

# **NATIONAL AIR QUALITY STATUS REPORT**

---

## **(2008-2015)**



**Department of Environment and Natural Resources**  
**ENVIRONMENTAL MANAGEMENT BUREAU**

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## Acronyms and Abbreviations

µg/Nm <sup>3</sup>	micrograms per normal cubic meter
AAQS	Ambient Air Quality Standard
ADB	Asian Development Bank
ALS	Alternative Learning System
AQI	Air Quality Index
AQMF	Air Quality Management Fund
AQMS	Air Quality Management Section
ASB	Anti Smoke Belching
ASBU	Anti Smoke Belching Unit
BPS	Bureau of Philippine Standards
CAA	Clean Air Act
CACAP	Clean Air Compliance Assistance Program
CEMS	Continuous Emission Monitoring System
CENRO	City Environment and Natural Resources Office
CNG	Compressed Natural Gas
CO	carbon monoxide
COC	Certificate of Conformity
CSO	Civil Society Organization
DAO	Department Administrative Order
DBM	Department of Budget Management
DENR	Department of Environment and Natural Resources
DOH	Department of Health
DOTr	Department of Transportation
DTI	Department of Trade and Industry
EMB	Environmental Management Bureau
IARC	International Agency for Research on Cancer
IEC	Information and Education Campaign
IEMP	Industrial Emission Management Program
IRR	Implementing Rules and Regulations
JAO	Joint Administrative Order
kTOE	kilotonne of oil equivalent
LGU	Local Government Unit
LPG	Liquefied Petroleum Gas
LRT	Light Rail Transit
LTFRB	Land Transportation Franchising and Regulatory Board
LTO	Land Transportation Office

MC	Memorandum Circulars
MMDA	Metro Manila Development Authority
MMT	Multipartite Monitoring Teams
MMUTIS	Metro Manila Urban Transportation Integration Study
MRT	Metro Rail Transit
MV	Motor Vehicle
MVIC	Motor Vehicle Inspection Center
MVUC	Motor Vehicle User's Charge
MW	megawatt
NAAQGV	National Ambient Air Quality Guideline Value
NAT	Nuclear and Analytical Technique
NCR	National Capital Region
NESSAP	National Emission Standards for Sources Specific Air Pollutant
NGVPPT	Natural Gas Vehicle Program for Public Transport
NO <sub>2</sub>	nitrogen dioxide
NOV	Notice of Violations
NO <sub>x</sub>	nitrogen oxides
O <sub>3</sub>	ozone
OAP	Outdoor Air Pollution
PCO	Pollution Control Officer
PETC	Private Emission Testing Center
PM	Particulate matter
PM <sub>10</sub>	Particulate matter with diameter of less than 10 microns
PNR	Philippine National Railways
PPP	Public-Private Partnership
PTO	Permit to Operate
RA	Republic Act
RITMT	Roadside Inspection, Testing and Monitoring Team
SAT	Sampling Assessment Team
SMIEC	Social Marketing, Information and Education Campaign
SO <sub>2</sub>	sulfur dioxide
SUV	Sports Utility Vehicle
SVPCF	Special Vehicle Pollution Control Fund
TPSETF	Third Party Source Emission Testing Firm
TSP	Total Suspended Particulates
USEPA	United States Environmental Protection Agency
UV	Utility Vehicle
UVVRP	Unified Vehicular Volume Reduction Program
WHO	World Health Organization

## Executive Summary

The latest National Emissions Inventory by source conducted in 2015 showed that the majority (65%) of air pollutants came from mobile sources such as cars, motorcycles, trucks and buses. Almost 21% 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. However, the Emissions Inventory for the National Capital Region (NCR) in the same year reported a huge 88% contribution of mobile sources to air pollution in the area compared to only 10% from stationary sources and a mere 2% from area sources. The National Emissions Inventory of 2015 also shows the contribution of different types of pollutants such as volatile organic compounds (VOC), sulfur oxides (SO<sub>x</sub>), nitrogen oxides (NO<sub>x</sub>), carbon monoxide (CO) and particulate matter (PM) to emissions nationwide. The major pollutants coming from mobile sources are VOC (91%) and CO (89%). Stationary sources generate substantial amounts of gases such as SO<sub>x</sub> (72%) and NO<sub>x</sub> (39%) while area sources produce mostly particulate matter (45%).

As of 2015, there were 93 air quality monitoring stations nationwide. These manual and real-time stations are situated in highly urbanized cities and also rural areas in different regions of the country. Monitoring stations keep track of criteria pollutants or air pollutants for which National Ambient Air Quality Guideline (NAAQGV) values have been established. These pollutants include Total Suspended Particulates (TSP), Particulate matter with diameter of less than 10 microns (PM<sub>10</sub>), Particulate matter with diameter of less than 2.5 microns (PM<sub>2.5</sub>), sulfur dioxide (SO<sub>2</sub>), nitrogen dioxide (NO<sub>2</sub>) and ozone (O<sub>3</sub>).

Furthermore, a set of pollution standard index of air quality, called the Air Quality Index (AQI) was formulated in line with Republic Act (RA) 8749 or Clean Air Act (CAA). 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*. 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 Ave. Manila, DPWH-Timog Quezon City, PLV-Valenzuela and Commonwealth Ave. Quezon City), through DENR- Environmental Management Bureau (DENR-EMB) website: [http:// www.emb.gov.ph](http://www.emb.gov.ph).

From the enactment of CAA in 1999 to 2015, the accomplishment of DENR-EMB included the designation of airsheds throughout the Philippines, establishments 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 were done through Memorandum Circulars (MC), Department Administrative Orders (DAO), Joint Administrative Orders (JAO).

As of 2015, there was a total of 22 airsheds in the country. For officially designated airsheds, 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 and civil society.

As to the management of stationary sources of air pollution, all stationary sources must have a Permit to Operate (PTO), issued by the DENR upon compliance with the standards specified in the Implementing Rules and Regulations (IRR) of RA 8749 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.

The Industrial Emission Management Program (IEMP) ensures compliance of industries to the emission standards set by the Bureau. 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 IRR. A total of 19 firms with a total of 31 teams are accredited to carry out the stack testing activity pursuant to DAO 2013-26.

As to the management of mobile sources, several measures 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, 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 CAA. 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. 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. Pursuant to RA 8749, Private Emission Testing Center (PETC) are Department of Trade and Industry (DTI), Land Transportation Office (LTO)- authorized and use equipment that are DENR-certified. Monitoring of PETCs is accomplished through a composite team comprised of DTI, DENR and Department of Transportation (DOTr)-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, namely, 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.

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, Department of Energy, issued a circular mandating the manufacture and sale of Euro IV automotive diesel oil and gasoline (with



# 1. Air quality

## 1.1 Sources of Air Pollution

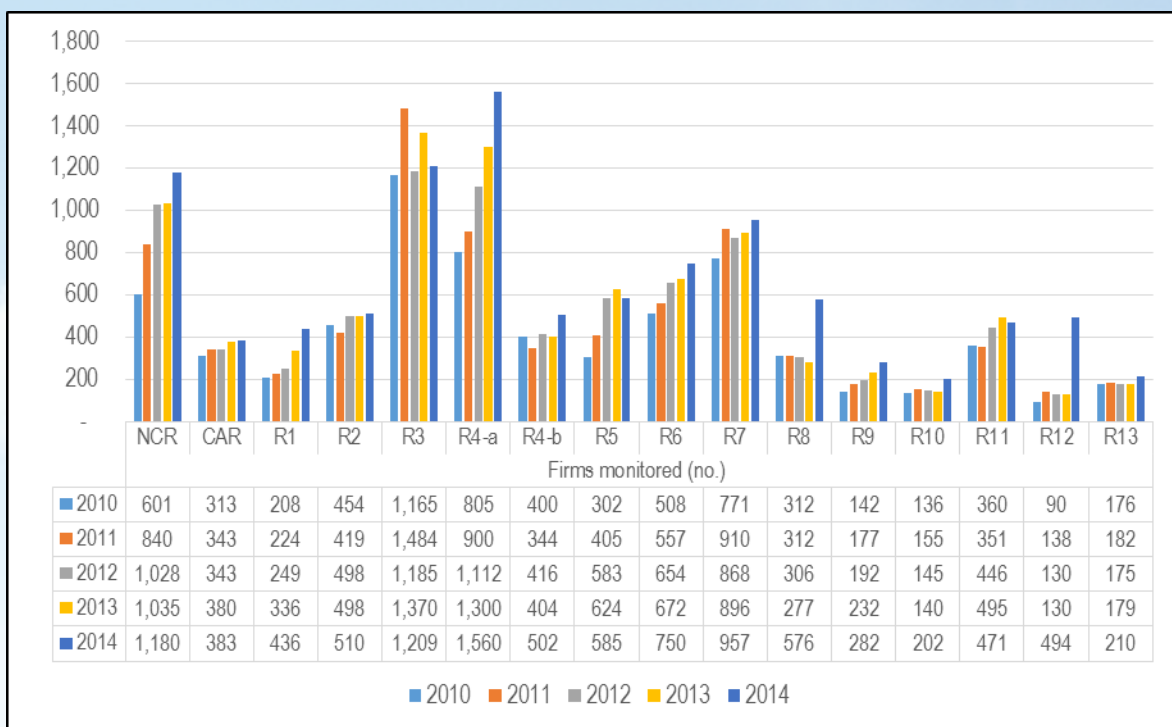
Air pollutants can come from both natural and anthropogenic sources, but anthropogenic air pollutants dominate the atmosphere of areas primarily undergoing industrialization. For management purposes, air pollution sources can be classified as stationary, mobile or area, as described in Republic Act (RA)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

### 1.1.2 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 Department of Environment and Natural Resources (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 DENR Administrative Order (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

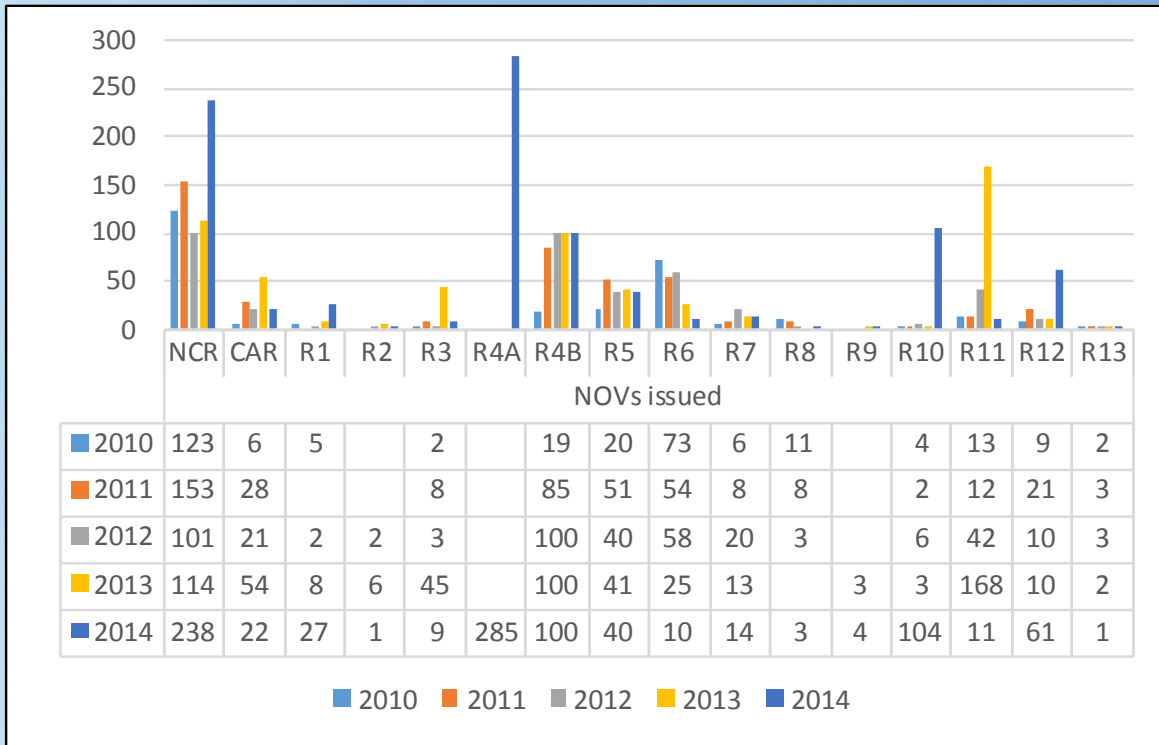
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where the level of industrial growth is high. Also notable is the sudden increase in the number of monitored firms in Regions 8 and 12 in 2014 (see Figure 1-1).

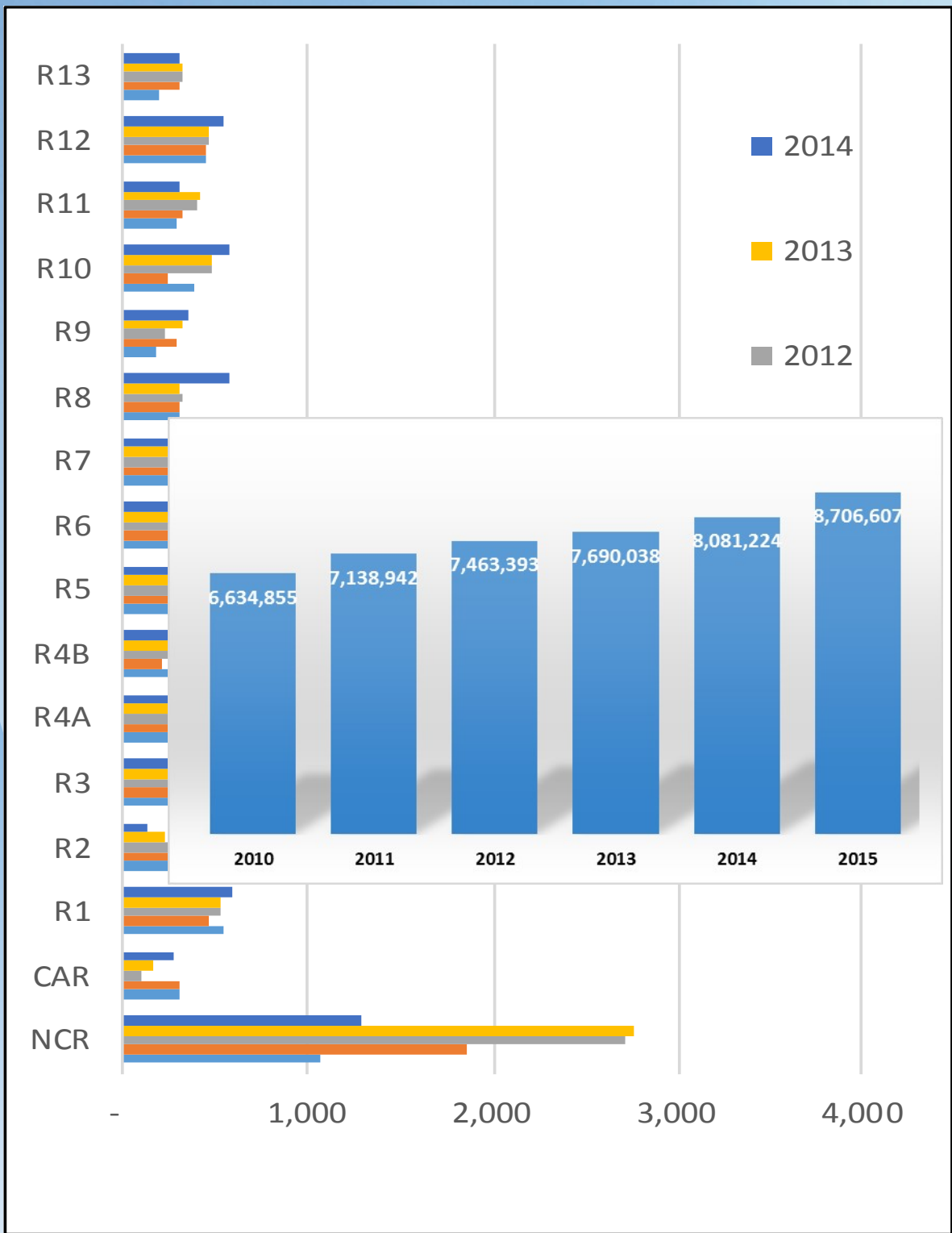
**Figure 1-1.  
Number of Firms Monitored, 2010-2014**

By region, 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 4A (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).



### **Figure 1-3. Number of PTOs Issued, 2010-2014**

*Source: EMB*

#### **1.1.2 Mobile Sources**

Mobile sources are any vehicles 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 nitrogen oxides (NO<sub>x</sub>) 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.

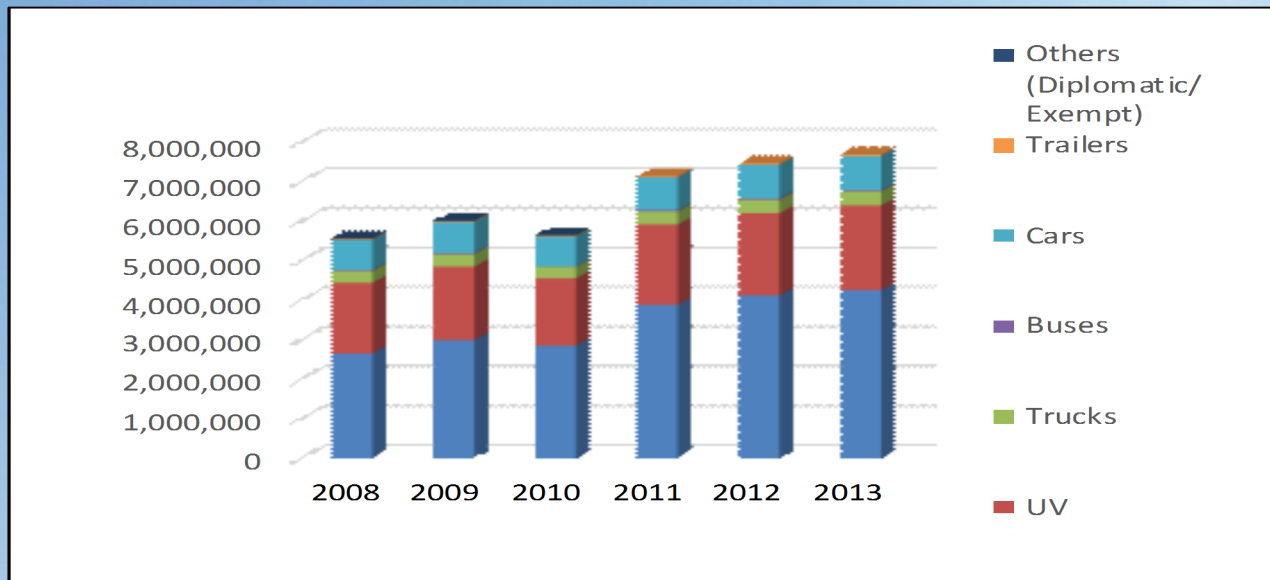
Figure 1-4 shows the number of total registered motor vehicles (MVs) in the Philippines from 2010 to 2015. The number of registered vehicles has continuously increased in the country, increasing the number of mobile emissions. From 6,634,855 MVs in 2010 to 8,081,224 MVs in 2014 recorded by the Land Transportation Office (LTO), the number of MVs grew by 22 percent during the five-year period.

### **Figure 1-4. Total Number of Registered Motor Vehicles in the Philippines from 2010-2015**

*Source: LTO, NSCB*

MVs are classified by the LTO for registration into seven groups: cars, utility vehicles (UVs), sports utility vehicles (SUVs), trucks, buses, motorcycles/tricycles 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 increased until it overtook the UV share and became the dominant MV in the Philippines.



**Figure 1-5. Number of Registered Motor Vehicles by Type, 2008-2013**

Source: LTO

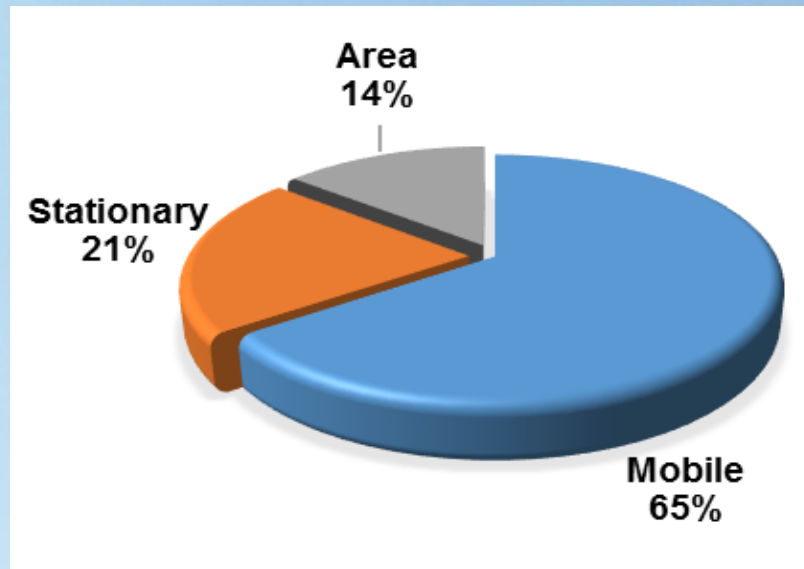
In general, increase in vehicle registrations is caused by the increase in population especially in urban centers to cater to the transport needs of the people. Although more national roads and bridges are being improved and built through the years, main roads remain heavily congested particularly during 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 Department of Transportation (DOTr) has implemented and still continues 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 Land Transportation Franchising and Regulatory Board (LTFRB) through Land Transportation Office (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 which 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 kilotonne of oil equivalent (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.

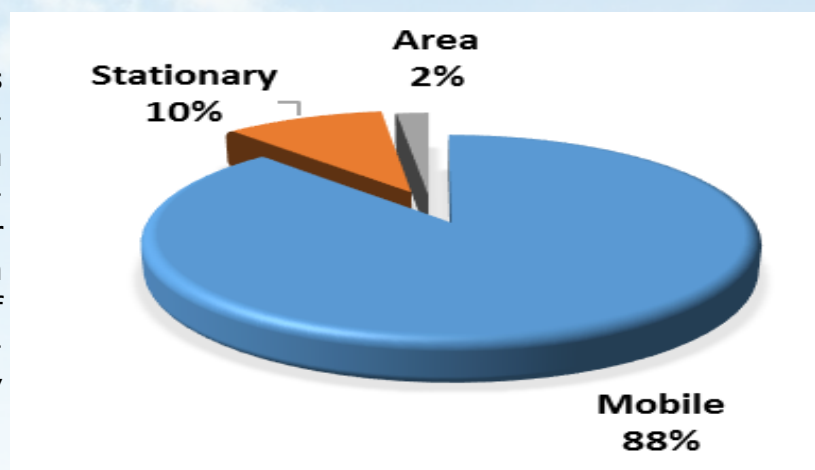
### 1.1.3 Area Sources

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, unpaved road ways, 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 Implementing Rules and Regulations (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.

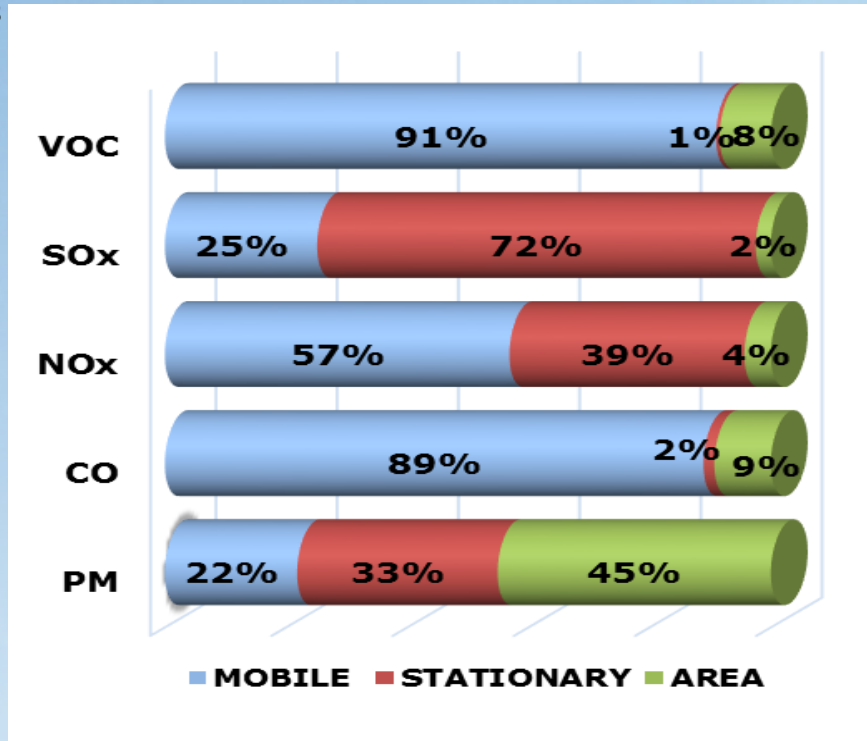
As specified in 8749, there is smoking in-building or an place includes and other transport or in ea outside of residence, pri-work or any enclosed Implementa-seems lacking



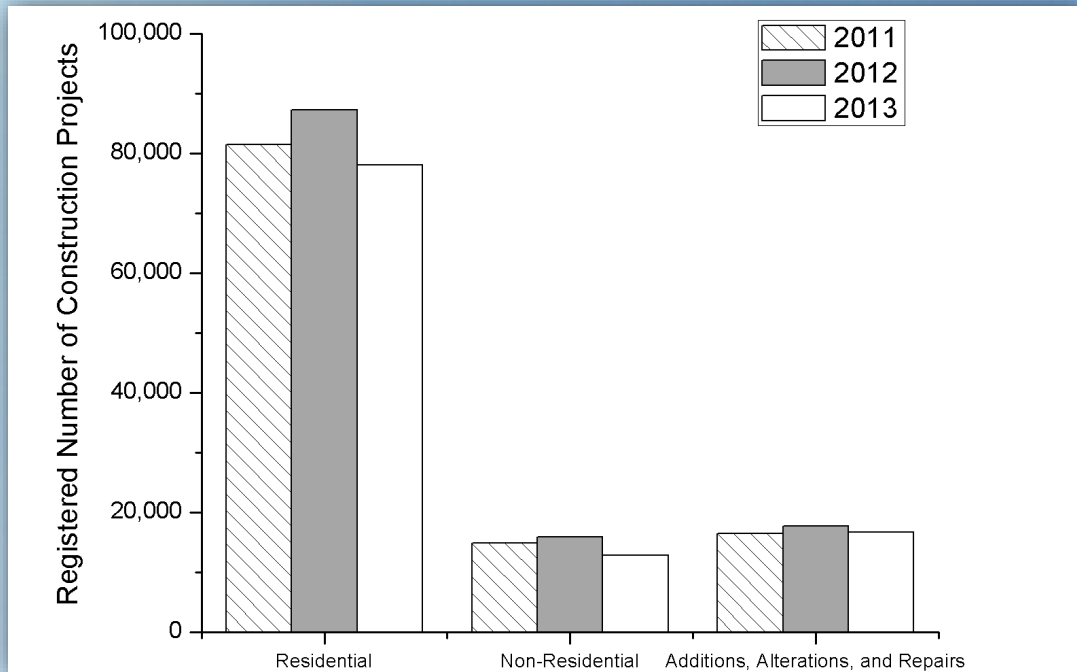
Section 24 of RA also a ban on side a public enclosed public ing public vehi-means of any enclosed ar-one's private vate place of duly designated smoking area. tion of this policy as a large part of

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 2013, the of construction residential, 70 to 75% of construction







**Figure 1-6. Number of Construction Projects in the Philippines, 2011-2013**

#### 1.1.4 Emissions Inventory

The Environmental Management Bureau (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).

**Fig- by** The National Emissions Inventory 2015 also shows the contribution of different types of pollutants such as volatile organic compounds (VOC), sulfur oxides (SOx), nitrogen oxides (NOx), carbon monoxide (CO) and particulate matter (PM) to national emissions. As presented in **Figure 1-8**, the major pollu-

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
Carbon Monoxide (CO)	1-hour	140
	8-hour	10
Lead (Pb)	1-hour	35
	Annual	1
	3 months	1.5

**Figure 1-8. NCR Emissions Inventory, Source, 2015**

Stationary Emissions Inventory of shows the contribution of different types of pollutants such as volatile organic compounds (VOC), sulfur oxides (SOx), nitrogen oxides (NOx), carbon monoxide (CO) and particulate matter (PM) to national emissions. As presented in **Figure 1-8**, the major pollutants com-

ing from mobile sources are VOC (91%) and CO (89%). Stationary sources generate substantial amounts of gases such as SOx (72%) and NOx (39%) while area sources produce mostly particulate matter (45%).

## **Figure 1-9. National Emissions inventory, by source and pollutant, 2015**

Source: EMB

### **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 Air Quality Management Section (AQMS) of the EMB 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 (see Table 1-1).

**Table 1-1. Types of Air Quality Monitoring Systems in the Philippines and Pollutants Monitored, 2015**

Type	Quantity
Manual/Reference Method – Particulate Matter with diameter of less than 10microns (PM <sub>10</sub> )	27
Manual/Reference Method - Total Suspended Particulates(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 (NAAQGV) 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**

Notes: Notes for Table 1-2

-SO<sub>2</sub> and Suspended Particulate Matter 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 (Total Suspended Particulates) and PM<sub>10</sub> (Particulate matter with diameter of less than 10 microns) 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 vehicu-

Region	Station	Total Suspended Particulates Annual Values (µg/Ncm)							
		2008	2009	2010	2011	2012	2013	2014	2015
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
	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								

lar combustion of fuel with high-sulfur content. In the atmosphere, it can undergo chemical reac-

Region	Station	Total Suspended Particulates Annual Values ( $\mu\text{g}/\text{Ncm}$ )							
		2008	2009	2010	2011	2012	2013	2014	2015
REGION 1	In front of Nepo Mart, Alaminos City								
	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., Baniad, Mandaue City				69	75	71	78	94
	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	Station	Total Suspended Particulates Annual Values ( $\mu\text{g}/\text{Ncm}$ )							
		2008	2009	2010	2011	2012	2013	2014	2015
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	**			
REGION 13	Station 3 in front of Mun. Hall, Isulan, Sultan Kudarat	83	75	73	53	**			
	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

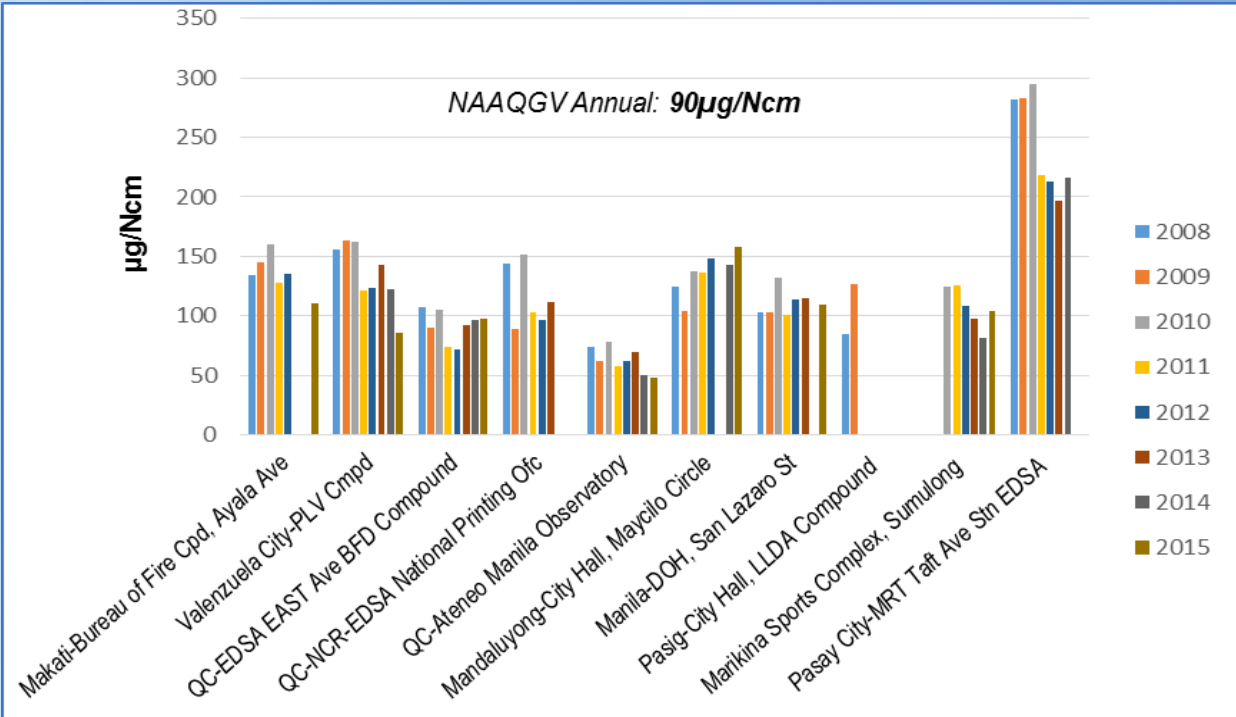
\*\* Shifted to PM10 Monitoring

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  $\mu\text{g}/\text{Ncm}$ .





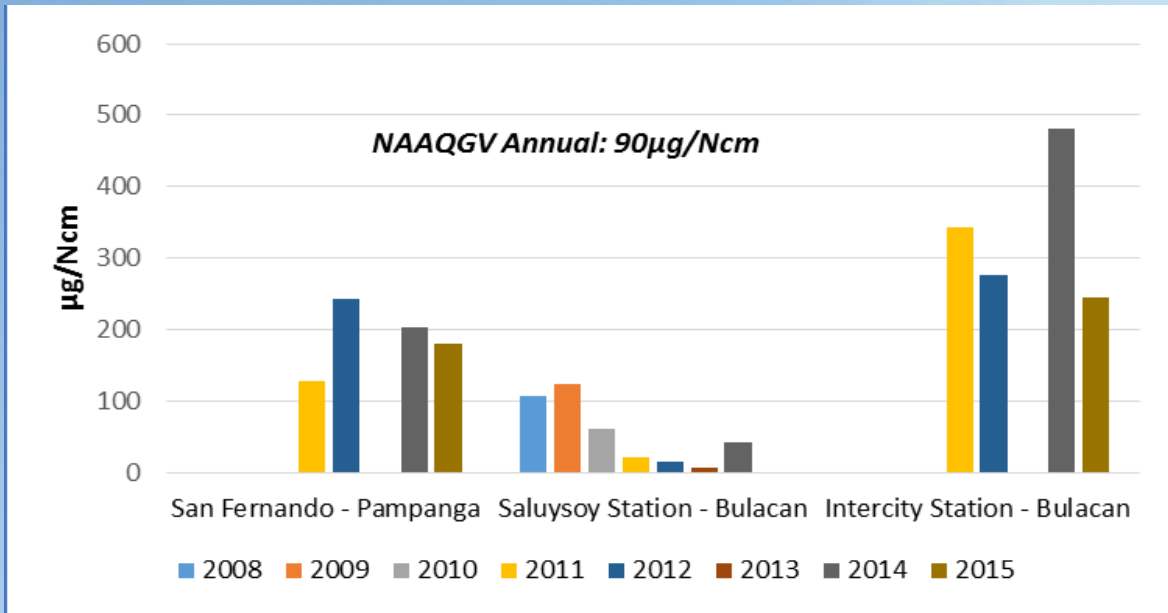
**Figure 1-10. TSP Annual Mean Values in NCR, 2008-2015**

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 Light Rail Transit (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.

Alt-



hough 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 Local Government Unit (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

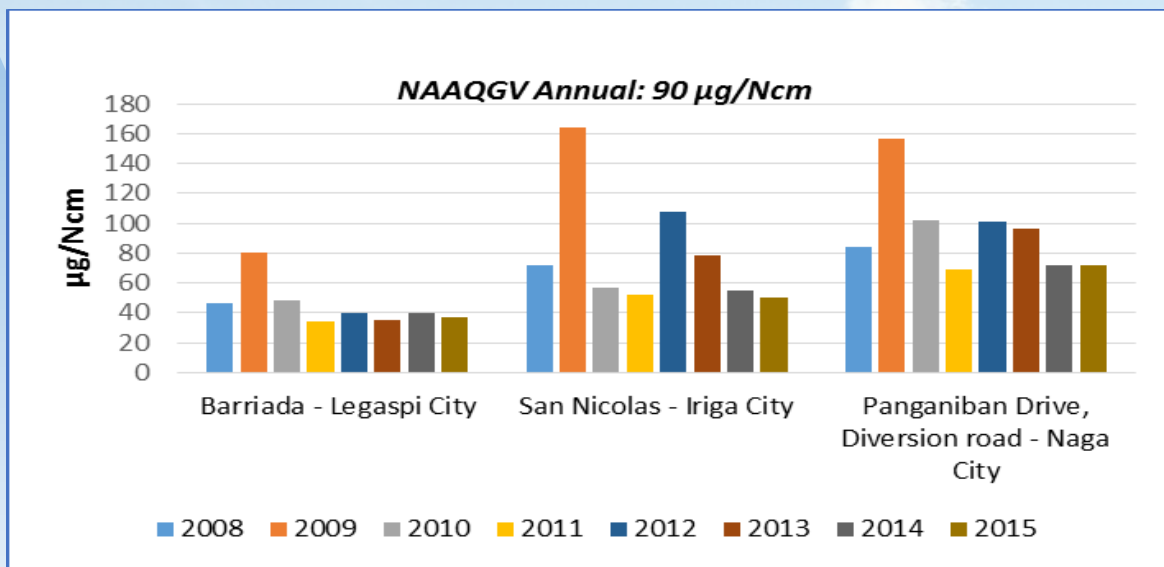
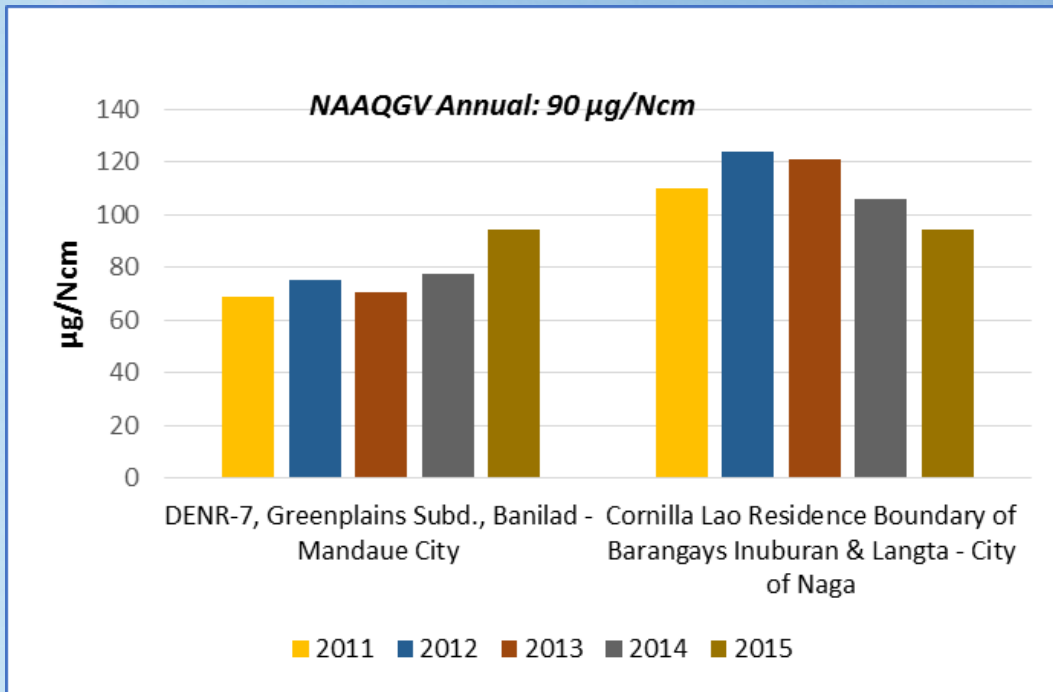


Fig-

ure 1-11. TSP Annual Mean Values in Region 3, 2008-2015

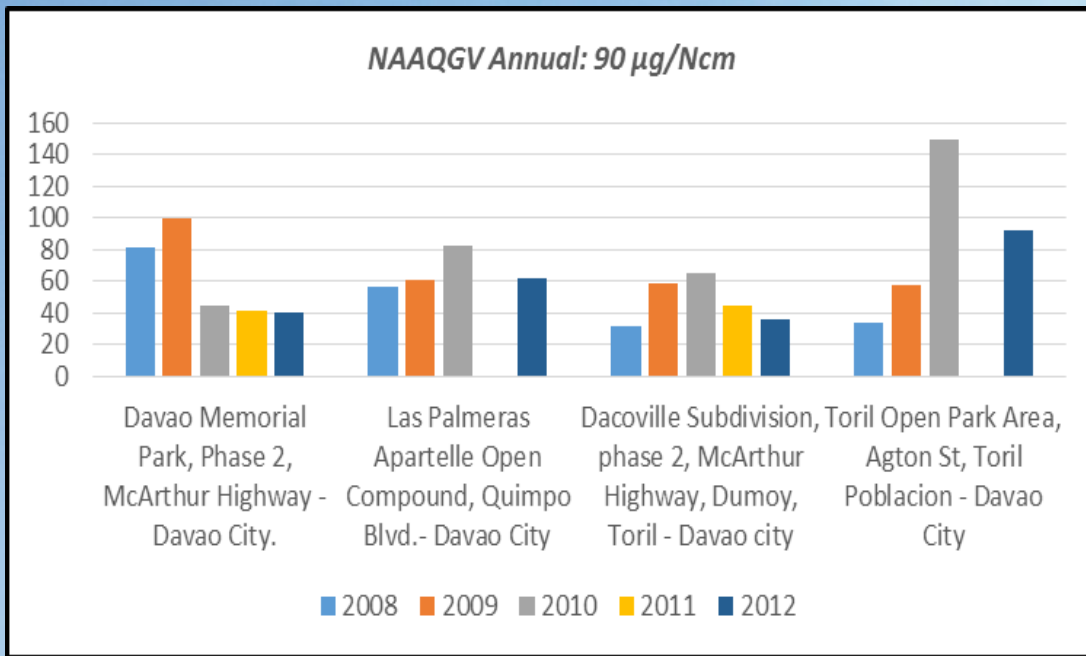
multi-pass rice milling machines owned by about 60 operators. This explains why TSP levels were alarmingly high from 2011 to 2015. More stringent monitoring and imple-



mentation 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.

**Fig-12.**  
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**Figure 1-**  
**TSP**  
**Annual**  
**Mean**  
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**2008-**  
**2015**

Region  
TSP  
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were  
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tored

in the cities of Mandaue and Naga from 2011 to 2015 (see Figure 1-12). 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.

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 Monumento, Caloocan City		25	36
		151	150	

**Figure 1-13. TSP Annual Mean Values in Region 7, 2011-2015**

REGION	STATION	PM <sub>10</sub> Annual Mean Values (µg/Ncm)		
		2012	2013	2014
NCR	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	*
	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, ilo-ilo 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

REGION	STATION	PM <sub>10</sub> Annual Mean Values (µg/Ncm)		
		2012	2013	2014
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*
	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

tions (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

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

REGION	Monitoring Method	Station	PM <sub>10</sub> Annual Mean Values (µg/Ncm), 2015
NCR	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
	Continuous	Makati Park, Dr. Jose P. Rizal Extension, East Rembo, Makati City	44*
	Continuous	Pateros Elementary School, Pateros City	52
	Continuous	Pinaglaban 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 <sup>+</sup>
	Continuous	Mariano Marcos State University, Batac, Ilocos Norte	24 <sup>+</sup>
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	Monitoring Method	Station	PM <sub>10</sub> Annual Mean Values (µg/Ncm), 2015
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 <sup>+</sup>
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 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	Approx. 100m from J. P. Laurel Ave., Davao City (Fronting Brgy. Hall)	45*
	Manual	Approx. 800m DMPI main gate, Davao City (Fronting Brgy. Hall)	34

Figure 1-14. TSP Annual Mean Values in Region 11, 2008-2012

Table 1-10: Annual TSP



REGION	Monitoring Method	Station	PM <sub>10</sub> Annual Mean Values (µg/Ncm), 2015
REGION 11	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 <sup>+</sup>
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

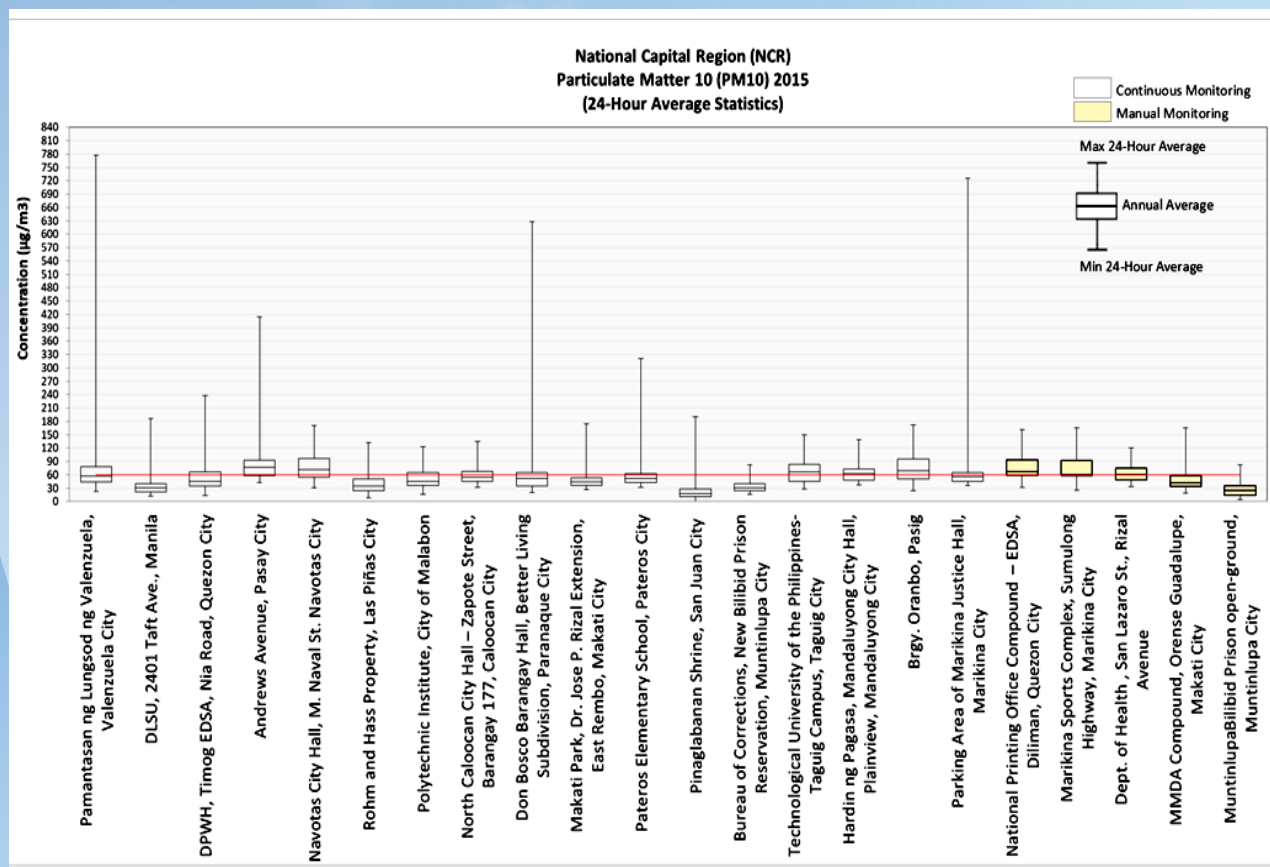
\* < 75% required data capture rate, equipment breakdown or under maintenance.

+ Arithmetic mean

ND – No data

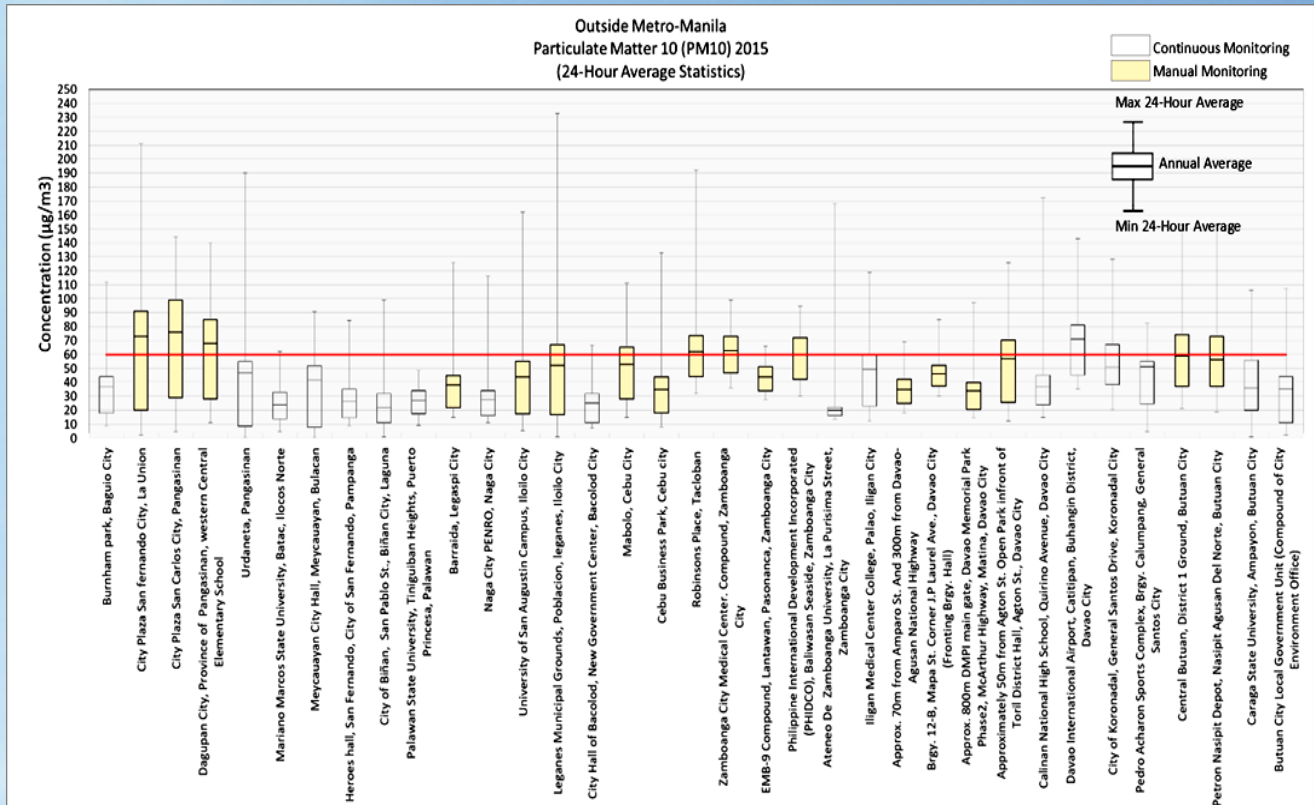
National Ambient Air Quality Guideline Value (NAAQGV): Annual – 60 µg/Ncm

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 1-15. PM<sub>10</sub> (24-Hour Average Statistics) in the National Capital Region, 2012-2015**



**Figure 1-16. PM<sub>10</sub> (24-Hour Average Statistics) Outside Metro Manila, 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  $\mu\text{g}/\text{Ncm}$

**Table 1-8. PM<sub>2.5</sub> Annual levels in NCR Monitoring Stations, 2012-2014**

<b>Stations</b>	<b>2013</b>	<b>2014</b>
<b>Commonwealth Ave. QC</b>		50
<b>DLSU Taft, Manila</b>	21	19
<b>DPWH, Timog EDSA, QC</b>	36	43
<b>PLV, Valenzuela City</b>	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 1-9. Average statistics for SO<sub>2</sub>, NO<sub>2</sub> and O<sub>3</sub> in NCR, 2014**

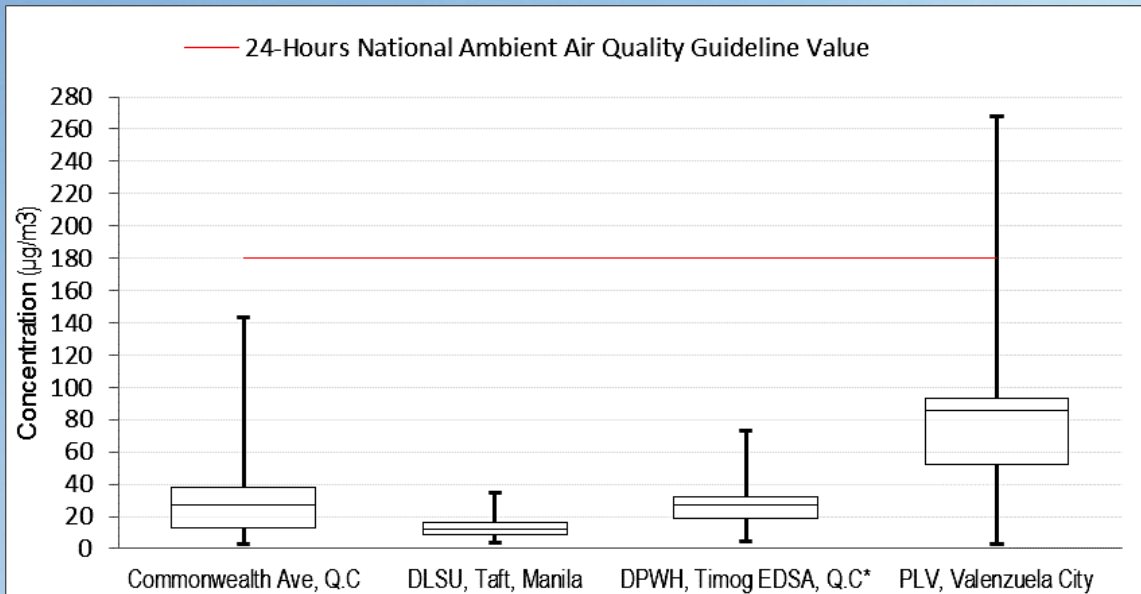
SO <sub>2</sub> 24-Hour Average Statistics	Station			
	Commonwealth Ave. QC	DLSU Taft, Manila	DPWH, Timog EDSA, QC	PLV, Valenzuela City
<b>Min</b>	3	4	5	3
<b>25 Percentile</b>	13	9	19	52
<b>Annual Ave</b>	27	12	27	86
<b>75 Percentile</b>	38	16	32	93
<b>Max</b>	143	35	73	268
<b>NO<sub>2</sub> 24-Hour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

Source: EMB

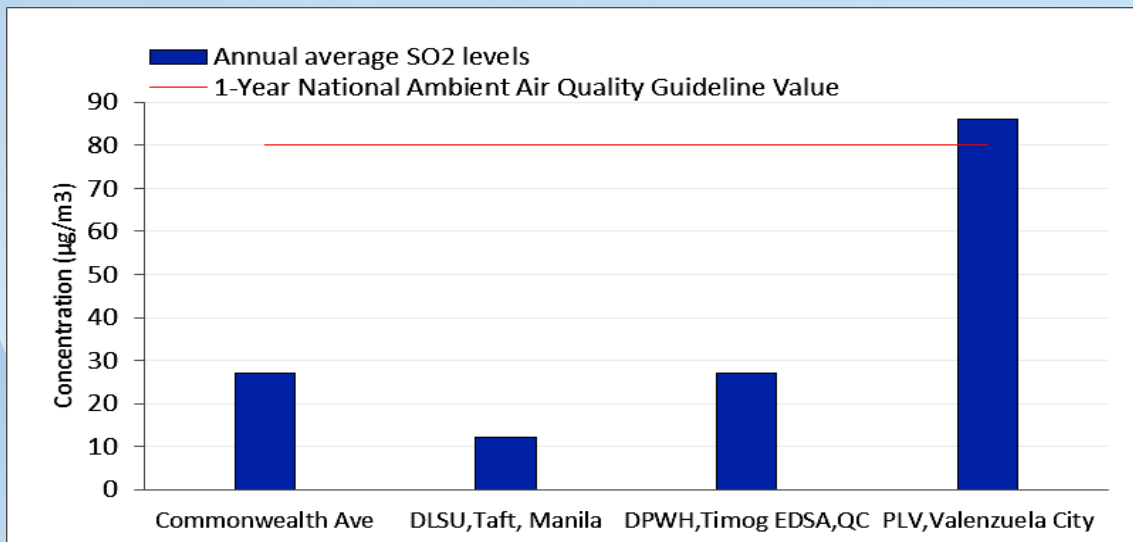
Sulfur dioxide (SO<sub>2</sub>) monitoring in NCR for year 2014

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/Ncm. 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/Ncm

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/Ncm.



**Fig-1-17.** plot 24-hour average levels in 2014



**ure Box of Av-SO<sub>2</sub> in NCR**

Source: EMB

1-

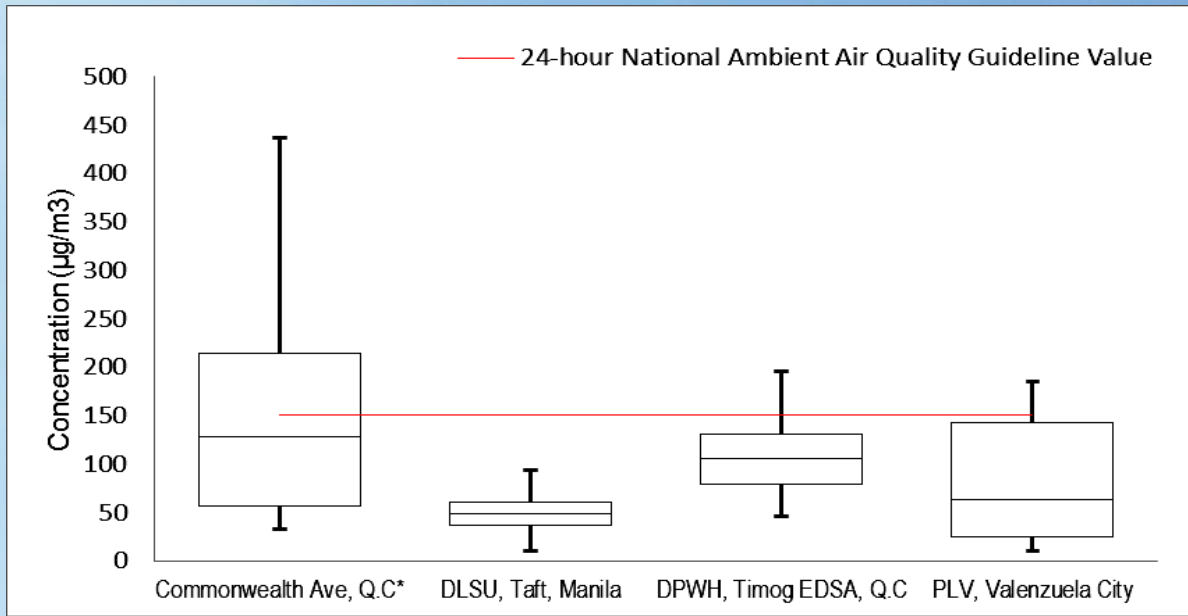


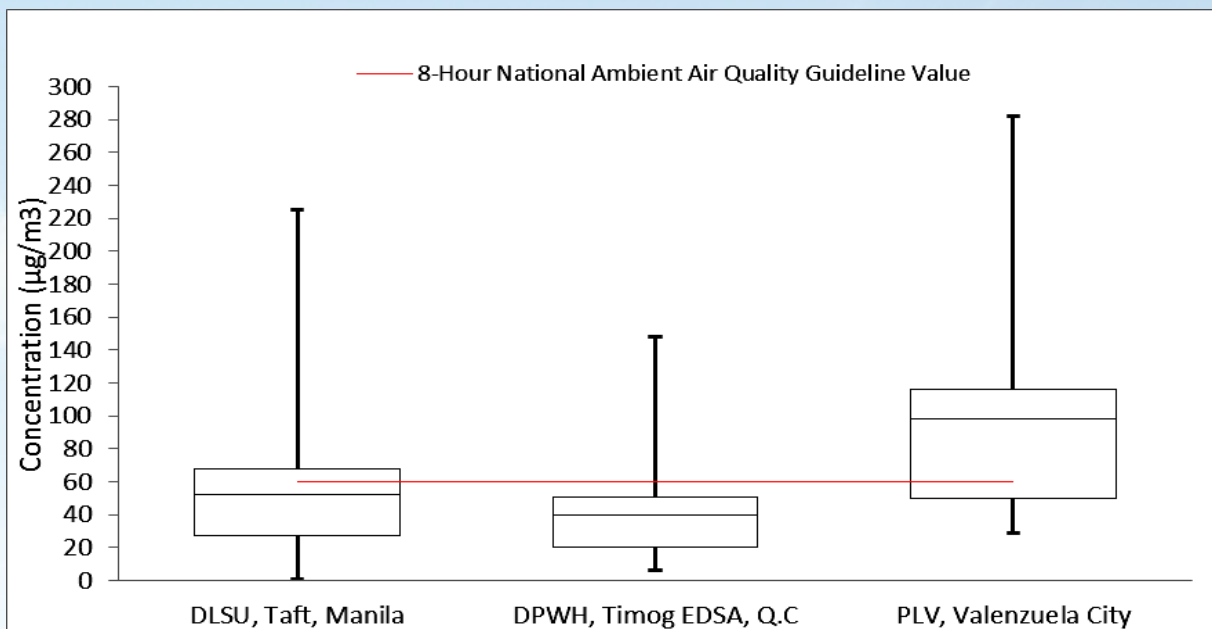
Figure 18. Annual average SO<sub>2</sub> levels in the NCR in 2014

### Annual average SO<sub>2</sub> levels in the NCR in 2014

Source: EMB

### 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 150µg/Ncm. 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.

**Figure 1-19. Box plot of 24-hour Average NO<sub>2</sub> levels in the NCR in 2014**

*Source: EMB*

Ozone (O<sub>3</sub>) 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 µg/m<sup>3</sup>. The PLV Valenzuela station registered average and maximum levels exceeding the guideline value (see Figure 1-19).



## **Figure 1-20. Box plot of 8-hour Average Ozone levels in the NCR in 2014**

Source: *EMB*

### **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 led 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 effect 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 World Health Organization (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. Table 1-9 shows the effects of air pollution attributable to short and long term effects while Table 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 1-10. Health Effects Attributable to Short-term and Long-term Exposure to Air Pollution**

<b>Short-term Exposure</b>	<b>Long-term Exposure</b>
<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>

Also playing important roles 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/Ncm PM<sub>10</sub> levels can reduce morbidity and mortality due to particulate matter pollution. The reduction values are summarized in Table 1-11.

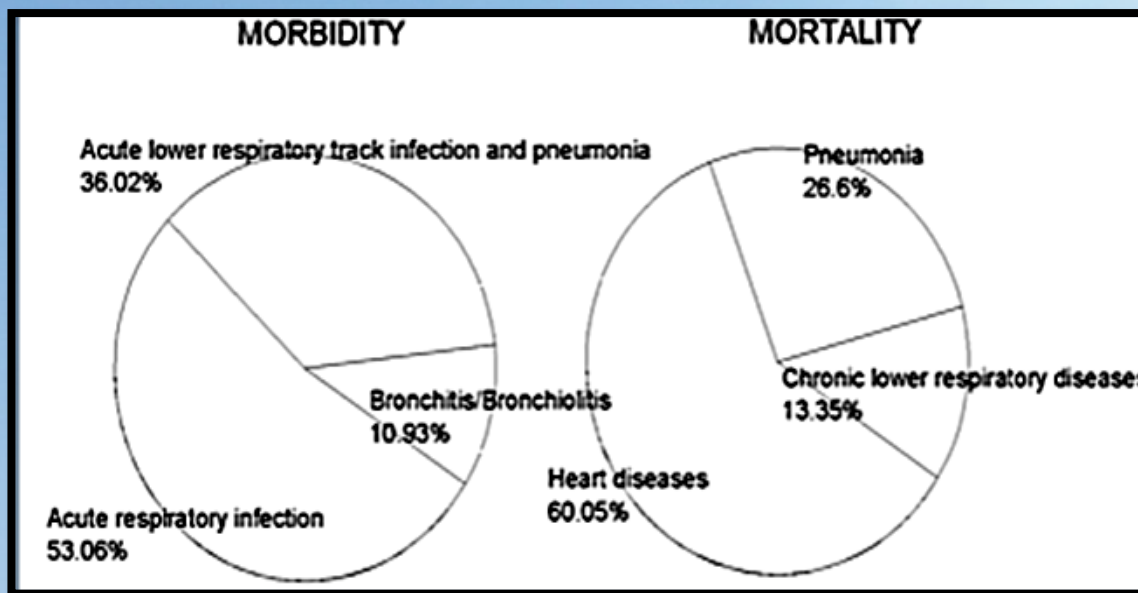
**Table 1-12. Effects of PM<sub>10</sub> Reduction on Air Pollution-related Morbidity and Mortality**

	<b>Effects of a uniform reduction of 10 µg/Ncm of PM<sub>10</sub></b>
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
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.

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.

**Figure 1-21. Leading Causes of Mortality and Morbidity Attributable to Air Pollution, 2010**

*Source: DOH, Philippine Health Statistics, 2010*

The Philippine Cancer Society also reports that lung cancer cases and deaths attributa-

ble 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" 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  $O_3$ ,  $SO_2$ ,  $NO_2$ ,  $H_2S$ ,  $F_2$  and peroxy acyl nitrate,  $NH_3$  and particulate matter. Symptoms of the effects of these pollutants to crops are detailed in Table 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 1-13. Symptoms of Effects of Air Pollutants on Plants**

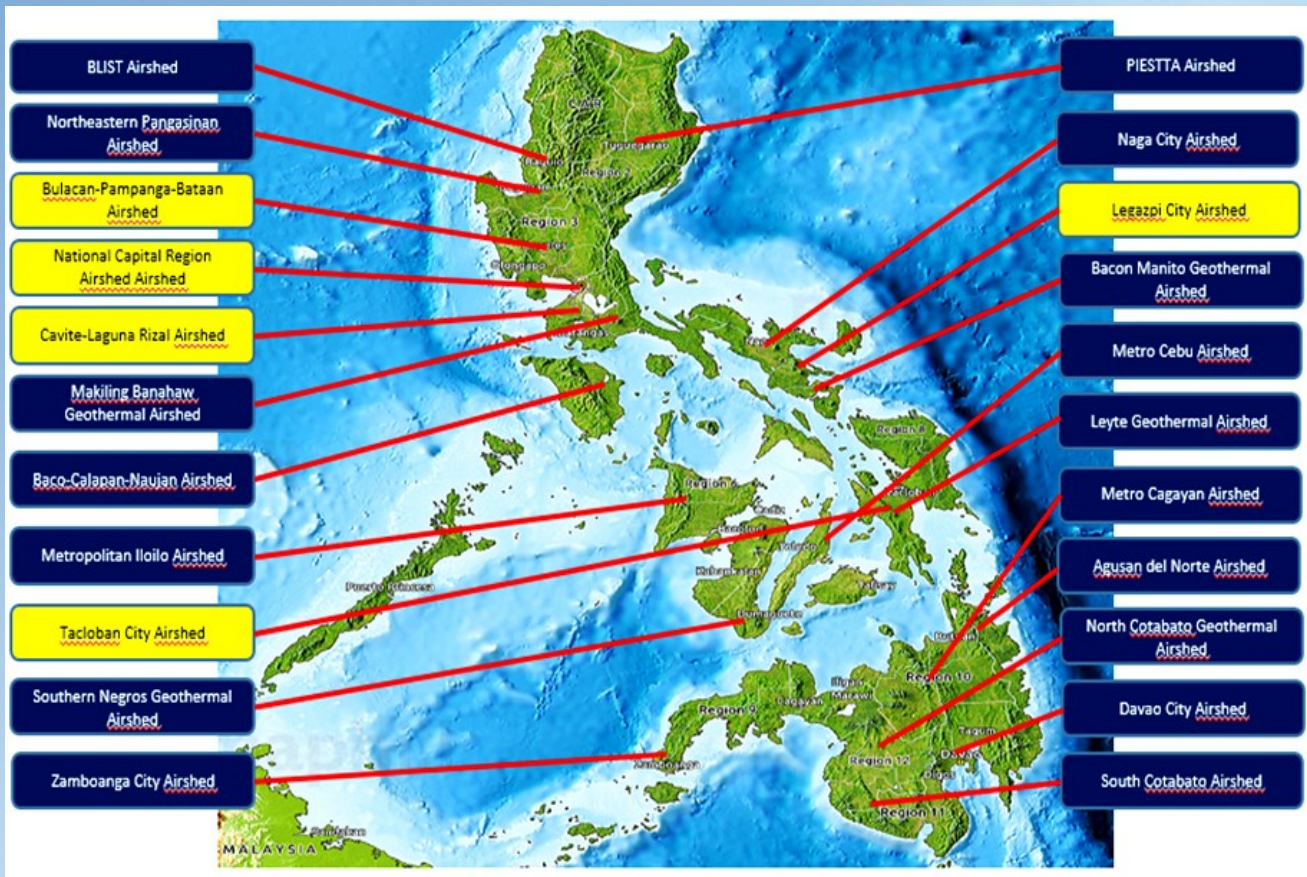
<b>Pollutant</b>	<b>Symptoms</b>
<b>Ozone</b>	flecking, bronzing or bleaching of the leaf tissues
	visible foliar injury
	yield reductions
<b>SO<sub>2</sub></b>	acute injury: lesions
	Chronic injury: yellowing or chlorosis of the leaf, and bronzing (under surface of the leaves)
<b>Fluoride</b>	Lesions
	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 pre-



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, they 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-Environmental Management Bureau**

From the enactment of RA 8749 in 1999 to 2015, the accomplishments of DENR through Environmental Management Bureau 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 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 1-22. Designated Airsheds in the Philippines,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 8749 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 Department of Budget and Management (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 Maintenance and other Operating Expenses 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 and 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 megawatt (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 indus-

tries 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 1-14). 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 1-14. List of Third Party Source Emission Testing Firms,2015**

<b>NO.</b>	<b>FIRM NAME</b>
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	Induframach
13	Omlu-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 and its are issued new motor models/ comply specified limits. This that the complies emission set Clean Air

<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>

to RA 8749 IRR, COCs to all brand vehicle types that with the emission is to ensure vehicle with the standard pursuant to Act.

From 2010 the num-increased

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.

to 2015, ber of COCs from 327 in



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 DENR 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 ASBU of the EMB Central Office, and more than thirty one thousand smoke belching vehicles were apprehended and tested by the Metro Manila

	Gasoline			Diesel
	Benzene (% by volume)	Aromatics (% by volume)	Sulfur (% by volume)	Sulfur (% by volume)
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

ASBU teams (see Table 1-15).

**Table 1-15. Metro Manila ASB Apprehension, 2015**

Source: EMB

The Anti Smoke Belching Program in Metro Manila is carried out through collaboration of

efforts from CAA Implementing Agencies DENR- EMB, DOTr-LTO, and Metro Manila Development Authority (MMDA), and the Local Government Units (LGUs). 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 Office. 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 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 1-16).

**Table 1-16. Garage Testing, 2015**

*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 1-17. Fuel specifications based on different standard levels.**

### Philippine Walkable-Bikeable Communities Awards'-"Bayanihan sa Daan"

The Special Recognition and Launching of the Philippine Walkable-Bikeable Communities Awards'-"Bayanihan sa Daan" was held on November 27, 2014 at the Kalayaan Hall, Malacañan Palace. The recognition aimed to highlight efforts made by local government units and individuals around the country to transform the roads into more walkable and bikeable communities, or pockets of promising and successful initiatives in the Road Sharing Campaign.

This is co-organized by the DENR-EMB with concerned civil society organizations and government offices which include the Office of the President, Office of the Presidential Adviser for Environmental Protection and the Climate Change Commission, and the Departments of Public Works and Highways, Transportation, Interior and Local Government. Among the recognized walkable-bikeable communities LGUs were Cebu, Iloilo, Marikina, Pasig and Vigan City.

### Clean Air Concert, Youth Forum and Exhibits

The first Clean Air Concert was held in 2012, with the theme, "Clean Air? Pwede!" in Emerald Avenue, Pasig City. This was followed by "Ayoko Mag-gas mask" in 2014, at Fairview Terraces Activity Center, Quezon City and "Perwisyong Usok Pigilan, Konting Abala Laking Ginhawa" in 2015.

The Clean Air Concert was organized by the DENR through EMB with the Earth Day Jam Foundation. The concert aimed to promote awareness on the quality of air in Metro Manila, and urge action for the Filipinos, particularly the youth, to combat the ill effects of air pollution, through biking, no smoking, preventive maintenance of vehicles, no burning of garbage and climate change.

### Clean Air Fiesta Caravan

Following the theme "Usok Mo, Buhay Ko," in 2012, Clean Air Fiesta Caravan was held at different communities in Metro Manila to promote awareness on the ill effects of air pollution and actions to help clean the air. The caravan was co-organized by the EMB and the Philippine Medical Association, which featured medical lectures, painting contests and environmental lectures on clean air management.

### Regional Information and Education Campaigns

To alleviate massive deforestation in Cordillera Administrative Region, the website named "GREENITIATIVE" was created to promote social mobilization and consciousness on forest significance. Lectures were also given to officials, students and teachers within



the Baguio, La Trinidad, Itogon, Sabang, Trinidad (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 Technical Education and Skills Development Authority (TESDA), LTO, Department of Health (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 were also organized by the EMB VI and the Metro Iloilo Airshed Governing Board.

## Accomplishments of other government agencies mandated under RA 8749

<b>Government agency</b>	<b>Accomplishments</b>
<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 Special Vehicle Pollution Control Fund (SVPCF) which constitutes 7.5% of the total collection from Motor Vehicle User's Charge (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 Public-Private Partnership (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> </ul>

<b>Government agency</b>	<b>Accomplishments</b>
	<ul style="list-style-type: none"> <li>◆ SVPCF-funded project, 'Public Utility Jeepney Modernization and Conversion Program", which seeks to encourage jeepneys to re-fleet and retrofit their units from diesel-fed engines into electric-LPG powered/or other alternative fuels.</li> <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 status 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" and</li> <li>◆ Digital format: "Wanted: Clean and Fresh air"</li> </ul> </li> </ul>

<b>Government agency</b>	<b>Accomplishments</b>
<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 multi element 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 Unified Vehicular Volume Reduction Program (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 PETCs scheme. As of December 2013, there are 1,168 accredited centers nationwide with 1,417 accredited stationary lanes</li> <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 for conformance to PNS ISO/IEC 17025. To date, there are three (3) laboratories which applied for accreditation.</li> </ul>

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 am-

<b>LGU</b>	<b>Initiatives</b>
<b>Makati City</b>	<ul style="list-style-type: none"> <li>◆ Introduced electric jeepneys and buses as a successful pilot project</li> <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> <li>◆ Declared November 21 as "Smoke-Free Day"</li> <li>◆ Through the Makati Health Department and Department of Environmental Services held an activity dubbed "Tigil Buga para sa Kalusugan"</li> <li>◆ Conducted Bantay Tambutso operations</li> </ul>
<b>Mandaluyong City</b>	<ul style="list-style-type: none"> <li>◆ Upgraded its tricycles in cooperation with PCA and MAFETA</li> <li>◆ Felded 20 e-tricycles as pilot project in partnership with ADB</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 electric 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:               <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> <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> </ul> </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 complement the DOTC, DENR and DTI monitoring of PETC based and operating in its territorial jurisdiction</li> </ul>

LGU	Initiatives
<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</li> <li>◆ Subjects flagged vehicles to their Roadside Inspection, Testing and Monitoring Team's 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" reports are done weekly to inform the public on RITMT operations and ambient air monitoring</li> <li>◆ The City Green Fleet also focuses on the emission testing of the city's red plates</li> <li>◆ Monthly multi-sector meetings of the Clean Air Monitoring Unit 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 and EMB</li> <li>◆ Participated in projects with the BLISTT Governing Board, and Saint Louis University</li> </ul>
<b>Taguig City</b>	<ul style="list-style-type: none"> <li>◆ In 2012, the City Environment and 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> <li>◆ A series of tune-up services were done in various tricycle terminals based on acceptable preventive maintenance procedures</li> </ul>
<b>Iloilo City</b>	<p>Iloilo City Emission Inventory (2011-2014) features:</p> <ul style="list-style-type: none"> <li>• A comprehensive approach (in terms of coverage of sources)</li> <li>• Bottom-up approach (survey-based/primary data collection)</li> <li>• Participatory approach (solicited inputs from key sectors)</li> <li>• Attempt for science-based approach (academic consortium)</li> </ul>

bient air quality monitoring stations were set up in 2014 to augment the manual moni-

LGU	Initiatives
<p><b>Iloilo City</b></p>	<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> <li>◆ Clean Air Plan Development and Implementation (2012-2015)</li> <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 Php 1 Million Grant from DENR <ul style="list-style-type: none"> <li>◆ launched in November 2014</li> </ul> </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> <ul style="list-style-type: none"> <li>◆ Perimeter Boundary Ordinance City Ordinance No. 2004 – 268, December 15, 2004– Authorized the establishment of public utility terminals in each districts of the city</li> <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>- the use of diesel fuel amounting to 11,152 liters/day</li> <li>- the emission of greenhouse gas amounting to 29 tons /day</li> <li>- the emission air pollutants <ul style="list-style-type: none"> <li>- NOx avoided - 111, 969 grams/day</li> <li>- SOx avoided - 2,177.75 grams/day</li> <li>- PM avoided - 12,959.37 grams/day</li> </ul> </li> </ul> </li> </ul>

LGU	Initiatives
<b>Iloilo City</b>	<ul style="list-style-type: none"> <li>◆ Fuel Switching (Energy Efficiency Program) Adopted by the city government in partnership with the International Council for Local Environmental Initiatives (ICLEI) <ul style="list-style-type: none"> <li>- Promoted fuel switching from gasoline to LPG</li> <li>- To date: 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>   <li>◆ Sustainable Transport Initiatives <ul style="list-style-type: none"> <li>Carless Day <ul style="list-style-type: none"> <li>- Promotion of Carless Day in Schools</li> </ul> </li> <li>Bike ways <ul style="list-style-type: none"> <li>- Construction of 6-km long bike lanes along Diversion Road</li> </ul> </li> <li>Walkability <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> </li> </ul> </li> </ul>



**Table 1.20. Initiatives of Civil Society Organizations and Private Sector on Air Quality Management**

CSO	Initiatives
<b>Clean Air Asia</b>	<ul style="list-style-type: none"> <li>Assists in implementing GIZ Transport and Climate Change 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 Ortigas Greenways in partnership with DOTr and Paulo G. Alcazaren and Associates (PGAA) to develop a high-quality, socially inclusive walking corridor in Ortigas Center</li> <li>Supports ADB in introducing and expanding Tutubi bike-sharing systems in the Philippines</li> <li>Conducts fuel economy baseline study together with United Nations Environment Programme 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>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</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 annual Clean Air Forum</li> </ul>
<b>Philippine Medical Association</b>	<ul style="list-style-type: none"> <li>Organized the Clean Air Summit dubbed as "<i>Usok Mo, 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 to reform the nation's transportation system to open the roads to all people and to prioritize less privately-owned vehicles</li> </ul>

## 1.5 Legal and Policy Aspects

Table 1.9 shows laws and legal issuances relevant to the implementation of Clean Air Act of mandated government agencies.

**Table 1.21. Laws and Legal Issuances Relevant to RA 8749**

<b>Laws and Legal Issuances</b>	<b>Title/Description</b>
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 placed 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 (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 bio-fuels
Republic Act 9513 (Implemented by the DOE)	"Renewable Energy Act of 2008" enacted to accelerate development of the country's renewable energy sources
Department of Finance – Bureau of Internal 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

## **1.7 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 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, CNG and 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 focus on controlled use of fireworks in public places. 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 firecrack-

ers 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

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, Department of Science and Technology, other agencies, private sector, the academe, non-government organizations and people's organizations to establish a National Research and Development Program 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, as these 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.

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EMB/DENR CARAGA

## **THE PROJECT TEAM**

Engr. Metodio Turbella  
Director, EMB

Engr. Vizmindia Osorio  
Assistant Director, EMB

### Air Quality Management Section-EMB

Mr. Jerry Capulong  
Engr. Jundy del Socorro  
Engr. Michiko Sibunga  
Mr. Joel Michael Tugano

### EMB Air Quality Management Technical Specialists

Engr. Jean Rosete  
Engr. Teresita Peralta

### Environment Education and Information Division-EMB

Ms. Elenida Basug  
Ms. Karen Pacpaco  
Ms. Cristina Francisco  
Ms. Daneelyn Manguerra  
Mr. Curtiss Lim  
Ms. Amherstia Calma  
Ms. Merva Arapo  
Mr. Emil Xavier Cruz

Mr. Mabini Arevalo, Jr., Editor



**Department of Environment and Natural Resources  
Environmental Management Bureau**

DENR Compound, Visayas Avenue, Quezon City  
Tel. No. (+63) 928-4674 and (+63) 376-5610  
Hotline No. (+63) 376-5541 / [emb\\_ecac@gmail.com](mailto:emb_ecac@gmail.com)  
[www.emb.gov.ph](http://www.emb.gov.ph) / [www.denr.gov.ph](http://www.denr.gov.ph)



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