (oxidation) creating sulfur trioxide, particulate sulfates and sulfuric acid which can lead to acid rain. Exposure to SO<sub>2</sub> can have adverse respiratory effects and heart diseases.

*Nitrogen dioxide (NO<sub>2</sub>)* is a reddish-brown gas with an odorless, pungent smell. The main sources of NO<sub>2</sub> are vehicular emissions, power plants and off-road equipment. Like SO<sub>2</sub>, it undergoes chemical reactions in the atmosphere, forming other toxic NO<sub>x</sub> compounds and nitrate particulates that pose respiratory health risks. If present in the atmosphere in high concentrations, it can react with sunlight in a process called photolysis which leads to ozone formation.

*Ozone (O<sub>3</sub>)* is a colorless, odorless gas that can be found at the upper layers of the atmosphere and serves as our protection from the sun's harmful rays. However, O<sub>3</sub> can also be formed at ground level through chemical reactions of NO<sub>x</sub> and volatile organic compounds (VOCs) especially during hot days. The main sources of NO<sub>x</sub> and VOCs include industrial and electric facility

emissions, vehicular exhausts, gasoline vapors and chemical solvents. O<sub>3</sub> can pose detrimental health risks, if inhaled, and can also affect sensitive vegetation and ecosystems since it is also classified as a greenhouse gas.

*Carbon monoxide (CO)*, is a colorless, odorless gas that is very toxic when inhaled as it reduces oxygen transport in the body. At very high concentrations, CO can even cause death. The main source of this pollutant is vehicular emissions especially in urban centers.

Heavy metals, primarily *Lead (Pb)* are measured in the atmosphere because of lead emissions from industrial sources and vehicular combustion of fuel. Pb used to be the main anti-knock component of gasoline but regulatory efforts have already prohibited the use of such fuel, reducing lead combustions. But like other heavy metals such as Arsenic (As), Cadmium (Cd), Mercury (Hg), Chromium (Cr) and Nickel (Ni), Pb is persistent in the environment and poses serious health risks.

### **1.2.3 Air quality index**

A complex relationship between air pollution levels and exposure exists. However, the public needs to be well informed of their ill health effects in a manner that is both simple and accurate. To protect public health, safety and general welfare, a set of pollution standard index of air quality, called the Air Quality Index (AQI) was formulated in line with Part II, Rule VII, Section 4 of RA 8749 IRR. For the six criteria pollutants, the air quality can be described in terms of six levels depending on pollutant concentration: *Good, Fair, Unhealthy for sensitive groups, Very unhealthy, Acutely unhealthy and Emergency*. **Table 1-3** summarizes the AQI applied in the Philippines.

In order for the public to better understand the AQI and its implication to human health, cautionary statements can be issued depending on the specific pollutant and its concentration level. The cautionary statements are issued depending on the prescribed averaging time in Table 1-3, detailed in **Table 1-4**. Daily reports of the AQI based on PM<sub>10</sub> have been made available starting in 2014 at the four continuous monitoring stations in NCR (DLSU-Taft, DPWH-Timog Q.C., PLV-Valenzuela and Commonwealth Ave, Q.C.), through the website <http://www.emb.gov.ph>.

**Table 1-3. Air Quality Index breakpoints, Annex of RA 8749-IRR**

Pollutant	Unit, Averaging Time	Good	Fair	Unhealthy for sensitive groups	Very unhealthy	Acutely unhealthy	Emergency
TSP	µg/Nm <sup>3</sup> , 24-hr	0 – 80	81 – 230	231 – 349	350 – 599	600 – 899	900 and greater
PM <sub>10</sub>	µg/Nm <sup>3</sup> , 24-hr	0 – 54	55 – 154	155 – 254	255 – 354	355 – 424	425 – 504
SO <sub>2</sub>	ppm, 24-hr	0.000 – 0.034	0.035 – 0.144	0.145 – 0.224	0.225 – 0.304	0.305 – 0.604	0.605 – 0.804
O <sub>3</sub>	ppm, 8-hr	0.000 – 0.064	0.065 – 0.084	0.085 – 0.104	0.105 – 0.124	0.125 – 0.374	<sup>a</sup>
	ppm, 1-hr	-	-	0.125 – 0.164	0.165 – 0.204	0.205 – 0.404	0.405 – 0.504
CO	ppm, 8-hr	0.0 – 4.4	4.5 – 9.4	9.5 – 12.4	12.5 – 15.4	15.5 – 30.4	30.5 – 40.4
NO <sub>2</sub>	ppm, 1-hr	<sup>b</sup>	<sup>b</sup>	<sup>b</sup>	<sup>b</sup>	0.65 – 1.24	1.25 – 1.64

<sup>a</sup>When 8-hour O<sub>3</sub> concentrations exceed 0.374 ppm, AQI values of 301 or higher must be calculated with 1-hour O<sub>3</sub> concentrations.

<sup>b</sup>NO<sub>2</sub> has no 1-hour term NAAQG

**Table 1-4. Summary matrix of pollutant-specific cautionary statements for the general public.**

Caution	TSP, PM <sub>10</sub> , SO <sub>2</sub> , Ozone and NO <sub>2</sub>		CO	
None	GOOD	FAIR	GOOD	FAIR
People with respiratory disease, such as asthma, should limit outdoor exertion.	Unhealthy for sensitive groups			
Pedestrians should avoid heavy traffic areas.	Very unhealthy		Very unhealthy	
People with heart or respiratory disease, such as asthma, should stay indoors and rest as much as possible.	Very unhealthy	Acutely unhealthy	Very unhealthy	
Unnecessary trips should be postponed.			Very unhealthy	Acutely unhealthy
People should voluntarily restrict the use of vehicles.				
People should limit outdoor exertion.				
People with heart or respiratory disease, such as asthma, should stay indoors and rest as much as possible.				
Motor vehicle use may be restricted	Acutely unhealthy		Acutely unhealthy	
Industrial activities may be curtailed.				
Everyone should remain indoors, (keeping windows and doors closed unless heat stress is possible).				
Motor vehicle use should be prohibited except for emergency situations.	Emergency			
Industrial activities, except that which is vital for public safety and health, should be curtailed.				
People with cardiovascular disease, such as angina, should limit heavy exertion and avoid sources of CO, such as heavy traffic.			Unhealthy for sensitive groups	Acutely unhealthy
Smokers should refrain from smoking.			Very unhealthy	
Everyone should avoid exertion and sources of CO, such as heavy traffic; and should stay indoors and rest as much as possible.			Emergency	

Source: EMB

### 1.2.4 Air quality trends

Ambient air quality trends nationwide and in selected regions are presented for criteria pollutants that have been monitored in air quality monitoring stations in most regions of the country. Average values were calculated for Total Suspended Particulates (TSP) and PM<sub>10</sub> to provide trends for most regions during the period 2008-2015. Average values and trends for other pollutants were also presented for the National Capital Region (NCR) and other regions. Data were subjected to quality assurance and quality control by EMB Central Office.

#### Total Suspended Particulates (TSP): annual trends

Among criteria pollutants, Total Suspended Particulates (TSP) have been the subject of monitoring for the longest period of time. TSP monitoring, which uses the manual/reference method, goes as far back as more than a decade ago.

The geometric mean of TSP readings in each monitoring site in the regions is presented as the yearly average for that site. **Table 1-5** presents the annual TSP trends for the period 2008-2015 at specific sites in most regions of the country. It must also be noted that a number of sites in some regions did not have data or had incomplete data during certain years. (There are no data from monitoring stations that are undergoing repair and those that did not meet the 75% percent minimum data capture requirement).

**Table 1-5. Total Suspended Particulates annual mean values (2008 – 2015).**

Region	Station	Total Suspended Particulates Annual Values (µg/Ncm)							
		2008	2009	2010	2011	2012	2013	2014	2015
NATIONAL CAPITAL REGION (NCR)	Makati Bureau of Fire Cmpd., Ayala Avenue cor., Buendia St., Belair, Makati City	134	145	160	128	135		130*	111
	Valenzuela Municipal Hall, Pamantasan ng Lungsod ng Valenzuela, Valenzuela City	156	164	162	121	123	143	122	86
	EDSA East Avenue BFD Cmpd. East Avenue Q. C.	107	90	105	74	72	92	96	97
	NCR-EDSA National Printing Ofc. Q.C	144	89	152	103	96	112	97*	
	Ateneo de Manila Observatory, Ateneo University	74	62	79	58	62	70	50	48
	Mandaluyong City Hall, Maycilo Circle, Plainview, Mandaluyong City	125	104	138	136	148		143	158
	Dept. of Health , San Lazaro St., Rizal Avenue	103	103	132	101	114	115	105*	109

Region	Station	Total Suspended Particulates Annual Values ( $\mu\text{g}/\text{Ncm}$ )							
		2008	2009	2010	2011	2012	2013	2014	2015
	LLDA Compound Pasig, City Hall	85	126						
	Marikina Sports Complex, Sumulong Highway, Sto. Niño, Marikina City			125	125	108	97	81	104
	MRT-Taft Avenue Station EDSA Cor. Taft Avenue, Malibay, Pasay City	282	283	294	219	213	197	216	
REGION 1	Vigan City, Ilocos Sur							127	145
	Pagudpud, Ilocos Norte								
	In front of Nepo Mart, Alaminos City, Pangasinan	133	132	125					
	San Fernando City, Beside Francisco Ortega Monument, Province of La Union			130	117				
REGION 2	Tuguegarao Stn. Brgy. 10, Tuguegarao City		77	94	108	87			
REGION 3	San Fernando City, Pampanga				128	243		202*	180
	Saluysoy Stn., Bulacan	106	124	61	21	14	6	41*	
	Intercity Stn., Bulacan				344	277		482*	244
REGION 4A	Cavite								
	Batangas	50	19	22					
	Quezon								
REGION 4B	Capitol Site, PGENRO, Capitol Site, Calapan City, Oriental Mindoro				159				
REGION 5	Barriada, Legaspi City	46	80	48	34	40	35	40	37
	San Nicolas, Iriga City	72	164	57	52	108	78	55	50
	Panganiban Drive, Diversion Road, Naga City	84	157	102	69	101	96	72	72
REGION 6	Jaro Police Station Cmpd., Iloilo	80	78	51					
	Lapaz Plaza, Iloilo	135	66	50	88		56	40	232
	Otan, Iloilo City				100		65	54	213
REGION 7	DENR-7, Greenplains Subd., Banilad, Mandaue City				69	75	71	78	94

Region	Station	Total Suspended Particulates Annual Values ( $\mu\text{g}/\text{Ncm}$ )							
		2008	2009	2010	2011	2012	2013	2014	2015
	Cornilla Lao Residence Boundary of Barangays Inuburan & Langtad, City of Naga				110	124	121	106	94
	Cebu Business Park, Cebu City				32				
REGION 9	Zamboanga City Medical Center, Dr. Evangelista St., Zamboanga City	135	165	141	137				
	Barangay Sto. Nino, San Jose Road, Zamboanga City	119	135	113	124				
	PHIDCO, Baliwasan Seaside, Zamboanga City	140	181	174	139				
REGION 11	Davao Memorial Park, Phase 2, McArthur Highway, Davao City.	81	99	44	41	40			
	Las Palmeras Apartelle Open Compound, Quimpo Blvd., Davao City	56	60	83		61			
	Dacoville Subdivision, Phase 2, McArthur Highway, Dumoy, Toril, Davao City	31	58	65	44	35			
	Toril Open Park Area, Agton st., Toril Poblacion, Davao City	34	58	150		92			
REGION 12	Station 1 in front of Mun. Hall Polomolok, South Cotabato	86	75	73	58	**			
	Station 2 in front of Mun. Hall, Surallah, Cotabato City	83	75	73	55	**			
	Station 3 in front of Mun. Hall, Isulan, Sultan Kudarat	83	75	73	53	**			
REGION 13	New Asia, Butuan city	63	63	49	55	54			
	Station Petron Nasipit Depot, Nasipit Agusan Del Norte, Butuan City						68	68	93
	Central Butuan, District 1 Ground, Butuan City				50	43	61	71	94

Source: EMB

Note:

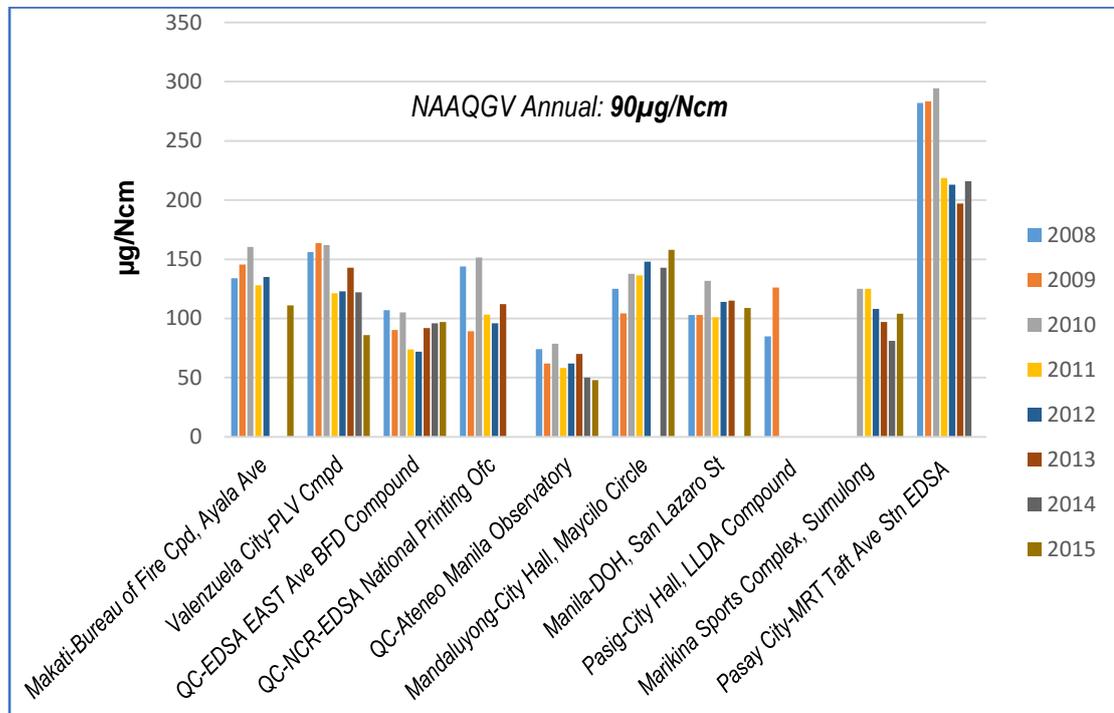
\* Did not meet required capture rate

\*\* Shifted to PM10 Monitoring

TSP National Ambient Air Quality Guideline Value (NAAQGV): Annual – 90  $\mu\text{g}/\text{Ncm}$

## Annual TSP trends in the NCR and other regions

Based on the above table, **Figure 1-9** shows the annual TSP trends in NCR from 2008 to 2015. Except for the Ateneo station which is a general ambient station, all NCR monitoring stations recorded average annual TSP values that exceeded the National Ambient Air Quality Guideline Value (NAAQGV) of 90  $\mu\text{g}/\text{ncm}$ .



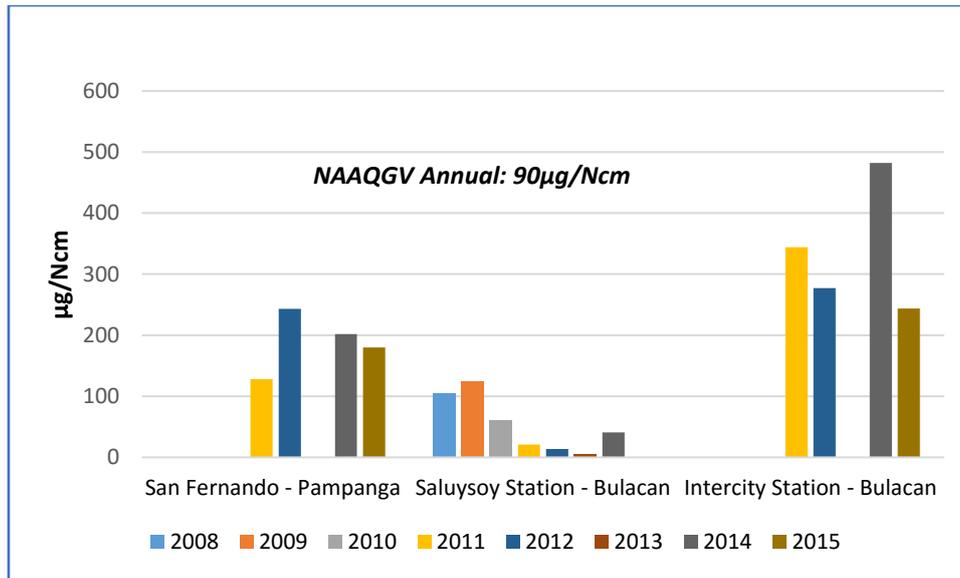
**Figure 1-9. TSP annual mean values in NCR, 2008-2015.**

The location of the monitoring station also plays a big role in the readings obtained, as in the case of the Pasay Rotunda station which registered the highest TSP levels in 2008-2014 way above twice the guideline value. It is located near the intersection of two main roads that experiences very heavy traffic volume especially during rush hours. Massive LRT structures over the equipment in the station also hinder air dispersion, trapping high amounts of particulate matter from vehicular emissions.

The only TSP measurements in 2008-2015 that are consistently below the NAAQGV were taken at the station located inside Ateneo de Manila University. Its present location is surrounded by plants and trees that serve as air buffer, explaining the low TSP measurements.

Annual average TSP values in other regions also show varying trends. **Figure 1-10** shows TSP levels in Region 3 that are monitored in 3 stations: San Fernando in Pampanga, Saluysoy in Bulacan and Intercity in Bulacan. In San Fernando and Intercity, TSP levels since 2011 to 2015 were way above the long-term NAAQGV while lower values were observed in Saluysoy for the same period. In San Fernando, the high TSP levels can be attributed to road dust and motor vehicle emissions alongside the growing

development of the area.

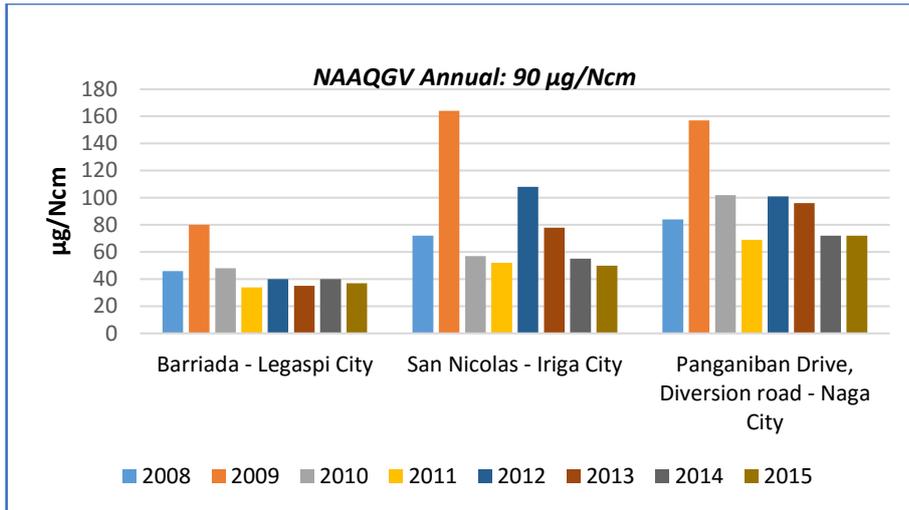


**Figure 1-10. TSP annual mean values in Region 3, 2008-2015.**

Although the Saluysoy station is exposed to open burning of solid waste, vehicular emissions and surrounded by several legal and illegal smelting plants, TSP levels were lower due to the close coordination of the LGU and EMB regional office to monitor all existing gold smelting plants in the area.

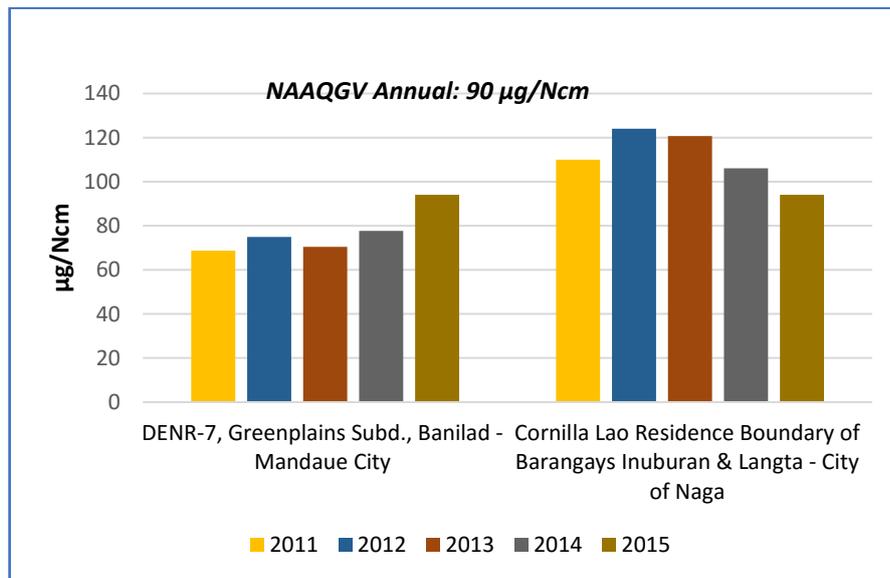
As for Intercity, it is located in an industrial area composed of around 90 units/sets of multi-pass rice milling machines owned by about 60 operators. This explains why TSP levels were alarmingly high from 2011 to 2015. More stringent monitoring and implementation of the penalty system should be done by the local government to improve the air quality in the area.

**Figure 1-11** shows average TSP levels in Region 5 during the period 2008-2015 in the cities of Naga, Legaspi and Iriga. TSP levels in the Legaspi City monitoring site were consistently below the guideline value. TSP levels also complied with the guideline value in the majority of monitoring stations in the cities of Naga and Iriga.



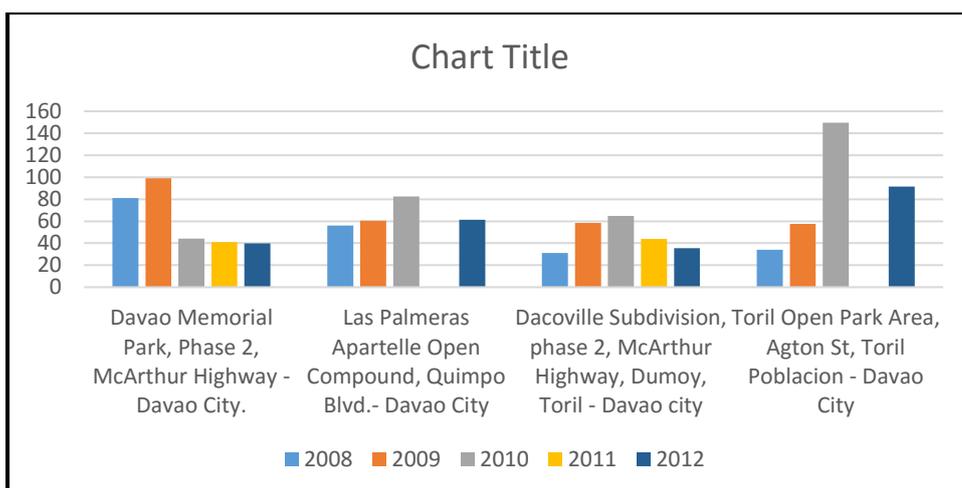
**Figure 1-11. TSP annual mean values in Region 5, 2008-2015.**

In Region 7, TSP levels were monitored in the cities of Mandaue and Naga from 2011 to 2015. (See **Figure 1-12**). TSP monitoring was discontinued in Cebu City in 2012. During the 4-year period, TSP monitoring showed contrasting results: the TSP levels in Mandaue City stayed below the guideline value while those in the City of Naga exceeded the guideline value.



**Figure 1-12. TSP annual mean values in Region 7, 2011-2015.**

In Region 11, TSP levels were monitored in 4 monitoring stations in Davao City from 2008 to 2012. (See **Figure 1-13**). Except for a couple of monitoring results in 2 stations, TSP levels in Davao City monitoring sites had been in compliance with the guideline value of 90 ug/ncm. Since 2013, TSP monitoring had been discontinued and replaced with PM<sub>10</sub> monitoring in the Davao area.



**Figure 1-13. TSP annual mean values in Region 11, 2008-2012.**

Particulate Matter 10 (PM<sub>10</sub>): annual trends

PM<sub>10</sub> levels are monitored in air quality monitoring stations in different regions of the country mostly using manual/reference method. In the NCR, seven (7) continuous ambient air quality monitoring stations were set up in 2014 to augment the manual monitoring stations and provide 24-hour real time data. **Table 1-6** shows annual PM<sub>10</sub> levels from 2012 to 2014.

**Table 1-6. PM<sub>10</sub> annual mean in regional monitoring stations, 2012-2014.**

REGION	STATION	PM <sub>10</sub> Annual Mean Values (µg/Ncm)		
		2012	2013	2014
NCR	National Printing Office Cmpd. EDSA Diliman, Quezon City	61	73	89
	Marikina Sports Complex Cmpd.Sumulong Highway Brgy. Sto Nino, Marikina City	67	62	47
	DOH Cmpd. Rizal Avenue Sta Cruz, Manila	51	69	
	MMDA Building Cmpd. Orense St. cor. EDSA Guadalupe, Makati City	54	67	52
	Pasay Rotonda Station EDSA cor. Taft Avenue Malibay, Pasay City	110	105	
	National Bilibid Prison, Muntinlupa		25	36
	Monumento, Caloocan City	151	150	
	Commonwealth Ave., Q.C.			57
	DLSU, Taft, Manila (RT)		29	27
	DPWH, Timog EDSA, Q.C (RT)		44*	66
	Pamantasan ng Lungsod ng Valenzuela, Valenzuela City			33
Ateneo de Manila Univ.,Q.C. (RT)	38	50	*	

REGION	STATION	PM <sub>10</sub> Annual Mean Values (µg/Ncm)		
		2012	2013	2014
	Valenzuela City - Radio ng Bayan (RT)	58	74	53
	NAMRIA, Taguig City (RT)	43	54	
CAR	Plaza Garden Park, Central Business District, Lower Session Road, Baguio City (RT)	72		
R1	City Hall Compound Urdaneta City, Pangasinan		40	
	West Central Elementary School, Dagupan City, Pangasinan	46	47	59
	City Plaza San Fernando City, La Union			81
	City Plaza San Carlos City, Pangasinan			83
R2	Tuguegarao City Monitoring, St. Paul University Philippines, Mabini Street, Tuguegarao City			29
R4A	Cavite State University, Indang, Cavite (RT)		32	
	Brgy. Bolbok, Batangas City (RT)		29	
R4B	Municipal Hall, Municipality of Baco, Oriental Mindoro	41		
	Naujan, Oreintal Mindoro			
R5	Barraida, Legaspi City		32	39
R6	Central Philippine University campus, Jaro, iloilo city	21		19
R7	Mabolo, Cebu City	77	73	58
	Cebu Business Park, Cebu city	36	33	20
R8	Tacloban City			74*
R9	Zamboanga City Medical Center. Compound, Dr. Evangelista Street Corners Veterans Ave., & Gov. Lim Ave., Zamboanga City		52	52
	EMB - 9 Compound, Lantawan, Pasonanca, Zamboanga City (Started 2013)		34	41
	Philippine International Development Incorporated (PHIDCO), Baliwasan Seaside Zamboanga City Zamboanga del Sur		44	52
R11	Approx. 70m from Amparo St. And 300m from Davao-Agusan National Highway		19	16*
	Brgy. 12-B, Mapa St. Corner J.P Laurel Ave., Davao City (Fronting Brgy. Hall)		21	21*

REGION	STATION	PM <sub>10</sub> Annual Mean Values (µg/Ncm)		
		2012	2013	2014
	Approx. 800m DMPI main gate, Davao Memorial Park Phase2, McArthur Highway, Matina, Davao City		14	15*
	Approximately 50m from Agton St. Open Park in front of Toril District Hall, Agton St., Davao City		27	30*
R12	Municipal Hall -Tupi, South Cotabato	54	50	56
	City Hall of Koronadal City	57	51	64
	Municipal Hall - Midsayap, North Cotabato	51	63	75

Note:

\* < 75% required data capture rate

PM<sub>10</sub> National Ambient Air Quality Guideline Value (NAAQGV) – 60 µg/Ncm

In 2015, a sizable number of additional PM<sub>10</sub> monitoring stations were installed nationwide bringing the total to 56 stations. These facilities consist of 23 manual and 33 continuous monitoring stations including 17 continuous monitoring stations in the NCR. **Table \_\_\_\_** shows station locations and the PM<sub>10</sub> annual mean per station in 2015. Of considerable concern also are about 17 reported equipment breakdown in stations that are mostly located outside the NCR, which were responsible for failing to meet the required data capture rate.

**Table \_\_\_\_ . PM<sub>10</sub> annual mean values in regional monitoring stations, 2015.**

Region	Monitoring Method	Station	PM <sub>10</sub> Annual Mean Values (µg/Ncm), 2015
NCR	Manual	National Printing Office Cmpd. EDSA Diliman, Quezon City	67
	Manual	Marikina Sports Complex Cmpd. Sumulong Highway Brgy. Sto Nino, Marikina City	61
	Manual	DOH Cmpd. Rizal Avenue Sta Cruz, Manila	60
	Manual	MMDA Building Cmpd. Orense St. cor. EDSA Guadalupe, Makati City	42
	Manual	National Bilibid Prison, Muntinlupa	25
	Continuous	De La Salle University, Taft, Manila	31
	Continuous	DPWH, Timog EDSA, Quezon City	46
	Continuous	Pamantasan ng Lungsod ng Valenzuela, Valenzuela City	58*
	Continuous	Andrews Avenue, Pasay City	78*
	Continuous	Navotas City Hall, M. Naval St. Navotas City	72
	Continuous	Rohm and Hass Property, Las Piñas City	35
	Continuous	Polytechnic Institute, City of Malabon	45
	Continuous	North Caloocan City Hall – Zapote Street, Barangay 177, Caloocan City	54
	Continuous	Don Bosco Barangay Hall, Better Living Subdivision, Paranaque City	52

Region	Monitoring Method	Station	PM <sub>10</sub> Annual Mean Values (µg/Ncm), 2015
	Continuous	Makati Park, Dr. Jose P. Rizal Extension, East Rembo, Makati City	44*
	Continuous	Pateros Elementary School, Pateros City	52
	Continuous	Pinaglabanan Shrine, San Juan City	18*
	Continuous	Bureau of Corrections, New Bilibid Prison Reservation, Muntinlupa City	31
	Continuous	Technological University of the Philippines-Taguig Campus, Taguig City	66
	Continuous	Hardin ng Pagasa, Mandaluyong City Hall, Plainview, Mandaluyong City	63*
	Continuous	Brgy. Oranbo, Pasig	69*
	Continuous	Parking Area of Marikina Justice Hall, Marikina City	56
CAR	Continuous	Burnham park, Baguio City	35*
REGION 1	Manual	City Plaza San fernando City, La Union	73*
	Manual	City Plaza San Carlos City, Pangasinan	75*
	Manual	Dagupan City, Province of Pangasinan, western Central Elementary School	68
	Continuous	Urdaneta, Pangasinan	47+
	Continuous	Mariano Marcos State University, Batac, Ilocos Norte	24+
REGION 2	Manual	St. Paul University Philippines, Mabini Street, Tuguegarao City	ND
REGION 3	Manual	Meycauayan City Hall, Meycauayan, Bulacan	45
	Manual	Heroes hall, San Fernando, City of San Fernando, Pampanga	29
REGION 4A	Continuous	City of Biñan, San Pablo St., Biñan City, Laguna	22*
REGION 4B	Manual	Municipal Hall, Municipality of Baco, Oriental Mindoro	60*
	Continuous	Palawan State University, Tiniguiban Heights, Puerto Princesa, Palawan	26
REGION 5	Manual	Barraida, Legaspi City	38
	Continuous	Naga City PENRO, Naga City	29
REGION 6	Manual	University of San Augustin Campus, Iloilo City	43*
	Manual	Leganes Municipal Grounds, Poblacion, leganes, Iloilo City	51
	Continuous	City Hall of Bacolod, New Government Center, Bacolod City	28
REGION 7	Manual	Mabolo, Cebu City	52
	Manual	Cebu Business Park, Cebu city	34
REGION 8	Manual	Robinsons Place, Tacloban	64+
REGION 9	Manual	Zamboanga City Medical Center. Compound, Dr. Evangelista Street Corners Veterans Ave., & Gov. Lim Ave., Zamboanga City	32
	Manual	EMB-9 Compound, Lantawan, Pasonanca, Zamboanga City	45
	Manual	Philippine International Development Incorporated (PHIDCO), Baliwasan Seaside Zamboanga City Zamboanga del Sur	60
	Continuous	Western Mindanao State University, Normal Road, Zamboanga City	11*
	Continuous	Ateneo De Zamboanga University, La Purisima Street, Zamboanga City	20

Region	Monitoring Method	Station	PM <sub>10</sub> Annual Mean Values (µg/Ncm), 2015
REGION 10	Continuous	Iligan Medical Center College, Palao, Iligan City	49
REGION 11	Manual	Approx. 70m from Amparo St. And 300m from Davao-Agusan National Highway	35*
	Manual	Brgy. 12-B, Mapa St. Corner J.P Laurel Ave., Davao City (Fronting Brgy. Hall)	45*
	Manual	Approx. 800m DMPI main gate, Davao Memorial Park Phase2, McArthur Highway, Matina, Davao City	34
	Manual	Approximately 50m from Agton St. Open Park in front of Toril District Hall, Agton St., Davao City	57
	Continuous	Calinan National High School, Quirino Avenue, Davao City	36
	Continuous	Davao International Airport, Catitipan, Buhangin District, Davao City	73+
REGION 12	Continuous	City of Koronadal, General Santos Drive, Koronadal City	49
	Continuous	Pedro Acharon Sports Complex, Brgy. Calumpang, General Santos City	35
REGION 13	Manual	Central Butuan, District 1 Ground, Butuan City	58
	Manual	Petron Nasipit Depot, Nasipit Agusan Del Norte, Butuan City	55
	Continuous	Caraga State University, Ampayon, Butuan City	37*
	Continuous	Butuan City Local Government Unit (Compound of City Environment Office)	35

Source: EMB

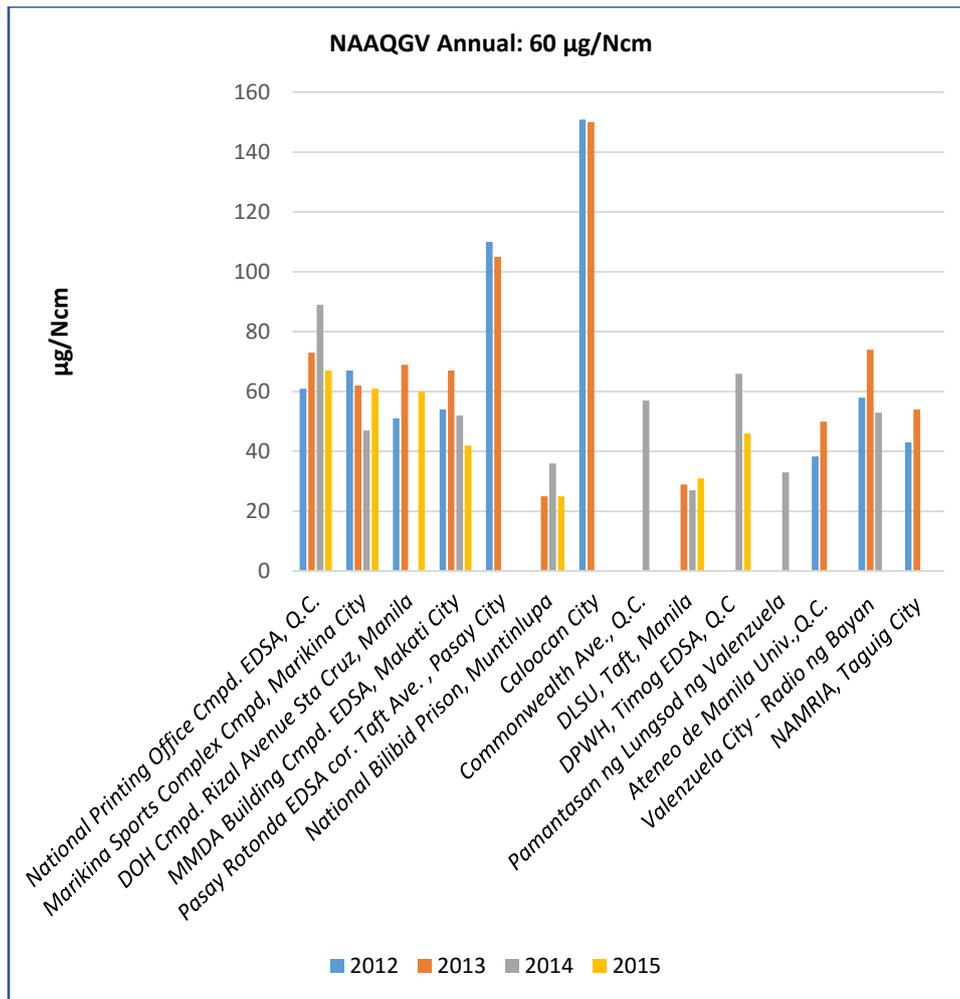
\* < 75% required data capture rate, equipment breakdown or under maintenance.

+ Arithmetic mean

ND – No data

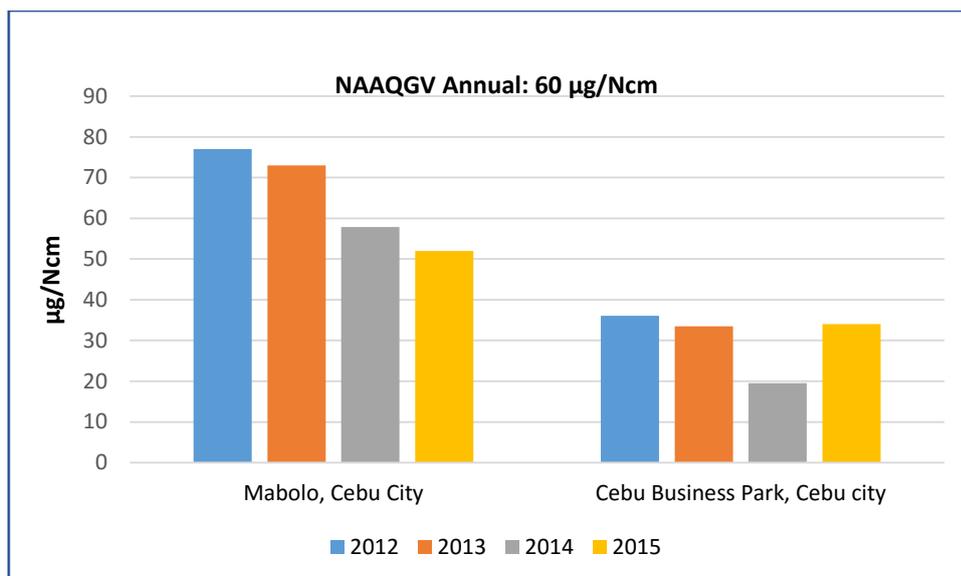
National Ambient Air Quality Guideline Value (NAAQGV): Annual – 60 µg/Ncm

**Figure 1-14** shows PM<sub>10</sub> levels in the NCR during the period 2012-2015. It is notable that there were fewer stations that registered measurements exceeding the guideline value of 60 µg/Ncm in 2012 and 2014. The majority of stations, however, had measurements that exceeded the guideline value in 2013. The NPO Compound in EDSA, Q.C. continuously registered high PM<sub>10</sub> levels during the 4-year period, all of which failed to meet the guideline value. Exceedingly high values were recorded in two stations in 2012-2013, namely, Pasay Rotonda EDSA corner Taft Avenue in Pasay and Monumento, Caloocan City station. In 2015, only 2 out of 8 stations had PM<sub>10</sub> levels that exceeded the guideline value (NPO in Q.C. and Marikina Sports Complex in Marikina). No data were recorded in 4 stations (Pasay, Caloocan, Ateneo and Taguig) from 2014 to 2015 due to equipment breakdown or maintenance problems.



**Figure 1-14. PM<sub>10</sub> annual levels in the National Capital Region 2012-2015.**

In Region 7 (Metro Cebu), PM<sub>10</sub> monitoring stations recorded constantly low levels during the period 2012 – 2015. (See **Figure 1-15**). In the Mabolo, Cebu City station, PM<sub>10</sub> dropped to 58 and 52 µg/Ncm in 2014 and 2015 from previous 2-year levels that exceeded the guideline value. The other station (Cebu Business Park) continuously registered low PM<sub>10</sub> levels during the 4-year period.



**Figure 1-15. PM<sub>10</sub> annual levels in Region 7 (Metro Cebu), 2012-2015.**

PM<sub>2.5</sub> levels in NCR: 2014

In the National Capital Region, PM<sub>2.5</sub> annual levels in 2014 are shown in **Table 1-7**. Both Quezon City monitoring stations recorded levels exceeding the guideline value of 35 µg/Ncm.

**Table 1-7. PM<sub>2.5</sub> annual levels in NCR monitoring stations, 2012-2014.**

Stations	2013	2014
Commonwealth Ave. QC		50
DLSU Taft, Manila	21	19
DPWH, Timog EDSA, QC	36	43
PLV, Valenzuela City	29	29

Source: EMB  
NAAQGV: Annual – 35 µg/Ncm

Monitoring of sulfur dioxide, nitrogen dioxide and ozone in NCR:2014

**Table 1-8** shows average values for SO<sub>2</sub>, NO<sub>2</sub> and O<sub>3</sub> in NCR for the year 2014. Boxplots are also shown for these trace gases in subsequent figures. Data were inadequate for 2015 due to failure to meet required data capture rate, equipment breakdown or maintenance problems.

**Table 1-8. Average statistics for SO<sub>2</sub>, NO<sub>2</sub> and O<sub>3</sub> in NCR, 2014.**

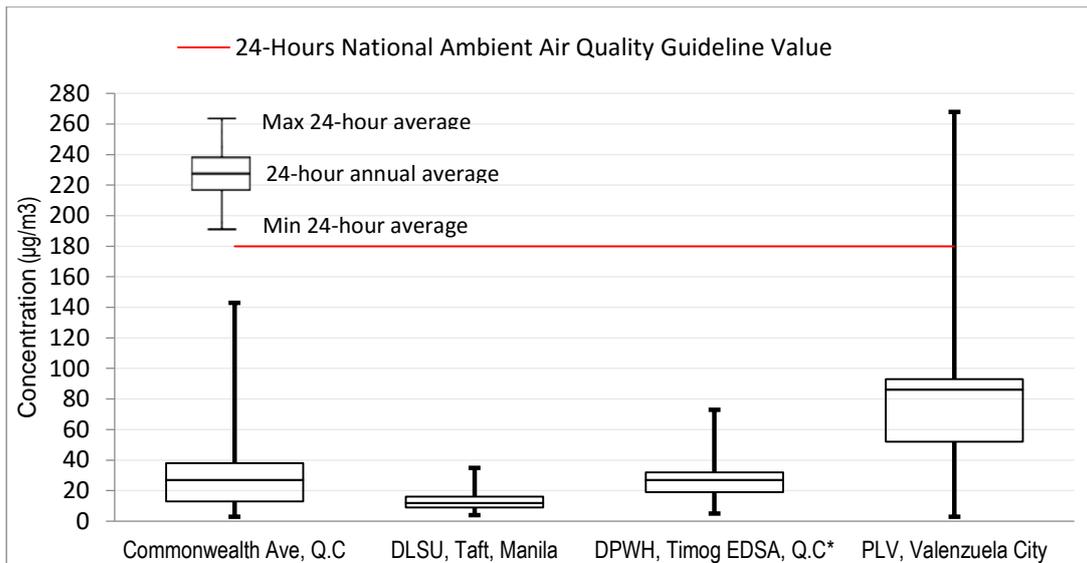
SO <sub>2</sub> 24-Hour Average Statistics	Station			
	Common wealth Ave. QC	DLSU Taft, Manila	DPWH, Timog EDSA, QC	PLV, Valenzuela City
Min	3	4	5	3
25 Percentile	13	9	19	52
Annual Ave	27	12	27	86
75 Percentile	38	16	32	93
Max	143	35	73	268
<b>NO<sub>2</sub> 24-Hour Average Statistics</b>				
Min	33	10	46	10
25 Percentile	56	37	79	24
Annual Ave	128	49	106	63
75 Percentile	214	60	130	142
Max	436	94	195	185
<b>Ozone 8-Hour Average Statistics</b>				
Min		1	6	29
25 Percentile		27	20	50
Annual Ave		52	40	98
75 Percentile		68	51	116
Max		225	148	282

Source: EMB

#### Sulfur dioxide (SO<sub>2</sub>) monitoring in NCR for year 2014

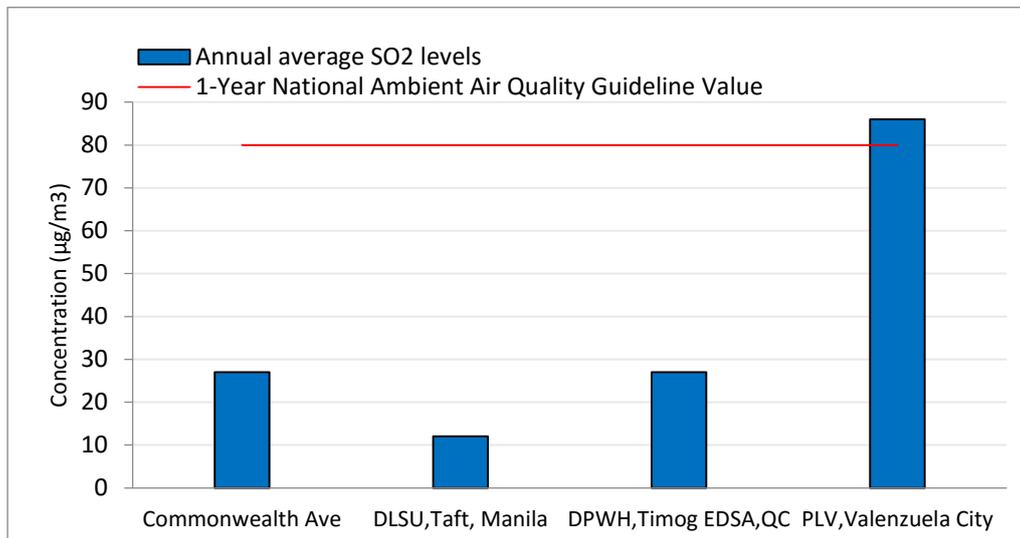
A box plot of the 24-hour average SO<sub>2</sub> monitoring data in the NCR for the year 2014 is shown in **Figure 1-16**. Annual 24-hour average values in all 4 stations were way below the 24-hour NAAQGV of 180 µg/m<sup>3</sup>. The stations also recorded maximum 24-hour concentrations that complied with the guideline value with the exception of the PLV, Valenzuela station which registered a maximum 24-hour concentration of 268 µg/m<sup>3</sup>.

**Figure 1-17** also shows 1-year average SO<sub>2</sub> levels in the NCR wherein only one station (PLV, Valenzuela) recorded annual average SO<sub>2</sub> that exceeded the guideline value of 80 µg/m<sup>3</sup>.



Source: EMB

**Figure 1-16. Box plot of 24-hour average SO<sub>2</sub> levels in the NCR in 2014.**

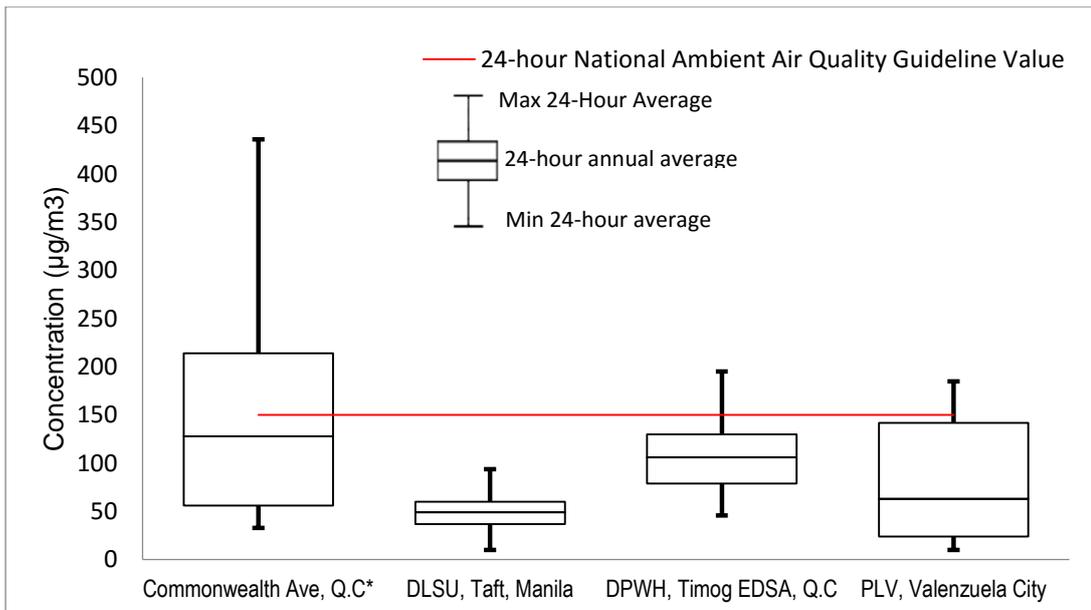


Source: EMB

**Figure 1-17. Annual average SO<sub>2</sub> levels in the NCR in 2014.**

Nitrogen dioxide (NO<sub>2</sub>) monitoring in NCR for year 2014

**Figure 1-18** shows a boxplot of 24-hour average NO<sub>2</sub> levels in the NCR in 2014 wherein the 24-hour annual average levels in all stations were compliant with the guideline value of 150 . However, maximum 24-hour concentrations recorded in 3 stations (Commonwealth Ave. and DPWH Timog EDSA in Quezon City and PLV in Valenzuela City) exceeded the guideline value.

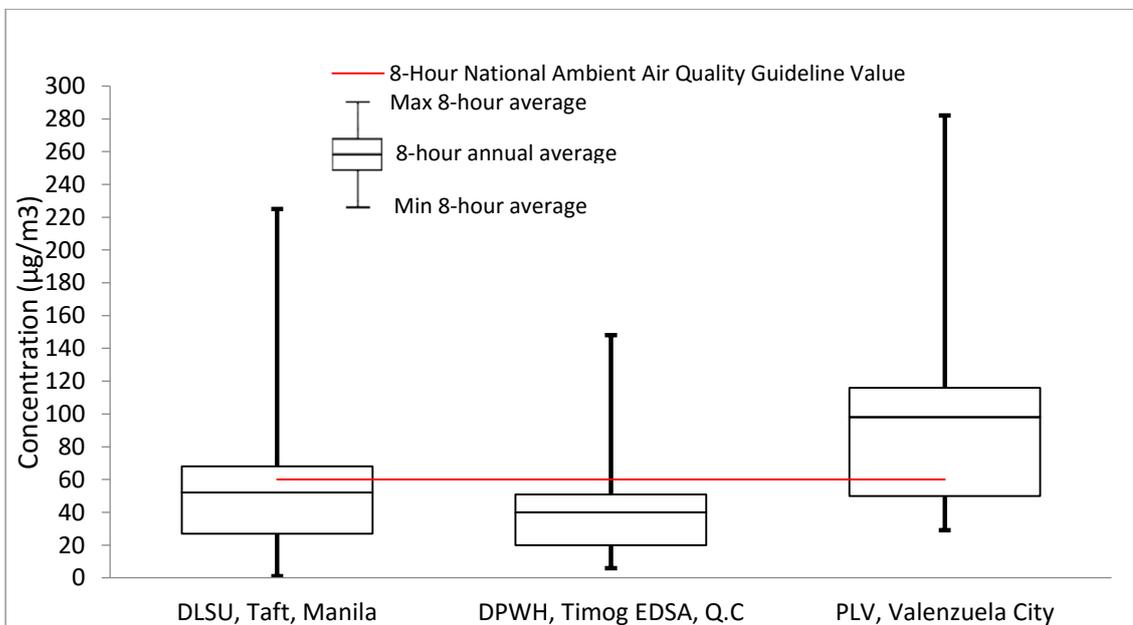


Source: EMB

**Figure 1-18. Box plot of 24-hour average  $\text{NO}_2$  levels in the NCR in 2014.**

Ozone ( $\text{O}_3$ ) monitoring in NCR for year 2014

A boxplot of 8-hour average ozone levels in the NCR in 2014 shows that 2 out of 3 stations (DLSU Taft, Manila and DPWH Timog EDSA, Q.C.) recorded 8-hour annual average values that were within the guideline value of  $60 \mu\text{g}/\text{m}^3$ . The PLV Valenzuela station registered average and maximum levels exceeding the guideline value. (See **Figure 1-19**)



Source: EMB

**Figure 1-19. Box plot of 8-hour average Ozone levels in the NCR in 2014.**

### **1.3 Impacts of air pollution**

Air quality is the overall description of air pollution levels in a defined area that may affect the environment and public health. Over the years, increasing levels of air pollutants from natural and human-related (anthropogenic) sources lead to poor air quality. According to the US EPA, an average adult inhales around 11,000 liters of air per day, while children breathe greater volumes of air, hence greater amounts of air pollutants which can lead to respiratory problems. In 2009, World Bank has estimated that annually, more than 1 million people get sick and 15,000 die prematurely due to outdoor air pollution (OAP) in the Philippines. The annual cost of disease due to OAP is estimated to be around Php 0.9 billion while the annual income loss from mortality is more than Php 5.0 billion. Thus, essentially, the cost of pollution is Php 5.9 billion annually. In other parts of the world, air pollution has also been linked to changes in climate through different mechanisms such as shifting of monsoons and accelerated melting of polar ice caps. Aside from these, several international studies including the Philippines have also proven major agricultural productivity losses, posing a threat to food security. Air quality is therefore of great national concern as it can affect the country's ecological balance and the health of every individual.

#### **1.3.1 Impacts on health**

The main reason in abating air pollution is the detrimental effects it poses on human health. As breathing clean air is a basic necessity for human well-being, elevated levels of pollutants in the atmosphere is one of the most significant global health concerns. The WHO reported in 2005 that urban indoor and outdoor air pollution causes more than 2 million premature deaths worldwide, primarily affecting populations of developing countries. In 2013, the International Agency for Research on Cancer (IARC) of the WHO has also classified outdoor air pollution as the leading environmental cause of cancer deaths.

Health effects of air pollution range from acute symptoms such as coughing and respiratory infections, to development of chronic diseases and even mortality. However, numerous studies have proven that severity of effects depends on the specific pollutant and actual exposure severity. **Error! Reference source not found.1-9** shows the effects of air pollution attributable to short and long term effects while **Error! Reference source not found.1-10** describes the health implications of exposure to criteria air pollutants. In urban areas where there are higher concentrations of people and air pollutants, poorer air quality would mean posing more detrimental health risks for its residents. Most exposed would be transport workers such as traffic enforcers, drivers and daily commuters.

**Table 1-9. Health effects attributable to short-term and long-term exposure to air pollution.**

Short-term Exposure	Long-term Exposure
<ul style="list-style-type: none"> <li>• Daily mortality</li> <li>• Respiratory and cardiovascular hospital admissions</li> <li>• Respiratory and cardiovascular emergency department visits</li> <li>• Respiratory and cardiovascular primary care visits</li> <li>• Use of respiratory and cardiovascular medications</li> <li>• Days of restricted activity</li> <li>• Work absenteeism</li> <li>• School absenteeism</li> <li>• Acute symptoms (wheezing, coughing, phlegm production, respiratory infections)</li> <li>• Physiological changes (e.g. lung function)</li> </ul>	<ul style="list-style-type: none"> <li>• Mortality due to cardiovascular and respiratory disease</li> <li>• Chronic respiratory disease incidence and prevalence (asthma, COPD, chronic pathological changes)</li> <li>• Chronic changes in physiological functions</li> <li>• Lung cancer</li> <li>• Chronic cardiovascular disease</li> <li>• Intrauterine growth restriction (low birth weight at term, intrauterine growth retardation, small for gestational age)</li> </ul>

Source: WHO, 2006

**Table 1-10. Health effects of criteria air pollutants.**

Pollutant	Health Effect
Particulate Matter (PM)	Poses the biggest threat to human health as PM <sub>2.5</sub> can penetrate deep into the lungs
	Difficulty in breathing
	Lung tissue damage
	Aggravate existing cardiovascular diseases and lung problems
	Cancer-causing
	High vulnerability for elderly and children
Nitrogen Dioxide (NO <sub>2</sub> )	Lung-irritant
	Lower resistance to respiratory diseases such as influenza
	Impairment of child lung development
	Increase chances of children developing asthma
	Structural changes in the lungs
	High vulnerability for elderly and children people already suffering from asthma
Sulfur Dioxide (SO <sub>2</sub> )	Difficulty in breathing
	Affect lung functions
	Eye irritation
	Aggravate existing respiratory problems
	People sensitive to SO <sub>2</sub> may develop symptoms such as wheezing, shortness of breath and coughing
	High vulnerability for asthmatics and individuals with cardiovascular disease or chronic lung disease, children and elderly
Ozone (O <sub>3</sub> )	Difficulty in breathing
	Trigger asthma
	Coughing and chest pains

Pollutant	Health Effect
	Irritation of throat and eyes
	Lower resistance to respiratory diseases
	Inflammation and malfunction of the lungs
	High vulnerability for people already suffering from respiratory problems, such as asthma
Carbon Monoxide	Reduces oxygen transport to body cells and tissues (Has 300 times greater affinity for hemoglobin than oxygen)
	Impairment of visual perception, manual dexterity, learning ability and performance of complex tasks
	High vulnerability for people with heart problems (angina or peripheral vascular disease), anemia and for smokers

Source: DOH, 2010

Also playing an important role are environmental factors and the susceptibility of the exposed individual which is based on age, health status, diet, lifestyle and genetics. Children are at higher risks since they breathe in higher volumes of air compared to adults. Those with pre-existing cardiac or respiratory diseases are also more likely to experience more intense effects. Pregnant women, old and immune-compromised people are also at higher risks.

World Bank reported that in 2001, the health costs of PM<sub>10</sub> exposure in Metro Manila, Baguio City, Cebu City and Davao City, are estimated to be over \$430 million annually due to 2,000 premature deaths and 9,000 people suffering from chronic bronchitis. According to the Metro Manila Air Quality Improvement Sector Development in 2004, uniform reduction of 10 µg/Nm<sup>3</sup> PM<sub>10</sub> levels can reduce morbidity and mortality due to particulate matter pollution. The reduction values are summarized in

Table 1-11.

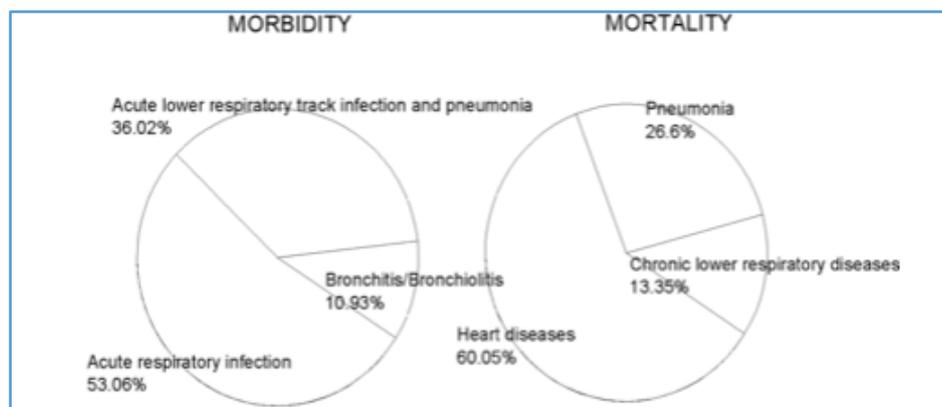
**Table 1-11. Effects of PM<sub>10</sub> reduction on air pollution-related morbidity and mortality.**

	Effects of a uniform reduction of 10 µg/Nm <sup>3</sup> of PM <sub>10</sub>
Morbidity	Reduction of: > 23,000 cases of acute bronchitis > 400 cases of asthma > 30 cases of chronic bronchitis 20 respiratory cases per million people 4 cardiovascular cases per million people

	Effects of a uniform reduction of 10 µg/Nm <sup>3</sup> of PM <sub>10</sub>
Mortality	35-39 fewer deaths/million population from natural causes 5-28 fewer deaths/million population from cardiovascular causes 43-49 fewer deaths/million population from respiratory causes

Source: Metro Manila Air Quality Improvement Sector Development, 2004

In 2009, World Bank published the Philippines' Country Environmental Analysis and it was estimated that due to outdoor air pollution in urban areas, more than 1 million people get sick and 15,000 die prematurely every year. The annual cost of disease is estimated to be around Php 0.9 billion, and annual income loss from the mortality is more than Php 5.6 billion. Indoor pollution is caused by the use of coal and biomass for domestic energy needs, primarily for cooking of food. In the Philippines, the World Bank report also states that around half of the population uses fuel wood or charcoal for cooking. This causes several types of respiratory disease and premature death-around half a million illnesses that are linked to 6,000 deaths annually. Resulting economic costs reach more than Php 1.4 billion per year.



Source: DOH, Philippine Health Statistics, 2010

**Figure 1-20. Leading causes of mortality and morbidity attributable to air pollution, 2010.**

According to the most recent data of the Philippine Health Statistics, the leading cause of mortality in the Philippines attributable to air pollution are diseases of the heart, pneumonia, and chronic lower respiratory diseases, resulting in a total of 27,834 deaths in 2010. In the same year, acute respiratory infection, acute lower respiratory tract infection and pneumonia, and bronchitis are the main causes of morbidity in the country attributable to air pollution, resulting in a total of 433,810 cases. **Figure 1-20** shows the summary of the report.

The Philippine Cancer Society also reports that lung cancer cases and deaths attributable to air pollution are 2,930 and 2,700, respectively in 2005 and these values decreased to 1,948 and 1,561, respectively, in 2010.

### **1.3.2 Impacts on climate and influence on atmospheric conditions**

Air pollution has been linked to changes in climate through different mechanisms. For instance, particle pollutants affect climate directly by absorbing sunlight, thus heating the surface atmosphere. Such is the effect of black carbon, commonly known as soot. Indirectly, soot of finer sizes forms clouds with smaller droplet sizes, forming small cloud droplets that acts as mirrors and reflects back heat towards the earth's surface. Direct effects include the general ability of soot to absorb heat from surroundings. This results in elevated ambient temperatures on the Earth's surface that further leads to warmer air and ocean temperatures, more high-intensity rainfall events and more frequent heat waves. As ambient temperatures become much higher due to climate change, this also promotes the formation of ozone (O<sub>3</sub>) smog from nitrogen oxide compounds, thus aggravating atmospheric pollution and its health effects.

Particles such as sulfates and nitrates on the other hand have a cooling effect, as it reflects sunlight. Indirectly, particles can affect climate by influencing precipitation and cloud formation by acting as condensation nuclei or 'cloud seeds' where water vapor condenses on.

The PAGASA has published "Climate Change in the Philippines<sup>71</sup>" in 2011 discussing the climate trends in the country from 1951 to 2009, with the average period of 1971 to 2000 as a reference value. The key findings include increase in annual mean temperature by 0.57°C and significant increase in number of hot days but decrease in cool nights. There is no indication of an increase in frequency of occurrence of typhoons, but a very slight increase in number of cyclones greater than 150kph and above. However, there had been no reference made on the actual effect of air pollution levels in the country on these changes in climate.

Atmospheric conditions which can affect air pollutant levels include ambient temperature, pressure and amount of rainfall. Cooler temperatures during dry months make the air more dense, bringing pollutants at a much lower altitude where it is at breathing level. High pressure systems also induce inversion layers, wherein cold air is trapped close to the surface. This prevents pollution dispersion, and can lead to smog formation. In some of the monitoring stations in the Philippines where the samplers are coupled to or near a weather station, the basic observation is the decrease in particulate levels during rainy season as the pollutants are washed out by precipitation and there are stronger winds for pollutant dispersion.

### **1.3.3 Impacts on agriculture**

Poor air quality adversely affects organisms and the ecological systems with which they thrive in. Aside from affecting humans, air pollutants also have a detrimental impact on plants because of its immobility. Some of the major phytotoxic (substances which pose a certain toxicity to plants) pollutants

are O<sub>3</sub>, SO<sub>2</sub>, NO<sub>2</sub>, H<sub>2</sub>S, F<sub>2</sub> and peroxy acyl nitrate, NH<sub>3</sub> and particulate matter. Symptoms of the effects of these pollutants to crops are detailed in Error! Reference source not found.1-12. Effects of air pollution on plants can be visible, such as loss of color, necrosis, decrease in yield and morphological changes. Non-visible effects have also been determined wherein the physiological and biochemical process of the plant is altered, thus changing the rate of metabolism and photosynthesis.

**Table 1-12. Symptoms of effects of air pollutants on plants.**

<b>Pollutant</b>	<b>Symptoms*</b>
<b>Ozone</b>	flecking, bronzing or bleaching of the leaf tissues
	visible foliar injury
	yield reductions
<b>SO<sub>2</sub></b>	acute injury: lesions
	Chronic injury: yellowing or chlorosis of the leaf, and bronzing (under surface of the leaves)
<b>Fluoride</b>	Lesions
	injury to plum foliage
	tips of the leaves build up injurious concentrations
<b>NH<sub>3</sub></b>	irregular, bleached, bifacial, necrotic lesions
	reddish, interveinal necrotic streaking or dark upper surface discolouration (grasses)
<b>PM</b>	inhibit the normal respiration and photosynthesis mechanisms within the leaf
	chlorosis and death of leaf tissue
	affect the normal action of pesticides and other agricultural chemicals
	increase soil pH to levels adverse to crop growth (alkaline dusts)

*Source: Ontario Ministry of Agriculture and Food, 2003*

In a 2004 study made on a few selected agricultural crops (green chili, tomato, pumpkin, winged bean, spinach and rice) in Sri Lanka, exposure to ozone has resulted in leaf drop, visible damage to leaves and eventually plant death. Through modeling, a research on the global impact of surface ozone on agricultural crop yield was published in 2009 stating that in the Philippines, a 3.7% increase in relative soybean yield loss is projected from 2000 to 2030. However, more studies are yet to be done on the specific effects of exposure to air pollutants on major agricultural crops in the country. In agricultural regions where air pollution levels are high, impact analyses should also be prioritized to minimize economic losses and ensure food security.

#### **1.3.4 Impacts on water quality**

Air pollutants remain in the atmosphere from a few hours to a few weeks,

and for some, even months, depending on the actual pollutant and the environmental conditions of the area. Pollutants can be transported from one place to another, chemically react and be transformed into other types of compounds. Eventually, these pollutants can undergo atmospheric deposition directly into water bodies or onto land through precipitation, in dust or through gravity. Once in land, it can be eroded into water bodies mainly through surface run-off or water flow from land.

Once the pollutants are in aquatic systems, it can affect the water quality by becoming water contaminants. During rainy season in the Philippines when measured air pollutant levels are observed to be less, the air pollutants may be dispersed, transported to other areas, directly deposited to water systems or carried by rainfall down to the land, and eventually end up in canal systems, rivers or oceans. Aside from the determination of pollutant levels in the atmosphere, its deposition rates should also be analyzed in order to have an idea of atmospheric contribution to levels of water pollution, ensuring an integrated approach to environmental safety and management for the country.

### **1.3.5 Other impacts: poor visibility**

Aside from alarming hazards to health, excessively high concentrations of air pollutants can result in poor visibility that may affect transportation safety. During New Year's celebrations in the Philippines, pollutant levels go as high as ten times the NAAQGV due to the use of fireworks and firecrackers.

## **1.4 Air quality management**

### **1.4.1 DENR/EMB**

From the enactment of RA 8749 in 1999 to 2015, the accomplishments of DENR EMB include the designation of airsheds throughout the Philippines, establishment and operationalization of the Air Quality Management Fund (AQMF), establishment of Ambient Air Quality Monitoring Network nationwide, emissions inventory every three years and management of mobile and stationary sources. These are done through Memorandum Circulars (MC), Department Administrative Orders (DAO), Joint and Administrative Orders (JAO).

#### Airsheds

One of the Air Quality Principles stated in the IRR of RA 8749 is the recognition that the cleaning of the environment is primarily area-based and that air quality management and control are most effective at the level of airsheds. As defined in the act, "Airsheds" are areas with similar climate, meteorology and topology which affect the interchange and diffusion of pollutants in the atmosphere. Sub-areas within airsheds may therefore have similar air quality, and face similar problems, development programs

and prospects

**Figure 1-21. Designated Airsheds in the Philippines, as of 2015.**



As of 2015, there was a total of 22 airsheds in the Philippines. (See **Figure 1-21**). Also included are geothermal airsheds that are specially designated due to the presence of a geothermal plant in the area. For airsheds officially designated, Governing Boards have also been established which oversee the planning and implementation of air quality management policies and ensure strong coordination among government agencies and between government agencies and private sector / civil society.

#### Air Quality Management Fund

As established by the IRR of RA 8739, the Air Quality Management Fund (AQMF) is a special account in the National Treasury established to finance containment, removal, and clean-up operations of air pollution cases, guarantee restoration of ecosystems and rehabilitate areas affected by the acts of RA 8739 violators, to support research, enforcement and monitoring activities and capabilities of the relevant agencies, as well as to provide technical assistance to the relevant agencies. In order to do these undertakings, such fund may be allocated per airshed. In 2012, no budget was released by the DBM but in 2013, PHP 35 million was allocated to 16 regions (PHP 2 million each) and PHP 3 million to the DENR Central Office. In 2014, no budget was released but in 2015, DBM allocated PHP 35 million to EMB central and regional offices. The process of disbursement is the same as Regular Fund (101) wherein the Total Capital Outlay is PHP 31.5 million and the Total MOOE is PHP 3.5 million.

### Management of stationary sources

All trade, industry, process, fuel-burning equipment or industrial plant emitting air pollutants are classified as stationary sources. All stationary sources must have a Permit to Operate (PTO), issued by the DENR upon compliance with the standards specified in the IRR of RA 8739 called the National Emission Standards for Source Specific Air Pollutants (NESSAP). In order to properly manage stationary sources, close monitoring of all firms within the region should be performed, imposing the necessary fees to be paid and issuance of a Notice of Violation (NOV) in the case of non-compliance. Pollution Control Officers (PCOs) are required to be designated by industries to oversee all operations related to air pollution source and control facilities, and to submit to the DENR Quarterly Self-Monitoring Reports.

Establishment owners are encouraged to install high-technology facilities and perform mitigating measures to lessen air pollutants generated during their operation. In large-scale industries such as cement plants, beverages manufacturing plants and power generating plants, the Multipartite Monitoring Teams (MMT) of the project/company establishes ambient air quality monitoring stations. A Continuous Emission Monitoring System (CEMS) is specifically required to be installed in the following major industries for particulates and SO<sub>2</sub> emissions:

- a) Fossil fuel-fired power plant over 10 MW rating (including NO<sub>x</sub>);
- b) Petroleum refinery, petrochemical industries (including NO<sub>x</sub>);
- c) Primary copper smelter (including NO<sub>x</sub>);
- d) Steel plant, ferro-alloy production facility (particulates only); and
- e) Cement Plant (particulates only)

### *Industrial Emission Management Program*

The Industrial Emission Management Program (IEMP) ensures compliance of industries to the emission standards set by the Bureau. Thus, issuance of permit and regular monitoring is done. With the increasing number of stationary sources, extensive monitoring is required. In order to monitor all sources with potential to emit air pollution, the Bureau accredits Third party Source Emission Testing firms (TPSETF) to carry out source emission test and effectively perform sampling activities in accordance with the provisions of CAA and its Implementing Rules and Regulations.

A total of nineteen (19) firms with a total of thirty one (31) teams are accredited to carry out the stack testing activity pursuant to DAO 2013-26. (**See Table 1-13**). The TPSETF undergoes written, oral and proficiency exam in order to pass the accreditation. These are done by the Sampling

Assessment Team (SAT) which are selected personnel of AQMS from the central and regional offices. The said team also conducts regular monitoring/observation of accredited firms to ensure that they continuously follow proper testing procedure. Annual training on stack emission testing are also carried out in order to provide lectures to stack testers aside from the regular coordination meeting to discuss updates, issues and concerns.

**Table 1-13. List of Third Party Source Emission Testing firms,2015.**

NO.	FIRM NAME
1	(Elite) Environmental Life Industrial Technologies
2	Aeronics Incorporated
3	Alpine systems Inc.
4	Berkman Systems Inc.
5	CRL Calabarquez Corp.
6	Environair Asia
7	Fastlab First Analytical Services and Technical Cooperative
8	Geosphere Technologies
9	Global Environmental
10	GMSI – GM Sandoval Inc.
11	Greentek Engineering Environmental Services
12	Industramach
13	Omli-Ostrea Mineral Laboratories
14	Optimal Laboratories
15	PEASCORP – Progress Equipment and Systems Corporation Philippines
16	SAGE – Sugar Regulatory Administration
17	SGS Philippines Inc.
18	Shema Environmental Testing Laboratory
19	TADCHEM Marketing

*Source: EMB*

### Management of mobile sources

Management of mobile sources is of utmost importance in urban regions, which have a significant share in the emissions. Mobile source emissions

inventory is given emphasis in most, if not all regions in the country.

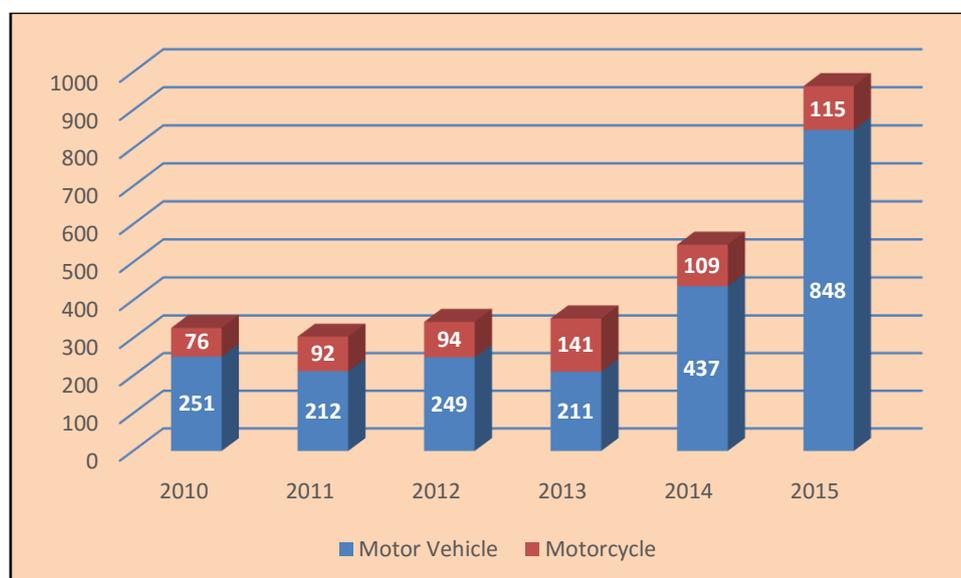
### *Motor vehicle emission*

Based on the 2012 emissions inventory, mobile sources contributed 69% to the total emission in the national level and 90% of the total emission in Metro Manila, compared to area source and stationary source.

Several measures and activities were carried out to reduce mobile emissions. For brand new motor vehicles, all vehicle types must meet the emission standard before they are introduced in the market for sale. They should be evaluated for their compliance with the prescribed exhaust emission limits/standards before a Certificate of Conformity (COC) is issued.

Pursuant to RA 8749 and its IRR, Certificates of Conformity (COCs) are issued to all brand new motor vehicle models/types that comply with the specified emission limits. This is to ensure that the vehicle complies with the emission standard set pursuant to Clean Air Act.

From 2010 to 2015, the number of COCs increased from 327 in 2010 to 546 in 2014 (67%) and further increased by 76% to 963 in 2015. These increases were due to the surge in the number of COCs issued for motor vehicles – 437 in 2014 and 848 in 2015. **(Figure 1-22)**. The increase is due to increased number of Euro 2/II COC application which ended in December 2015, as per the policy issued by the Department on the implementation of Euro 4/IV Emission Compliance (DAO 2015-04) which began in 2016.



**Figure 1-22. Number of COCs issued from 2010 to 2015.**

### *Motor Vehicle Inspection Program*

Pursuant to RA 8749, PETCs are DTI accredited, LTO-authorized and use

equipment that are DENR-certified. Monitoring of PETCs is accomplished through a composite team comprised of DTI, DENR and DOTC-LTO.

Although EMB-DENR is not the lead implementing agency for vehicular emission control but invoking its mandate as the lead implementing agency of the CAA, two major activities were undertaken, the roadside anti smoke belching (ASB) operation and the free garage emission testing specifically for PUVs such as buses and jeepneys. There were also seminars and lectures on preventive maintenance, fuel efficiency and eco-safe driving.

#### *Anti-Smoke Belching Program*

To ensure the compliance of in-use motor vehicles to the prescribed emission standard, apprehension and garage testing were done under MVEMP of the CAP. Coordination with the ASBU Teams from other implementing agencies and local government was conducted. Quarterly ASBU coordination meetings were regularly held to discuss updates, issues and other related matters to improve operation. Training on the proper apprehension procedure and equipment use as well as Clean Air Act provisions on motor vehicle was conducted. However, on 17 June 2015, the operation was stopped due to the Secretary's instruction to shift into non-contact apprehension. From January to June 17, 2015, more than four thousand motor vehicles were apprehended by the EMB CO ASBU, and more than thirty one thousand smoke belching vehicles were apprehended and tested by the Metro Manila ASBU teams (See **Table 1-14**).

**Table 1-14. Metro Manila ASB apprehension, 2015.**

<b>LGU / AGENCY</b>	<b>PASSED</b>	<b>FAILED</b>	<b>TOTAL</b>
<b>MAKATI</b>	<b>970</b>	<b>2,624</b>	<b>3,594</b>
<b>MANDALUYONG</b>	<b>498</b>	<b>1,985</b>	<b>2,483</b>
<b>MUNTINLUPA</b>	<b>896</b>	<b>402</b>	<b>1,298</b>
<b>MANILA</b>	<b>422</b>	<b>2,311</b>	<b>2,733</b>
<b>PASIG</b>	<b>2,676</b>	<b>6,289</b>	<b>8,965</b>
<b>PASAY</b>			<b>-</b>
<b>QUEZON CITY</b>	<b>208</b>	<b>6,024</b>	<b>6,232</b>
<b>SAN JUAN</b>	<b>55</b>	<b>744</b>	<b>799</b>
<b>EMB NCR</b>			<b>-</b>
<b>EMB CO</b>	<b>61</b>	<b>3,967</b>	<b>4,028</b>
<b>MMDA</b>	<b>506</b>	<b>1,037</b>	<b>1,543</b>
<b>LTO</b>			<b>-</b>
<b>TOTAL</b>	<b>6,292</b>	<b>25,383</b>	<b>31,675</b>

*Source: EMB*

The Anti Smoke Belching Program in Metro Manila is carried out through collaboration of efforts from CAA Implementing Agencies DENR- EMB, DOTC-LTO, and MMDA, and the Local Government Units. Eight (8) LGUs

with ASB Ordinance namely Makati, Mandaluyong, Muntinlupa, Manila, Pasig, Pasay, Quezon City, and San Juan are regularly apprehending smoke belching vehicles within their area of jurisdiction. Their apprehension data are regularly reported every Quarter during the quarterly Metro Manila Anti Smoke Belching Units Coordination Meeting which is being organized by EMB Central. The said coordination meeting is an avenue to discuss whereabouts of the operation and the issues dealt by the apprehending officers. Recently, the Ombudsman Office (Environmental Ombudsman) also joined the regular coordination meeting due to increasing concerns in the ASBU Operation.

### *Garage testing*

Garage Testing successfully engaged the cooperation of Metro Manila bus operators and public utility jeepneys (PUJs). Assistance provided by this program include free emission testing, information and education campaign (IEC) on fuel efficiency and management and regular vehicle maintenance. Out of 2,494 vehicles tested, 975 passed while 1,519 failed the vehicle emission standard **(See Table 1-15)**.

**Table 1-15. Garage testing, 2015**

MONTH	NUMBER OF VEHICLES TESTED	RESULT						GARAGE
		PASSED	FAILED	UV	BUS	PUJ	TRK	
JANUARY	NO TARGET FOR JANUARY							
FEBRUARY	65	43	22		29	36		4
MARCH	82	67	15			82		4
APRIL	190	144	46			182	8	4
MAY	NONE							
JUNE	44	40	4		23	21		4
JULY	490	204	286	24	143	323		17
AUGUST	792	226	566	19	154	619		32
SEPTEMBER	595	169	426	99	30	429	37	22
OCTOBER	218	76	142		16	188	14	8
NOVEMBER	18	6	12		18			1
DECEMBER	NO TARGET FOR DECEMBER							
<b>TOTAL</b>	<b>2,494</b>	<b>975</b>	<b>1,519</b>	<b>142</b>	<b>413</b>	<b>1,880</b>	<b>59</b>	<b>96</b>

Source: EMB

### *Regulation of fuels, additives and substances*

**Table 1-16** shows the fuel specifications based on different standard levels, and based on maximum % sulfur content, the Philippines should have followed Euro 2/II standards by 2004 as specified in RA 8749. However, the Euro 2/II emission standard was only imposed in January 2008. As early as 2005, discussions on implementing Euro 4/IV equivalent standards for diesel and petroleum were already underway. In 2009, the target date for

implementation was set to 2012, two years later than the original 2010 date. Finally, in 2015, the DENR issued an administrative order directing the implementation of Motor Vehicle Emission limits for Euro 4/IV and In-use Vehicle Emission Standards beginning July 1, 2015, with full implementation on January 1, 2016.

In support to this, another government agency in the Philippines, the Department of Energy, issued a circular mandating the manufacture and sale of Euro IV automotive diesel oil and gasoline (with 50 ppm sulfur content) nationwide effective January 1, 2016.

**Table 1-16. Fuel specifications based on different standard levels.**

	Gasoline Benzene (% by volume)	Aromatics (% by volume)	Sulfur (% weight)	Diesel Sulfur (% by weight)
EURO 1				0.20
EURO 2			0.05	0.05
EURO 3	1.0	42.0	0.015	0.035
EURO 4	1.0	35.0	0.005	0.0050/0.0010
WWFC				
1	5.0	50.0	0.10	0.20
2	2.5	40.0	0.015	0.03
3	1.0	35.0	0.003	0.005
4	1.0	35.0	0.001	0.001
RP	2.0	35.0	0.05	0.05

*Source: Department of Energy*

### *Alternative Fuel Program*

In order to reduce emissions from mobile sources, the use of alternative clean fuels such as liquefied petroleum gas (LPG) and compressed natural gas (CNG) has been promoted further in 2012 up to the present. Substantially composed not of petroleum but of biological materials and electricity, alternative fuels are expected to yield significant energy security and environmental benefits to its consumers.

### Management of area sources

Management of area sources is a great challenge because of the lack of comprehensive data on the actual activities considered as 'area sources', duration of the activity and the scope of area that may be affected by it. In most, if not all regions in the Philippines, area sources include open burning of garbage, slash-and-burn activities (kaingin), building and road construction, forest fires, and other similar activities. In agricultural regions such as Region 2 and 6, the most common area source of air pollution is open burning of agricultural wastes like corn, rice, sugarcane stalks and other livestock production residues. A 'No Burning Policy' is thus advocated

by most municipalities pursuant to RA 9003 also known as "The Ecological Solid Waste Management Act" which prohibits any form of open burning of wastes. Greening Programs are also implemented to address issues on climate change, global warming and carbon emission reduction, such as in the case of Legazpi, Iriga and Naga cities in Region 5.

In Region 6, several Bio-ethanol plants have been established in Negros Occidental and are already operational. These are the San Carlos Bioenergy, Inc. and Roxol Bioenergy Corp. Several industries have also shifted to the use of rice hulls and bagasse as biomass fuels while distilleries and piggery projects put up methane recovery facilities. Cogeneration in generating electricity is also being practiced in some industries in the region through the use of excess steam instead of fossil fuel in electricity production. A lot of taxis in Iloilo use LPG as fuel but the LTO has no statistics yet on this as the taxis are still registered as gasoline vehicles.

Industries in Region 9 have also started to improve production processes in order to minimize greenhouse gas and generally improve air quality emissions while cutting costs. Nestle Philippines, Inc. in Cagayan de Oro City now focuses on biomass use; Philippine Sinter Corp. is researching on the use of LPG injection in the sintering process; and BUSCO Sugar Milling Co., in Bukidnon uses their recovered boiler ash as fertilizer.

#### Environmental education and awareness initiatives

To alleviate massive deforestation in the Cordillera Administrative Region, the website named "GREENITATIVE" was created to promote social mobilization and consciousness on forest significance. Lectures were also given to officials, students and teachers within the BLISTT Airshed municipalities. Plans and programs are also discussed and promoted over DZEQ Radyo ng Bayan, a government radio station aired every Friday from 10:00 to 11:00 in the morning. The title of the program is called, "Makialam sa Kapaligiran" or "The State of the Brown Environment." In Baguio City, Alay sa Kalinisan (ASK) reports are done weekly to inform the public on RITMT operations and ambient air monitoring.

DENR EMB Region 2 has also a regular radio program over DWPE entitled "Tao at Kapaligiran," where environmental concepts including abatement of air pollution are discussed on air. A forum attended by the Officers of the Tricycle Operators and Drivers Association and Barangay Officials within Tuguegarao City on the salient features of RA 8749 was also held in Region 2 in 2013.

In Region 6, an orientation/planning workshop was conducted in 2012, in Iloilo City, which was attended by LGU Committee on Environment members with the objective of "Clean Air for All." There is also the celebration of Environment Month every June, where an environmental symposium was conducted in the Oton Municipal Hall and attended by high

school students. A Driver’s Forum was also held in Iloilo City in 2012 where speakers from TESDA, LTO, DOH and EMB talked about air pollution, the ill effects of air pollution (smoking, pollution from motor vehicles), traffic rules and proper engine maintenance (focusing on driver’s proper engine maintenance to lessen smoke emission). Around 50 drivers and operators attended it. An On-the-Spot Poster Making Contest and Environmental Quiz Bee in celebration of the National Clean Air Month and Environmental Awareness Month in November was also organized by the EMB VI and the MIAGB.

#### 1.4.2 Accomplishments of other government agencies mandated under RA 8749

Government agency	Accomplishments
<b>Department of Energy</b>	<ul style="list-style-type: none"> <li>• promoted the shift from gas-fueled tricycle to electric tricycles (Lithium-ion battery-powered e-vehicles)</li> <li>• works toward the establishment of associated EV support industries (charging stations, motor and parts supply chain, with maintenance and repair services)</li> <li>• through the Oil Industry Management Bureau, created the Technical Committee on Petroleum Products and Additives (responsible for the issuance of petroleum standards based on EURO 4/IV)</li> <li>• promoted the use of natural gas in the transport sector through EO 290, the “Natural Gas Vehicle Program for Public Transport” (NGVPPT)</li> <li>• improvement of fuel standards: In 2007, RA 9367 or the “Biofuels Act of 2006” has been signed and mandated that in the same year, diesel fuel should have a 1% Biodiesel blend which increased to 2% by 2009. Aside from this, it is also mandated that all gasoline should have a 10% ethanol blend by 2011.</li> </ul>
<b>Department of Transportation and Communication</b>	<ul style="list-style-type: none"> <li>• Philippine Clean Vehicles Program is funded through SVPCF which constitutes 7.5% of the total collection from MVUC : Nationwide establishment of the motor vehicle inspection centers (MVICs) complete with equipment and software capable of inspecting current and future motor vehicle population throughout the country. The target is to install automated system check for roadworthiness and providing at least one operational MVIS center at each LTO site. A feasibility study to implement the project through PPP is on-going.</li> <li>• undertaken activities related to the importation and pilot testing in Metro Manila and selected provincial cities of alternative public utility vehicles (auto-LPG conversion of LTFRB taxis)</li> <li>• SVPCF-funded project, ‘Public Utility Jeepney Modernization and Conversion Program”, which seeks to encourage jeepneys to</li> </ul>

<b>Government agency</b>	<b>Accomplishments</b>
	<p>refleet and retrofit their units from diesel-fed engines into electric-LPG powered/or other alternative fuels.</p> <ul style="list-style-type: none"> <li>• pushed for the Natural Gas Vehicle Program for Public Transport</li> <li>• as of June 2012, acquired 61 CNG buses; got 7 bus operators to commit 200 vehicles for piloting CNG buses</li> <li>• existing CNG infrastructures are upgraded (e.g. Malampaya Gas Field and several refueling stations)</li> <li>• Promotion of high occupancy transport modes through the mass transit system like BRT, MRT/LRT and PNR Commuter Rail.</li> <li>• Ortigas Greenways Project: Has been included in the CY2014 SVPCF for final deliberation by the Road Board.</li> <li>• Integrated terminal system which will reduce the air pollution from motor vehicles will be constructed to connect provincial buses with other modes of transportation. The project aims to maximize road usage by reducing vehicle volume and improving traffic flow along Manila's major thoroughfare, particularly EDSA. Three proposed terminals and their statuses are: South West terminal (Awaiting NEDA approval of changes in project terms), South Terminal (movement of NFA warehouses from FTI location is on-going), and North Terminal (site selection is on-going).</li> </ul>
<b>Department of Education</b>	<ul style="list-style-type: none"> <li>• provides public information and education to encourage participation of an informed and active public in air quality planning and monitoring</li> <li>• curriculum integration approach: topics on clean air are integrated into the teaching of Science, Health and Social Studies</li> <li>• Alternative Learning System (ALS) is also used as a mechanism for information dissemination on clean air initiatives through transforming modules into a <ul style="list-style-type: none"> <li>• radio script: "Hangin Pumapatay" or</li> <li>• digital format: "Wanted: Clean and Fresh air"</li> </ul> </li> </ul>
<b>Philippine Nuclear Research Institute</b>	<ul style="list-style-type: none"> <li>• has undertaken research monitoring of PM<sub>2.5</sub> range using nuclear and related analytical techniques (NATs) to generate multielement data for use in receptor modelling</li> <li>• generated black carbon and organic carbon/elemental carbon data</li> <li>• Carbonaceous particulate matter characterization in an urban and a rural site in the Philippines.</li> <li>• air pollutant source identification and apportionment studies</li> <li>• preliminary characterization of carbonaceous aerosol emissions of different combustion sources</li> </ul>
<b>Metro Manila Development Authority</b>	<ul style="list-style-type: none"> <li>• reduction of vehicle volume through the UVVRP and the elimination of smoke belching vehicles through ASBUs</li> <li>• planted <i>ficus</i> trees in sidewalks to decrease CO<sub>2</sub></li> <li>• establishment of bicycle lanes to promote the use of non-motorized transport</li> <li>• reduction of billboard signages believed to trap smoke and air pollutants</li> </ul>
<b>Department of Trade and Industry</b>	<ul style="list-style-type: none"> <li>• Through its Regional and Provincial Offices and the Bureau of Philippine Standards (BPS), the DTI continues to implement the Accreditation of Private Emission Testing Centers (PETCs) scheme. As of December 2013, there are 1,168 accredited centers nationwide with 1,417 accredited stationary lanes</li> </ul>

Government agency	Accomplishments
	<ul style="list-style-type: none"> <li>• BPS has also initiated meetings with BPS recognized calibration laboratories. The laboratories were encouraged to apply for accreditation by the DTI Philippine Accreditation Bureau (PAB) for conformance to PNS ISO/IEC 17025. To date, there are three (3) laboratories which applied for accreditation.</li> </ul>

### 1.4.3 Initiatives on air quality management from various sectors

In 2012, the Philippines celebrated the 10<sup>th</sup> Anniversary of the Clean Air Act. The event was a multi-stakeholder effort from all sectors of Philippine society. Government agencies such as the DENR, DOTC, DOE, DepEd, MMDA and others led the clean air initiatives by providing a general direction and strategy, as well as a scientific, systematic and target-specific monitoring and evaluation system for the clean air and climate change campaigns. These were coupled with the efforts and collaboration from the private sector and civil society groups as well as the scientific researches of academic institutions.

#### The Local Government Units

LGU	Initiatives
<b>Makati City</b>	<ul style="list-style-type: none"> <li>• introduced electric jeepneys and buses as a successful pilot project <ul style="list-style-type: none"> <li>• Green Frog Zero Emission Transport: provides e-buses that ply the Buendia-EDSA-SLEX route</li> <li>• 3,000 electric buses are set to be imported in a span of 7 years</li> </ul> </li> <li>• declared November 21 as "Smoke-Free Day"</li> <li>• through the Makati Health Department (MHD) and Department of Environmental Services (DES) held an activity dubbed "Tigil Buga para sa Kalusugan"</li> <li>• conducted Bantay Tambutso (BanTam) operations</li> </ul>
<b>Mandaluyong City</b>	<ul style="list-style-type: none"> <li>• upgraded its tricycles in cooperation with PCA and MAFETA <ul style="list-style-type: none"> <li>• fielded 20 e-tricycles as pilot project in partnership with ADB</li> </ul> </li> </ul>
<b>Pasig City</b>	<ul style="list-style-type: none"> <li>• instituted "car-less" Sundays in Ortigas Center and other main thoroughfares of the city</li> <li>• adopted environment-friendly technologies such as electronic jeepneys, bike to work loan program for its city employees and upgraded the tricycles</li> <li>• instituted bicycle lanes and created the Bicycle Promotion Committee to promote bicycles as an alternative healthful and environmentally sound mode of transportation</li> <li>• installed walkways and skywalks to encourage people to walk</li> </ul>
<b>Quezon City</b>	<ul style="list-style-type: none"> <li>• through its Environmental Protection &amp; Waste Management Department (EPWMD): <ul style="list-style-type: none"> <li>• organized a training program on Eco-Driving with the TODAS of Quezon City</li> <li>• launched the "Clean Air Compliance Assistance Program" (CACAP) to address the issue of competency of transport sector on vehicle emission control systems</li> </ul> </li> </ul>

LGU	Initiatives
	<ul style="list-style-type: none"> <li>• consolidated a handbook known as the "Gabay sa Pagbabawas ng Usok mula sa Tricycle at ibang Pampublikong Sasakyan" based from training materials from the academe, government, petroleum &amp; automotive industry, technical experts and technology providers</li> <li>• In 2013, initiated the "Tricycle Management Code" that included the integration of clean air related policies on franchising and extensive training and education on emission related maintenance systems</li> <li>• Quezon City Council legislated an Ordinance to compliment the DOTC, DENR and DTI monitoring of Private Emission Testing Center based and operating in its territorial jurisdiction</li> </ul>
<b>San Juan City</b>	<ul style="list-style-type: none"> <li>• installed air quality monitoring stations</li> <li>• initiated limited car-less days on special occasions.</li> </ul>
<b>Baguio City</b>	<ul style="list-style-type: none"> <li>• passed a City Ordinance in 2008 (CO 61) entitled 'Clean Air Ordinance of the City of Baguio' <ul style="list-style-type: none"> <li>• subjects flagged vehicles to their Roadside Inspection, Testing and Monitoring Team's (RITMT) roadside testing</li> <li>• violators of the emissions standards are required to pay polluter's fees and are not allowed to enter the city until the vehicles are repaired and emission standards are met</li> <li>• "Alay sa Kalinisan" (ASKI) reports are done weekly to inform the public on RITMT operations and ambient air monitoring</li> <li>• the City Green Fleet of the city also focuses on the emission testing of the city's red plates</li> <li>• monthly multi-sector meetings of the Clean Air Monitoring Unit (CAMU) are performed</li> <li>• continuous training of RITMT members, enforcers, operators and owners are done</li> <li>• emission inventory trainings are held by Clean Air Asia (CAA) and EMB</li> </ul> </li> <li>• participated in projects with the BLISTT Governing Board, CAA and Saint Louis University (SLU)</li> </ul>
<b>Taguig City</b>	<ul style="list-style-type: none"> <li>• In 2012, the City Environment &amp; Natural Resources Office (CENRO) conducted trainings labeled as "TRICYCLEAN" for the tricycle using a compilation of materials from the academe, government, motorcycle and petroleum industry and technology providers</li> </ul> <p>a series of tune-up services were done in various tricycle terminals based on acceptable preventive maintenance procedures</p>
<b>Iloilo City</b>	<p>Iloilo City Emission Inventory (2011-2014)</p> <p>Features:</p> <ul style="list-style-type: none"> <li>• Comprehensive (in terms of coverage of sources)</li> <li>• Bottom-up approach (survey-based/primary data collection)</li> <li>• Participatory (solicited inputs from key sectors)</li> <li>• Attempt for science-based (academic consortium)</li> </ul> <p>Conduct of related studies:</p> <ul style="list-style-type: none"> <li>• Rapid Assessment of Traffic Police Enforcers Exposed to Mobile Emission Sources (University of Iloilo Graduate School, 2010)</li> <li>• Health Status of Traffic Management Personnel Exposed to Mobile Sources ( Philippine College of Chest Physician, started in 2010, On-going)</li> <li>• Alternative Jeepney Engine Study ( GIZ, Clean Air Asia, UPV and City of Iloilo, 2014)</li> </ul> <p>Planned/Next Steps:</p> <ul style="list-style-type: none"> <li>• Institutionalization of Iloilo Clean Air Research Network (2015)</li> <li>• Demonstration of repowered jeepneys (2015)</li> </ul> <p>Clean Air Plan Development and Implementation (2012-2015)</p>

LGU	Initiatives
	<ul style="list-style-type: none"> <li>• One of the first LGUs in the country to formulate the said document</li> </ul> <p>Anti-smoke Belching Program</p> <ul style="list-style-type: none"> <li>• Received a 1 Million Grant from DENR</li> <li>• launched in November 2014</li> </ul> <p>Program Components</p> <ul style="list-style-type: none"> <li>- Social Marketing, Information and Education Campaign (SMIEC) – awareness raising campaign to help jeepney drivers and other stakeholders understand the health implications of air pollution</li> <li>- Roadside Apprehension – enactment of Anti-smoke Belching Ordinance</li> <li>- Roadside Air Quality Monitoring – air quality monitoring of streets and junctions where traffic is usually heavy</li> </ul> <p>Perimeter Boundary Ordinance City Ordinance No. 2004 – 268, December 15, 2004, Authorized the establishment of public utility terminals in each districts of the city</p> <ul style="list-style-type: none"> <li>• Limited the entry of more than 1000 provincial jeepneys who were duplicating several city routes</li> <li>• Helped avoid : <ul style="list-style-type: none"> <li>- <i>the use of diesel fuel amounting to 11,152 liters/day</i></li> <li>- <i>the emission of greenhouse gas amounting to 29 tons /day</i></li> <li>- <i>the emission air pollutants</i> <ul style="list-style-type: none"> <li>- NOx avoided - 111, 969 gm/day</li> <li>- SOx avoided - 2,177.75 gm/day</li> <li>- PM avoided - 12,959.37 gm/day</li> </ul> </li> </ul> </li> </ul> <p>Fuel Switching (Energy Efficiency Program) Adopted by the city government in partnership with the International Council for Local Environmental Initiatives (ICLEI)</p> <ul style="list-style-type: none"> <li>- Promoted fuel switching from gasoline to LPG</li> <li>- To date: <ul style="list-style-type: none"> <li>- more than 1000 taxis shifted to LPG</li> <li>- helped avoid the emission of no less than 10,000 tons of greenhouse gas per year</li> </ul> </li> </ul> <p>Sustainable Transport Initiatives</p> <p>Carless Day</p> <ul style="list-style-type: none"> <li>- Promotion of Carless Day in Schools</li> </ul> <p>Bike ways</p> <ul style="list-style-type: none"> <li>- Construction of 6 km long bike lanes along Diversion Road</li> </ul> <p>Walkability</p> <ul style="list-style-type: none"> <li>- Construction of 2 km linear park along Iloilo River (Esplanade 1 &amp; 2) to promote walkability</li> </ul>

Other public and private entities

Civil society organizations

CSO	Initiatives
<p><b>Clean Air Asia</b></p>	<ul style="list-style-type: none"> <li>• Assists in implementing <b>GIZ Transport and Climate Change</b> project by operationalizing the Special Vehicle Pollution Control Fund and in identifying gaps, needs, and potential areas for assistance through a stocktaking report of the structure of the land transport sector</li> <li>• Supports Asian Development Bank (ADB) in implementing <b>Ortigas Greenways</b> in partnership with Department of Transportation and Communications (DOTC) and Paulo G. Alcazaren and Associates (PGAA) to develop a high-quality, socially inclusive walking corridor in Ortigas Center.</li> </ul>

CSO	Initiatives
	<ul style="list-style-type: none"> <li>• Supports ADB in introducing and expanding Tutubi bike-sharing systems in the Philippines</li> <li>• Conducts <b>fuel economy baseline study</b> together with United Nations Environment Programme (UNEP) and Department of Energy</li> </ul>
<b>Firefly Brigade</b>	<ul style="list-style-type: none"> <li>• organized the yearly caravan called "Tour of the Fireflies" to attract cyclists in promoting the most environment-friendly mode of transportation-biking</li> </ul>
<b>FSSI</b>	<ul style="list-style-type: none"> <li>• co-sponsored the "Clean Air Concert" held at Trinoma on November 21, 2013</li> </ul>
<b>Greenpeace Philippines</b>	<ul style="list-style-type: none"> <li>• actively campaigned for companies and government to shift to cleaner, non-toxic products and product processes</li> </ul>
<b>Philippine Institute of Petroleum (PIP)</b>	<ul style="list-style-type: none"> <li>• a constant supporter of clean air programs, has been active as board member of the Partnership for Clean Air</li> <li>• supported the Tricycle Upgrading Project in Mandaluyong and Pasig City</li> </ul>
<b>Partnership for Clean Air</b>	<ul style="list-style-type: none"> <li>• led projects such as the Car-Free Day and the Clean Air Concert dubbed as "<i>Clean Air? Pwede</i>" on November 25, 2012</li> </ul>
<b>Philippine Medical Association (PMA)</b>	<ul style="list-style-type: none"> <li>• organized the Clean Air Summit dubbed as "<i>Usok M, Buhay Ko</i>" in February 29, 2012 at the Phil. Medical Association Auditorium at North EDSA, Quezon City</li> <li>• organized the Clean Air Caravan which conducted clean air monitoring every Saturday and Sunday for the whole month of November (Clean Air Month)</li> </ul>
<b>Share the Road Movement</b>	<ul style="list-style-type: none"> <li>• works to bring communities together to make the roads a safer, cleaner, and more reliable way to travel</li> <li>• has been urging the government reform the nation's transportation system to open the roads to all people and to unprioritize privately-owned vehicles</li> </ul>

## 1.5 Legal and policy aspects

### 1.5.1 Laws and legal issuances relevant to RA 8749

Laws and legal issuances	Title/Description
1997 Presidential Proclamation No. 1101 (Activities led by DENR-EMB)	Month of November: CLEAN AIR MONTH with activities focused on issues and concerns related to the problems of air pollution throughout the country
Republic Act 8794 (Implemented by DOTC/LTO)	Enacted to impose a Motor Vehicle User's Charge on owners of all types of motor vehicles and provides for a seven and one-half percent (7.5%) of such will be allotted to and place in the Special Vehicle Pollution Control Fund.
Office of the President-Memorandum Circular No. 2004 - 55	Directing all Departments, Bureaus, Offices and Instrumentalities of the Government, including Government-owned and controlled, Corporations to Incorporate the use of 1% by volume Coconut Methyl Ester in their Diesel Requirements
Republic Act No. 9211	Enacted to regulate the packaging, use, sale, distribution and advertisement of tobacco products and bans smoking in public places.

Republic Act 9367 <sup>39</sup> (Implemented by the DOE)	"Biofuels Act of 2006" enacted to direct the use of Biofuels in motor vehicles, imposes the phase out of harmful gasoline additives and/or oxygenates, the mandatory use of Biofuels and an incentive scheme to encourage investments in the production, distribution and use of locally-produced biofuels
Republic Act 9513 <sup>40</sup> (Implemented by the DOE)	"Renewable Energy Act of 2008" enacted to accelerate development of the country's renewable energy sources
DOF – BIR REVENUE CIRCULAR Order No. 2012-16	Smoking Prohibition based on the 100% Smoke-Free Environment Policy, Restrictions on Interactions with the Tobacco Industry and Imposition of Sanctions for Violation of the Rule

## 1.6 Challenges and recommendations

This section aims to list a number of recommended steps and measures in four main aspects – policy, research and development, capacity building and institutional framework, and finance, which various stakeholders can consider to implement in the immediate or long-term periods, with strong support at the national and local levels of governance in the country.

### Mobile source management

#### *The National Motor Vehicle Inspection and Maintenance Program*

The Clean Air Act provides for the formulation and implementation of a national motor vehicle inspection and maintenance program that will promote efficient and safe operation of all motor vehicles - to ensure the substantial reduction of emissions from motor vehicles. Thus, the Department of Trade and Industry (DTI) should already develop and implement standards and procedures for the certification of training institutions, instructors and facilities and the licensing of qualified private service centers and their technicians as prerequisite for performing the testing, servicing, repair and the required adjustment to the vehicle emission system. The DTI should also prescribe regulations requiring the disclosure of odometer readings and the use of tamper-resistant odometers for all motor vehicles including tamper-resistant fuel management systems for the effective implementation of the inspection and maintenance program.

In line with the goal of reducing the emissions of motor vehicles, Republic Act 9367, also known as the "*Biofuels Act of 2006*" was also enacted to direct the use of Biofuels in motor vehicles. Specifically, it imposes the phase out of harmful gasoline additives and/or oxygenates, the mandatory use of Biofuels and an incentive scheme to encourage investments in the production, distribution and use of locally-produced biofuels. The promotion of the use of alternative fuels thru conversion to E-vehicles, compressed natural gas (CNG) and liquefied petroleum gas (LPG), including infrastructure development for refilling/charging stations should be actively pursued. Provision of more incentives, such as reduced tax for vehicles

using alternative fuels and vehicles with fuel-efficient engines, will help promote the use of low emission vehicles.

Measurement of carbon dioxide levels should also be part of the emissions testing of motor vehicles and incentives for low-carbon emissions may be provided.

#### Area source management

The use of firecrackers during New Year's celebration should be regulated as it contributes extremely high levels of pollutants in the atmosphere. Municipalities can instead focus on controlled use of fireworks for the public. To better understand the pollution contribution of fireworks, chemical analyses of its composition and emissions can also be done. RA 7183 regulates the sale, manufacture, distribution and use of firecrackers and other pyrotechnic devices, and this law should be more stringently implemented considering the effects of such materials on air quality and the corresponding health risks involved.

#### Local legislation: ENRO

Considering the important functions of Environment and Natural Resources Office (ENRO) under Section 37, RA 8749 and the mandated role of LGUs to undertake full administration of air quality management in their territorial jurisdiction (section 36), the optional provision on creation of ENRO per LGU should be made mandatory through local legislation.

#### Research and development

To alleviate air pollution, there should be a continuous understanding of the latest information on what factors define it, the full extent of its impacts and the new developments and technology related to its mitigation. Section 15 of Chapter 2, Article 1 of the RA 8749 IRR mandates the DENR, DOST, other agencies, private sector, the academe, NGOs and POs to establish a *National Research and Development Program* (NRDP) for the prevention and control of air pollution. As such, the following research and development projects are therefore recommended:

##### *Specific studies on health impacts*

More research on the detailed health impacts of specific levels of pollutants should be done in the country, and reported in a manner that can be understood by the general public as Filipinos tend to disregard health advisories unless they are already affected. For example, specific health studies can be done on workers most exposed to air pollution such as traffic enforcers or PUV drivers, and the objective result would be to identify respiratory ailment/s which can be developed given this amount of exposure to specific pollutant levels. Area-based data generated would increase

awareness of the public and would thus encourage participation in improving the quality of air.

#### *Mobile source management through transport research and development*

Real time monitoring of traffic conditions especially in urban areas, combined with more accurate emission factors can be of use in predicting real-time, pollutant levels through modeling. More effort should be placed on managing the transport flow not only because of the inconvenience but also of the health implications brought by air pollution. Continuous development of mass transit systems is also important as reduction of mobile vehicles will directly lessen air pollutants. The government must see to it, however, that modes of mass transportation can keep up with the demand while ensuring the safety of the commuters.

Multi-partite studies should also be done on the efficiency and health safety of using converted engines for alternative fuels such as LPG and CNG. Results of these studies can provide stronger support to the claim that engine conversion is the best way to alleviate air pollution in the country and not just a 'band-aid solution' that can lead to other implications in the future.

It is also recommended that vehicles of use for 15 years and greater, if not phased-out, should be limited to areas with air quality that is not compromised.

#### Land use planning

An efficient land use plan particularly for urban areas also plays a role in improving air quality because the development of land, building design and orientation affects the transportation choices of people. The location of urban centers and places with essential services such as schools, hospitals and business districts, and the availability of mass transit will determine whether people will opt to take public transportation, use private vehicles, or ride a bicycle to work.

It is also very important that there is a high forestland cover as trees and other types of vegetation contribute in the reduction of air pollution by helping to settle, trap and hold particle pollutants, absorb carbon dioxide and other gases while replenishing the oxygen in the atmosphere. Further, areas with lush vegetation and trees reduce ultraviolet radiation, lower air temperature and alter wind patterns which can lead to pollutant dispersion. In urbanized regions where there is low vegetation and forest cover and high percentage of built-up areas, high levels of pollution are expected. Land use and changes in land cover due to urbanization impact air quality by affecting emissions, heat and energy balances, climate and pollutant deposition.