Key Indicators of Environmental Quality: An Overview of Air Quality in Ireland

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***Abstract**: environmental indicators are usually key statistics and/or numerical values that summarise a given environmental issue (e.g., air pollution), and are also used to measure environmental performance and progress towards sustainable development. It has also played an important role in guiding and managing our world, both theoretically and practically. Such examples of environmental indicators are the atmospheric concentrations of air pollutants in cubic meters of air such as airborne particulate matter and ground-level ozone (a quality indicator). Therefore, changes in a quality of the environment can impact on human health, biodiversity and can have adverse economic consequences for sectors such as the tourism sector. In addition, the environmental performance index, means the resulting of a final performance scores for a variety of individual indicators (e.g., air quality). The aim of the present paper is to give an overview on the air pollution at EU-level in general and Ireland in particular, it serves as an introduction assessing air pollution and gives background on the policies of environmental protection and management (Air Quality Assessment and Management) for a variety of air pollutants. Finally, European air quality policy and management in general, have successfully reduced emissions of many air pollutants, and Ireland's in particular, have significantly reduced emissions of Pb and smoke of coal.*

Keywords: Air pollution, Air Quality, Legislation, Standards Regulations, Directives, Networks

1 Introduction

Air pollution is one of invisible killers that affect the quality of public and environmental health. The most important air pollutants which will be discussed in this review are the particulate matter (PM), sulphur dioxide (SO_2), nitrogen oxides (NO_x), nitrogen dioxide (NO_2), ozone (O_3), lead (Pb), carbon monoxide (CO) and Benzene (C_6H_6). The main effects of air pollution can be summarised as: damage the human and environmental health, increase the acidification and eutrophication in ecosystems, decreased the agricultural crops and yield production, affects the climatic quality, damage to materials and buildings, etc. However, European countries have significantly reduced emissions of many air pollutants (such as SO_2, CO, C_6H_6 and Pb) in recent decades. It was due to considerable successes in European air quality policy and management in reducing air pollution. While, in the cases of, PM, O_3, NO_x and NO_2 are still a significant threat to human and environmental health. Therefore, an air quality is an important issue for public health, the economy and the environment [1]. The environmental quality, quality of life and economic development are interlinked and interdependent. This can be seen as a mutualistic relationship in which the environmental interests of society to maintain and improve the life quality and also, protecting the environment for the new generations. The balance between society and the environment can be changed by economic development and changing lifestyles [2]. In case of Ireland, preliminary totals for the 2006 census show that the Irish population has reached 4.239.848 persons [3]. While, census 2011 results show that the Irish population has continued to grow strongly since census 2006, increasing by 348.404 persons to 4.588.252 persons. This represents an increase of 8.2% over the 5 year period, an annual average increase of 1.6% [4]. This increasing has led to an increase in the level of spending on goods and services, and the possible environmental impact and damage. Moreover, economic and social well-being is closely related to the environment protection [5], therefore, any change in the economic and social fields leading to effects on the environment. Finally, human activities and economic growth, including industrial processes, agricultural activities, transportation, energy consumption and waste management, which are the major sources of air pollution.

2 Air Pollution

It is well known that air pollution is one of the most serious environmental problems. Therefore, increasing pressures on the environment and increased environmental awareness has led to the need to take into account many interactions between all sectors of the economy and the environment. As with natural resources, it is desirable for the costs associated with pollution and environmental degradation (emissions) to be allocated in the accounting structure to the economic sectors responsible for them, in accordance with the accounts' input-output framework. So, the production of goods and services has led to impacts on the natural environment. These impacts are particularly the depletion of resources and the production of waste returned to the environment. Further, pollution occurs when these wastes disturb or alter natural systems, such as air, which are important to human well-being. Furthermore, if the natural environment is understood as a stock of natural capital, and if its uses are considered to be services flowing from this stock, in principle the natural environment of economic activity can be used in the same way as the use of other types of capital (e.g., manufactured capital) and the products it raises. Moreover, there was no dispute about the importance of the natural environment to economic activity. Obviously, its role in resource provision, waste assimilation and in general maintain a habitable world is fundamental [6]. In addition, the environment-economy interactions (transformation processes) in simplified form, as physical flows of natural raw materials and residuals (contaminants/pollutants) between the economy and the natural environment can be seen in Figure (1).

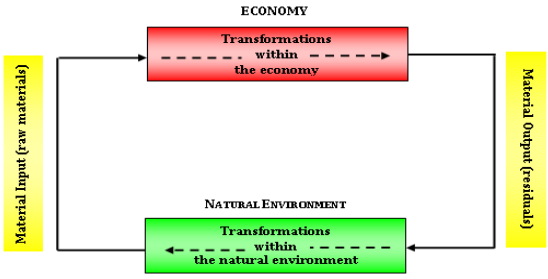

Figure 1

Interrelationships between the Economy and the Natural Environment [6, 7]

So, the main environmental cause of Europe's early death is related to air pollution as recently quantified by several studies. World Health Organisation (WHO) and European Union (EU) estimated that more than 400.000 early deaths/year relate to poor/bad air quality in Europe. Further, air pollution has significant impacts on human health, on ecosystems and buildings, also has a clear impact on climate, which cause climate change. Figure (2) summarise the key effects of the major air pollutants on health, on vegetation and the built environment, and on the world's climate [8]. In Ireland, air quality remains the best in Europe and has shown significant improvement over the decades at local, national and European levels. Generally, Ireland has good air quality due to the Irish's and European's air policies and legislation, e.g., the introduced of the smoky coal ban in Ireland is a good example of a national change that has resulted in significant improvements at local levels. And also, the phase-out of Pb in petrol and the continuous improvement of vehicle emission reduction technologies are examples of European policy changes in improving air quality [9].

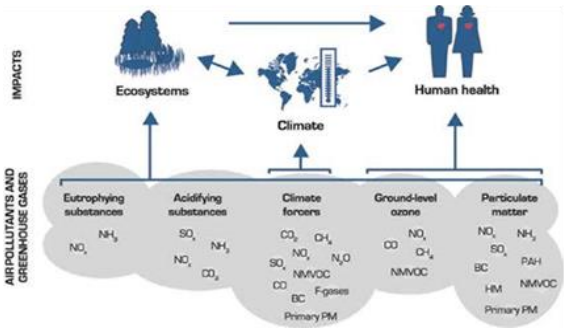

Figure 2

Impacts of Air Pollution [8]

The state of air quality in Ireland for example is examined by comparing air quality monitoring results with air quality standards and limit values for a variety of air pollutants, which impact health and the ecosystem. As stated above, the most important air pollutants are; PM, SO_2, NO_x, NO_2, O_3, Pb, CO and C_6H_6, so, information on the concentrations of these pollutants is necessary to determine compliance with the standards and to formulate policies and strategies to control the emissions concerned of these compounds. Further, fossil fuel combustion is the main source of air pollutants e.g., PM, SO_2, NO_x and CO. Elevated concentrations of PM, SO_2 and NO_2 affect the upper respiratory tract and reducing lung function, while exposure to CO reduces the capacity of the blood to carry O_2 [10]. For more detailed about the main sources of these air pollutants and the adverse effects of each pollutant on health and the environment see in O'Leary [11, 12]. Furthermore, air pollution is emerging as a key threat to human health and the environment. Therefore, as mitigation measures continue to reduce emissions of major pollutants from stationary combustion sources, transport in general, and road transport in particular, has become more important as a major source of air emissions in many countries [13]. The success of controlling/reducing air emissions (pollution control) associated with stationary combustion sources leaves emissions from road traffic (vehicle emissions) as the key threat to air quality in Ireland [14]. In general, air pollution is a complex problem, causes human disease and environmental problems [15]. So, under increasing numbers of population and economic growth, environmental problems are becoming more and more complicated due to excessive use of natural resources [16]. Nevertheless, the state of the Irish environment is generally good, because of proactive policies and large-scale environmental protection investments. This is recognised internationally: the Environmental Performance Index [17] which placed Ireland the 10th out of 133 countries for environmental policies and the 7th in the EU as listed in Table (1).

Table 1

Environmental Performance Index (EPI) Scores (0-100) [17]

Rank	Country	EPI Score	Policy Categories*	Rank	Country	EPI Score	Policy Categories*	Rank	Country	EPI Score	Policy Categories*
1	New Zealand	88.0		47	Unit. Arab Em.	73.2		93	Kenya	56.4	
2	Sweden	87.8		48	Suriname	72.9		94	China	56.2	
3	Finland	87.0		49	Turkey	72.8		95	Azerbaijan	55.7	
4	Czech Rep.	86.0		50	Bulgaria	72.0		96	Papua N. G.	55.5	
5	Unit. Kingdom	85.6		51	Ukraine	71.2		97	Syria	55.3	
6	Austria	85.2		52	Honduras	70.8		98	Zambia	54.4	
7	Denmark	84.2		53	Iran	70.0		99	Viet Nam	54.3	
8	Canada	84.0		54	Dom. Rep.	69.5		100	Cameroon	54.1	
9	Malaysia	83.3		55	Philippines	69.4		101	Swaziland	53.9	
10	Ireland	83.3		56	Nicaragua	69.2		102	Laos	52.9	
11	Portugal	82.9		57	Albania	68.9		103	Togo	52.8	
12	France	82.5		58	Guatemala	68.9		104	Turkmenistan	52.3	
13	Iceland	82.1		59	Saudi Arabia	68.3		105	Uzbekistan	52.3	
14	Japan	81.9		60	Oman	67.9		106	Gambia	52.3	
15	Costa Rica	81.6		61	Thailand	66.8		107	Senegal	52.1	
16	Switzerland	81.4		62	Paraguay	66.4		108	Burundi	51.6	
17	Colombia	80.4		63	Algeria	66.2		109	Liberia	51.0	
18	Norway	80.2		64	Jordan	66.0		110	Cambodia	49.7	
19	Greece	80.2		65	Peru	65.4		111	Sierra Leone	49.5	
20	Australia	80.1		66	Mexico	64.8		112	Congo	49.4	
21	Italy	79.8		67	Sri Lanka	64.6		113	Guinea	49.2	
22	Germany	79.4		68	Morocco	64.1		114	Haiti	48.9	
23	Spain	79.2		69	Armenia	63.8		115	Mongolia	48.8	
24	Taiwan	79.1		70	Kazakhstan	63.5		116	Madagascar	48.5	
25	Slovakia	79.1		71	Bolivia	63.4		117	Tajikistan	48.2	
26	Chile	78.9		72	Ghana	63.1		118	India	47.7	
27	Netherlands	78.7		73	El Salvador	63.0		119	D. R. Congo	46.3	
28	United States	78.5		74	Zimbabwe	63.0		120	Guin.-Bissau	46.1	
29	Cyprus	78.4		75	Moldova	62.9		121	Mozambique	45.7	
30	Argentina	77.7		76	South Africa	62.0		122	Yemen	45.2	
31	Slovenia	77.5		77	Georgia	61.4		123	Nigeria	44.5	
32	Russia	77.5		78	Uganda	60.8		124	Sudan	44.0	
33	Hungary	77.0		79	Indonesia	60.7		125	Bangladesh	43.5	
34	Brazil	77.0		80	Kyrgyzstan	60.5		126	Burkina Faso	43.2	
35	Trin. & Tob.	76.9		81	Nepal	60.2		127	Pakistan	41.1	
36	Lebanon	76.7		82	Tunisia	60.0		128	Angola	39.3	
37	Panama	76.5		83	Tanzania	59.0		129	Ethiopia	36.7	
38	Poland	76.2		84	Benin	58.4		130	Mali	33.9	
39	Belgium	75.9		85	Egypt	57.9		131	Mauritania	32.0	
40	Ecuador	75.5		86	Côte d'Ivoire	57.5		132	Chad	30.5	
41	Cuba	75.3		87	Cen. Afr. Rep.	57.3		133	Niger	25.7	
42	South Korea	75.2		88	Myanmar	57.0					
43	Jamaica	74.7		89	Rwanda	57.0					
44	Venezuela	74.1		90	Romania	56.9					
45	Israel	73.7		91	Malawi	56.5					
46	Gabon	73.2		92	Namibia	56.5					

** This column contains sparklines for each of the 6 EPI policy categories showing the relative strengths & weaknesses for each country.*

Health Biodiv. Energy Water Air Nat. Res.

At European level, the EU Directives set out a European wide approach to the monitoring, assessment and management of air quality. The Directives (Daughter Directives) are included, strict standards for a variety of air pollutants. In Ireland, the Directives were transposed into Irish law with the air quality Standards Regulations 2002 and O_3 in ambient air Regulations 2004. The EPA is the competent authority responsible for implementation of the EU Air Quality Directives in Ireland. The monitoring stations; in the cities are managed by local authorities, while in small towns and rural areas are managed by the EPA. In addition, air pollutants emitted in large cities and in industrialised areas, therefore, this transboundary pollution can be travelled and spread over national borders and over wide distances leading to environmental problems, acidification and eutrophication on ecosystems. Finally, the emissions of transboundary pollutants are controlled/regulated through a range of EU Directives, Regulations and Decisions as well as the United Nations Economic Commission for Europe, Gothenburg Protocol in Sweden on 30 November 1999 [18].

3 Air Quality

In order to improve air quality in Europe, the EU has acted at a number of levels to reduce exposure to air pollution through the EU's legislation and directive, through policies and strategies, through cooperation with organisations responsible for air pollution, through authorities and non-government organisations at national, regional and international level [19].

3.1 Legislation; Standards Regulations and Directives of Air Quality

Environmental pollution is the main challenge facing all countries in the world [16]. So, since the 1970s, a broad range of environmental legislation has been put in place to assess and manage air quality, and also to limit harmful emissions, improve fuel quality and integrate requirements for environmental protection in different sectors. The body of EU environmental law (environment legislation) is the amounts to some 500 directives, standards regulations and decisions. Over this period, the level of environmental protection in most parts of Europe has improved, therefore, emissions of specific pollutants to the air, has generally been decreased significantly. On one hand, these improvements are to a substantial degree a result of the comprehensive environment legislation established at European level, and they are delivering a range of direct environmental, economic and societal benefits. On the other hand, these policy tools have played a significant role in decreasing concentrations of harmful pollutants e.g., SO_2, Pb and C_6H_6 in ambient air quality. Nevertheless, major environmental challenges remain to be done, particularly with airborne pollutants e.g., PM and O_3, which present significant health risks when limits are exceeded [20, 21].
Furthermore, an approach developed at European level is having a major bearing on air quality monitoring, assessment and management in Ireland. Council Directive 96/62/EC [22] on ambient air quality assessment and management (Air Quality Framework Directive) provides the framework for this new approach. The objectives of this Directive are summarised as the followings [10]:

- to define and establish objectives for ambient air quality in the European Countries that will reduce harmful effects on human health and the environment;
- to assess and manage ambient air quality in Member States on the basis of common methods;
- to obtain information on ambient air quality and ensure that it is made available to the public and;
- to maintain and improve ambient air quality [10].

According to EU legislation on air quality, Member States are required to divide their territory into zones for the assessment and management of air quality. The levels of air quality monitoring and reporting are also based on the defined zones according to Council Directive [22]. The zones (A, B, C and D) adopted in Ireland to meet the criteria for air quality assessment and management as described in the Framework Directive and Daughter Directives, so, these zones are shown in Figure (3) and the location (territory) designated of the four air quality zones are as the followings [23]:

1. Zone A: Dublin City and environs;
2. Zone B: Cork City and environs;
3. Zone C: 16 urban areas with population greater than 15.000, and;
4. Zone D: Represents the rural area and the remainder of the country [23].

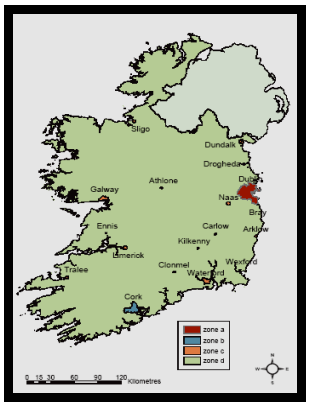

Figure 3

Zones for Air Quality Assessment and Management in Ireland [10]

Air quality in each zone is assessed and classified with respect to Upper Assessment Thresholds (UAT) and Lower Assessment Thresholds (LAT) based on the measurements over the previous five years [18]. Further, McGettigan [24] described the basic principles of the European Commission's assessment and management approach as published by EPA [10]. Therefore, the assessment and management of air quality in zones is undertaken in relation to UAT and LAT, limit values and margins of tolerance, as specified in daughter Directives [25, 26, 27] for different pollutants [10]. The monitoring and assessment in any zone is determined mainly by population size and the air quality status (whether ambient air quality concentrations exceed the UAT, are between the UAT and LAT, or are below the LAT) of the zone. Therefore, the greatest monitoring effort applies where concentrations are above the UAT [10, 18].

In 2006, EPA mentioned that in the absence of significant reduction of NO_x from the road transport sector, which have grown rapidly over the last decades, Ireland is unlikely to meet its commitments under the National Emissions Ceilings (NEC) Directive (2001/81/EC) by 2010 [28]. The strategies to achieve compliance with the EU Directive on NEC have reduced emissions of SO_2, while the emissions of NO_x are expected to remain high in the short term mainly in urban areas. Existing policies and measures are expected to maintain compliance with the ceilings for the other NEC gases [18]. Further, the NEC Directive [29] for certain pollutants sets upper limits for each Member State for the total emissions in 2010 of the main pollutants such as SO_2 and NO_x (42 and 65 Kilotonnes respectively) as upper limits for Ireland's [30]. In generally, transport, industry, power plants, agriculture and households all contribute to Europe's air pollution. The main air pollutant emissions in Europe have declined since 1990, resulting an improved in air quality across the region. However, certain sectors have not sufficiently reduced their emissions in order to meet air quality standards, especially in urban areas [31].

European air pollution is a well-established environmental policy area; over a number of decades, these policies have resulted in decreased emissions of air pollutants [31]. However, air pollution is of concern since it seriously damages human health and the environment. The quality of Europe's air - and Europe's environment more generally - is protected by an extensive body of legislation, which has been informed by a continuously improving knowledge base [32]. In case of Ireland, the Air Quality Standards Regulations [33] transposed the Framework Directive [22] and the first two daughter Directives 1999/30/EC [25] and 2000/69/EC [26], into Irish law and established new air quality standards for PM_{10}, SO_2, NO_x, Pb, CO and C_6H_6 with those of the daughter Directives [10]. Further, in case of O_3 Regulations 2004 [34] transposed the third daughter Directive 2002/3/EC [27] which, dealing with O_3 into Irish law. While, the fourth and final daughter Directive [35] established target values e.g., for cadmium and nickel in ambient air [11, 12, 18]. It was transposed into Irish law by February 2007, and also in ambient air Regulations 2009 (S.I. No. 58 of 2009). As well as, the EU's Sixth Environment Action Programme [36] which set the long-term goal of achieving levels of air quality that do not give rise to significant negative impacts on human health and the environment [37].

The PM_{10}, SO_2, NO_x and Pb are covered in the Directive proposals which summarised by McGettigan [38]. On the other hand, the Clean Air for Europe (CAFE) Program has been running by the European Commission since 2001. It has resulted in a new Air Quality Directive (2008/50/EC); this Directive introduces a limit value for fine particulate matter ($PM_{2.5}$). The estimates presented in the European Commission's proposal for a Clean Air Policy Package show that major engineering companies in the EU already earn up to 40% of their revenues from their environment portfolios [39].

The CAFE Directive [40] was transposed into Irish legislation by the Air Quality Regulations 2011 (S.I. No. 180 of 2011). This Directive (2008/50/EC) requires that Ireland must reduce its average $PM_{2.5}$ background concentration by 10% by 2020. Therefore, the decreasing of $PM_{2.5}$ requires an integrated approach (e.g., National Emissions Reduction Target) across a number of sectors including transport, industrial and residential emissions to meet new standards for $PM_{2.5}$ concentrations by 2020 [9]. According to the European Commission's [41], there are a number of factors for the successful implementation of environmental legislation such as investment in capacity building and networking; review of monitoring systems; investment in the knowledge base; and, investment in information and communication [32].

3.2 Monitoring Networks and Assessment of Air Quality

EEA noted that a clean air is an essential resource vital to human well-being [42]. The mission and goal of these air quality monitoring networks are to meet the Air Quality Standards Regulations for the protection of human health and the environment from hazardous and/or harmful air pollution which is both an environmental and a social problem [31]. In addition, UNEP stated that there is an urgent need to reduce air pollution levels in the world. Despite the fact that air quality measures have shown positive results in

some parts of the world, millions of people in developing and developed countries are dying annually due to long-term exposure to air pollutants [43].
Ireland has a small population and has good air quality, which means that a relatively small number of monitoring stations (e.g., fixed air monitoring stations, mobile monitoring units) are enough across the country (four specified zones; A, B, C and D) for implementation of the EU Air Quality Directives as well as for application of the new Air Quality Standards Regulations [10, 18]. For more detailed about sampling and analysis methods carried out by the mobile units for measurements of air pollutant concentrations (e.g., PM, SO_2, NO_x and Pb) see in McGovern and McGettigan [44].

Airborne Particulate Matter: includes dust, dirt, smoke and aerosols. So, PM is classified according to its aerodynamic size (PM_{10} and $PM_{2.5}$), mainly due to the different health effects associated with particles of different diameters. It is generally accepted that measurements of these particle fractions are better indicators of suspended particulate matter in air, as it affects human health, than those provided by the currently used black smoke or total suspended particulates methods [38].
Ireland's emissions of $PM_{2.5}$ varied between 10.000 and 11.400 tonnes between 1990 and 2007. Emissions have subsequently decreased by 22% to 7.800 tonnes in 2012 [45]. While in case of PM_{10} concentrations in 2004 were significantly lower than in 2003 in Ireland [46]. In general, the highest levels of particulate matter are located in areas which affected by heavy traffic, mainly in urban areas. Therefore, the pollutant of particulate matter needs to be closely monitored and management plans to reduce this pollutant where it is occurs. More recently, in 2012 EPA [47] reported that the mean concentrations of PM_{10} at all stations across Ireland were below the annual limit value of 40 $\mu g/m^3$. On the other hand, the CAFE Directive introduced mandatory monitoring of $PM_{2.5}$. So, levels in Ireland are below both the stage one and stage two limit values of 25 $\mu g/m^3$ and 20 $\mu g/m^3$ in 2012 [47]. Additionally, $PM_{2.5}$ levels in Ireland are below the EU limit value, however, due to the calculation of the average exposure indicator and the national exposure reduction target, Ireland is obliged to decrease its average $PM_{2.5}$ concentrations by 10% by 2020 [47]. Overall, EEA [48] stated that between 2000 and 2013, emissions of PM_{10} and $PM_{2.5}$ in the EU-28 fell by approximately 19% and 18% respectively [48].

Sulphur Dioxide: SO_2 is formed primarily from the combustion of sulphur-containing fossil fuels (mainly coal and oil), which will effects human health and the environment. O'Dwyer [49] mentioned that there were no concentrations recorded of SO_2 more than the daily limit value of 125 $\mu g/m^3$ or the hourly limit value of 350 $\mu g/m^3$ as specified in 1999/30/EC Directive [25] at any station in Ireland in 2010 [49]. According to Lehane and O'Leary [50], Ireland achieved the emission ceiling of 42 Kilotonnes in 2009 due to the large decrease in SO_2 emissions in recent years [50]. Generally, SO_x emissions at EU-28 decreased by 87% in the period from 1990 to 2013 [48].

Nitrogen Oxides: Nitrogen emissions can have adverse impacts on the sensitive ecosystem due to acidification and eutrophication caused by N contamination in the air and water bodies [42]. So, the European Communities Directive 85/203/EEC [51] on Air Quality Standards for NO_2 sets a limit value 200 $\mu g/m^3$ should not exceed no more than 175 hours in a full year. This has been adopted as the Irish air quality standard [52]. The NO_2 was in compliance with EU Standards in 2007, and the annual average values recorded at all locations did not exceed the annual limit value of 40 $\mu g/m^3$ this limit value set by the 2002 Standards Regulations on Air Quality for human health protection [18]. More recently, in 2013, NO_2 values were below the annual limit value for all monitoring sites in Ireland [53]. Normally, high levels of NO_x across in urban areas, while in rural areas NO_x levels are low, mainly due to emissions from road traffic. In addition, the EU emissions from transport, energy and then industry are the main sectors which are responsible for NO_x emissions. So, in case of transport sector reduced emissions of NO_x by 39% between 1990 and 2009 while in cases of energy and industry sectors it decreased by 51% and 40% respectively. This is due to the European's air policies and legislation such as the EU Air Quality Directives [42].

Ozone Depletion: O_3 is formed by reactions between NO_x, VOCs, and CO gases in the presence of sunlight and heat. Road transport and industrial are the main sources of O_3 precursors [42]. O_3 is a transboundary pollutant whose impacts mainly affect central and southern Europe during summer season [28]. In Ireland, the recorded of O_3 levels are normally low [10] as specified in Council Directive 92/72/EEC [54]. In general, the concentrations of O_3 are strongly influenced by meteorological conditions [47]. All the exceedances occurred during the month of July and also, by a combination of transboundary pollution [12]. Additionally, at most European sites, the rate of O_3 increase has slowed over the last decade, so at present O_3 is decreasing at some European sites, particularly in summer months [8]. However, EU emissions of the air pollutants responsible for hazard and/or harmful build-up of O_3 level

have declined significantly in the period 1990-2009 [42]. Finally, industrial emissions and vehicle emissions are an example of the major sources of NO_x and VOCs, which are responsible for forming hazard and/or harmful ground-level O_3. The problem of O_3 pollution requires international cooperation through more mitigating efforts at the national and international level [31].

Lead: Pb is emitted as a result from petrol emissions in the air. Nowadays Pb levels are very low in Ireland [49] as defined in Council Directives 82/883/EEC [55] and 1999/30/EC [25] on a limit value for Pb in ambient air. So, there was a clear drop in Pb in Member States, according to the removal of Pb from the petrol, between 1990 and 2013, emissions of Pb in the EU-28 reduced by 92% [48]. Nevertheless, the reason for these reductions is mainly due to the phasing out of leaded petrol and/or introduction of unleaded petrol.

Carbon Monoxide: The Directive (2000/69/EC) on CO [26] specifies a limit value of 10 mg/m^3, which is applied to the maximum daily 8-hour mean concentration. The CO levels are low in Ireland [12]. Moreover, between 1990 and 2013, CO emissions decreased in the EU-28 by approximately 66% [48].

Benzene: Is one of the biggest pollution sources in the air due to the C_6H_6 combustion process. On one hand, Daughter Directive [26] specifies a C_6H_6 limit value of 5 $\mu g/m^3$ based on the annual mean concentration. On the other hand, in 2013, C_6H_6 concentrations were not exceeded the limit value at any station in Ireland [53].

Here we can conclude that, Ireland has good air quality and remains the best in Europe. In general, from the above mentioned overviews of air quality assessment, including PM_{10} and $PM_{2.5}$, SO_2, NO_x, O_3, CO, Pb and C_6H_6 were all below the limit and target values set out in different Directives. However, levels of NO_2 and $PM_{2.5}$ in Ireland are remains of concern in some areas subject to transport, industrial and residential emissions. Overall, energy, transport, industry, power plants and agriculture contribute to Europe's air pollution. Transport in general, and road transport in particular, remains a main contributor to poor air quality levels in cities (air quality problems) and health effects. As well as the promotion of diesel vehicles is contributing to air quality problems [20]. The increasing of diesel vehicles in European cities remains the main cause of high NO_2 and PM concentration in urban areas [56]. So, road transport, and particularly diesel vehicles, is a major source of NO_x and PM in EU cities [57]. Therefore, changes in the transport system, e.g., technological solutions (such as catalytic converters), promote the use of renewable sources (such as bio-fuels) and behavioural change are needed to reduce its harmful effects [20].

4 Conclusion

Air pollution is the most widespread form of pollution that affects at local, regional and global levels. Generally, air, water and soil are the three main environmental compartments which are essential for the life on the Earth, therefore, in case of air, many of air pollutants can cause a variety of serious environmental impacts (i.e. acidification and eutrophication) reduce the quality of public health and climate. However, since the late 1970s, one of the main environmental policy concerns in Europe's is air pollution [58].

EPA concluded that under the growing pressure from human activities and economic progress, the Irish environment remains with good quality and thus represents one of Ireland's most important assets. High environmental quality is an important for good quality of Ireland's life and supports the country's attractiveness to tourism, investment that is suitable for the modern economy. Emissions of pollutants from road traffic are one of the main factors that reduced the air quality in Ireland especially in urban areas.

Finally, as we know that air pollution reduced the environmental quality and human health especially by increasing the respiratory diseases, and highly impact on climate through the climatic changes, therefore, the effective action to control or reduce the negative effects of air pollution on our biosphere needs much to understand the major sources that cause air pollution, as well as formulate and apply strategic policies to control or reduce the emissions of air pollutants, also, exchanging information and the up-to-date knowledge of the local, regional and global air quality status and its effect on living and non-living factors.

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