Project cofinancé parle Fonds Européen de Développement Régional

Project co-finnaced by the European Regional Development Fund

WP3.2 – REPORT FROM GENOA REGION

THE CURRENT REPORT IS A COLLABORATION OF

UNIVERSITY OF WESTERN MACEDONIA

Scientific Group

Dr Eng John Bartzis – Professor of UOWM, Dr Dikaia Saraga, Katerina F. Filiou

PROVINCE OF GENOA

C. Brescianini, M.T. Zannetti

UNIVERSITY OF GENOA – DEPARTMENT OF PHYSICS

M.C. Bove, P. Brotto, F. Cassola, E. Cuccia, D. Massabò, A. Mazzino, P. Prati

L'Europe en Méditerranée
Europe in the Mediterranean

Projet cofinancé par le Fonds Européen de Développement Régional
Project co-financed by the European Regional Development Fund

ACKNOWLEDGEMENTS

For the composition of Genoa's region report, the scientific team of University of Western Macedonia would like to express acknowledgments to the APICE partners coming from Province of Genoa and Department of Physics – University of Genoa, for their excellent collaboration and their kind response to any required data.

SUMMARY

University of West Macedonia redacted five reports for each region which participates in APICE project: Barcelona, Marseille, Venice, Genoa and Thessaloniki. In each report, there is a brief presentation of each region and port area. An analysis of the air quality in each area for the last years follows and the interest is focused on PM10. Meteorological conditions influence is also examined. With the scope of the study of the port's contribution to the air quality of each city, these reports prepare the next steps of an inter-comparison campaign and an air long monitoring campaign for a source apportionment study as also for modeling activities and socio-economic trends. The present report refers to the port of Genoa.

L'Europe en Méditerranée
Europe in the Mediterranean
Project confinancé parle Fonds Européen de Développement Régional
Project co-finiaced by the European Regional Development Fund

CONTENTS

CONTENTS OF FIGURES

Project confinancé parle Fonds Européen de Développement Régional
Project co-financed by the European Regional Development Fund

CONTENTS OF TABLES

1. INTRODUCTION

The current report has been redacted in lines of APICE program (Common Mediterranean strategy and local practical Actions for the mitigation of Port, Industries and Cities Emissions). APICE project develops its actions within 5 study areas of 4 MED space Countries belonging to the regions of Veneto and Liguria (Italy), Provence-Alpes-Côte d'Azur (France), Cataluña (Spain) and Central Macedonia (Greece) and involve some of the most important port-cities of Mediterranean space. The project areas show common features related to the port-areas systems (in terms of harbor-industrial district organization) and present the same problems of air-pollution affecting seriously not only the populated urban centers but also the whole natural ecosystems and the cultural heritage (the project territories count several Sites of Community Importance & Special Protection Areas in their surroundings, as well as UNESCO sites).

The report includes a description of the air quality and meteorology network in Genoa region. Furthermore, a brief analysis of the air quality during the last years is included. The interest is focused on the Port of Genoa, the first harbor in Italy and in Mediterranean Basin. PM10 particles monthly, daily and hourly variation was examined for the year 2009. A discussion about PM10 limit values excesses as well as the effect of meteorological parameters to PM10 levels is also included. Finally, a description of the national and international framework follows.

2. PARTNERS PRESENTATION

PROVINCE OF GENOA - Environment and Energy Direction

"Comune di Genova" or Genova Municipality is the entity responsible for the management of a territory 243 sq. km located in Northern Italy, at the Northern edge of the Tirrenian Sea. Genoa also is the capital town of the Provincia of Genoa, which has a surface of 1.838 sq. km and a population of 875.732 (Dec 2004 estimate) and of the Liguria Region, 5.421 sq. km and a population of 1.592.309. Genoa Municipality is organized under divisions, project units and task forces, all dealing with administration and regulation purposes. Moreover, it has a strong share participation in AMGA, the formerly municipal gas and water Distribution Company, involved in the capillary methane distribution in the city; this cooperates in giving a sound experience in clean-energy related matters.

UNIVERSITY OF GENOA, Department of Physics

The **University of Genoa** (*Università degli Studi di Genova*) is one of the largest universities in Italy. Located in Liguria on the Italian Riviera, the university was founded in 1471. It currently has about 40,000 students, 1,800 teaching and research staff and about 1,580 administrative staff. The University of Genoa is organized in several independent campuses located in different city areas. Notable buildings are the main University premises (Via Balbi, 5) designed by the architect Bartolomeo Bianco and built in 1640, the new complex in Valletta Puggia, built in the 80s and 90s and hosting the Departments of Chemistry, Computer Science, Mathematics, and Physics, and the new seat of Facoltà di Economia, realized in 1996 by refurbishing old seaport docks.

3. PORT PRESENTATION

GENERAL INFORMATION

The Port of Genoa is an Italian seaport on the Mediterranean Sea. With a trade volume of 58.6 million tones it is the first port of Italy, the second in terms of twenty-foot equivalent units after the port of transshipment of Gioia Tauro, with a trade volume of 1.86 million TEUs.

The Port of Genoa covers an area of about 500 hectares of land and the same area on water, and it extends for 20 kilometers along the coastline, with 47 km of maritime ways and 30 km of operative quays. There are 4 main entrances:

- the Eastern inlet, affording access to the old port, to the shipyards, and to the terminals of Sampierdarena
- the Western (Cornigliano) inlet, used mostly by ships operating at the ILVA quays
- the Multedo entrance, for ships operating in the oil terminals and to the Fincantieri shipyards
- the Voltri entrance, at the western end of the port, for ships operating at the Voltri Terminal Europe

The quays of the passenger terminals extend over an area of 250 thousand square meters, with 5 equipped berths for cruise vessels and 13 for ferries, for an annual capacity of 4 million ferry passengers, 1.5 million cars and 250,000 trucks.[The historical maritime station of Ponte dei Mille is today a technologically advanced cruise terminal, with facilities designed after the world's most modern airports, in order to ensure fast embarking and disembarking of latest generation ships carrying thousand passengers. A third cruise terminal is currently under construction in the redesigned area of Ponte Parodi, once a quay used for grain traffic. Finally, there are two major lighthouses: the historical Lanterna, 76 meters tall and the small lighthouse of Punta Vagno, at the eastern entrance of the port.

Projet cofinancé par le Fonds Européen de Développement Régional
Project co-financed by the European Regional Development Fund

Besides the container and the passenger terminals, the shipyards and the other industrial and cargo facilities, in the port area there are also several marinas, where many sailboats and yachts are moored.

- The marina of the Exhibition centre.
- The marina Duca degli Abruzzi, home of the Yacht Club Italiano
- The marina Molo Vecchio, in the area of the old harbor
- The marina Porto antico
- The marina Genova Aeroporto

Located on the shores of the Ligurian Sea, the Port of Genoa is the hub of Italy's Riviera and the capital of the Genova province and the Liguria region. The Port of Genoa is just over 50 nautical miles northwest of the Port of La Spezia in Italy and 100 nautical miles northeast of the Port of Cannes in France. The city covers the western slope of the Apennine Mountains and a narrow coastal plain along the sea. In 2004, over 600 thousand people called the Port of Genoa home. With a long maritime history, the Port of Genoa enjoys a wonderful climate. Tourism is its most important economic sector, but it was an important industrial center in the past. Today, the old factories have converted into other businesses that include banking, insurance, communications, commerce, and services. Having been one of the four Sea Republics in ancient Italy, the Port of Genoa was tremendously powerful and wealthy. It seaport has long been the foundation for the city's economy. In 2004, Genoa was selected as one of two European Capitals of Culture by the European Union.

The Port of Genoa serves Italy's most industrialized area in the north, and it is ideally located to serve central Europe's consumer markets. Over seven thousand ships call at the Port of Genoa each year, and the port offers a wide range of specialized services to support any type of ship or cargo. From its birth, the Port of Genoa has been Italy's gateway to the Mediterranean and to international cultures that make it one of the modern world's most interesting tourist destinations. In 2007, the Port of Genoa handled a total of 58.6 million tons of cargo carried on more than 7800 vessels. Over 3.2 million passengers visited the Port of Genoa in 2007, including 2.7 million ferry passengers and over 520 thousand cruise passengers. Cargoes handled by the Port of Genoa in 2007 included 29.7 million tons of general cargo (18.8 million tons of that in 1.8 million TEUs of containerized cargo), 21.5 million tons of liquid bulk (including 20.5 million tons of mineral oils), almost 6 million tons of solid bulk, and 1.5 million tons of bunkers and supplies. Cargoes in 2007 included almost 40 million tons of imports and 18.7 million tons of exports. The single largest cargo category was general cargo (27.5 million tons), and crude oil made a significant portion (15 million tons) of cargo handled by the Port of Genoa in 2007. Other major cargo categories included hydrocarbons (3.9 million tons), energy derivatives (1.9 million tons), vehicles (1.2 million tons), and coal (881.6 thousand tons). Other cargoes over 100 thousand tons handled by the

L'Europe en Méditerranée
Europe in the Mediterranean
Projet cofinancé par le Fonds Européen de Développement Régional
Project co-financed by the European Regional Development Fund

Port of Genoa included chemical products, vegetable oils and animal fat, ferrous minerals, coke, non-ferrous metals, cement and lime, scrap and blast furnace powder, fresh and frozen vegetables and fruit, cellulose and waste, cereals, and pig iron.

PORT MANAGEMENT

In Italy the port management is regulated by the Law 84/1994, which has defined a new public body: the Port Authority. The institutional tasks of Port Authority are defined in the article 6 of the Law 84/1994, and can be resumed as follows:

- *Guidance, planning, coordination, promotion and monitoring of economic activities that concern the port;*
- *Management of port services of general interest;*
- *Maintenance of common parts.*

The Port Authority of Genoa has adopted in 1999 the “Port Plan”, a master plan that fixes the trend for a 10-year development of the port itself. Unfortunately this document is getting old and no updating is foreseen in short times. Nevertheless, the Port Authority of Genoa, in accordance with other local and national authorities, has recently undertaken several activities oriented to the sustainable development of the port.

1) Genoa Port Authority belongs to the network “EcoPorts Foundation (EPF)” (among the APICE partners also the ports of Marseille, Barcelona and Thessaloniki belong to this network). The foundation is a nonprofit organization established in 1999 by a group of 8 large European ports for the benefit of ports and port communities. As reported in the mission declaration of EPF, the primary purpose of Ecoport is to act as network platform. This enables European Port Communities to exchange environmentally effective solutions, and work together in collaborative projects addressing sustainability issues in ports and related to the logistic chain. Ecoport has identified a list of “top-ten environmental issues”, for which port managers are seeking concrete, practical and cost-effective solutions. Of course, air quality is in the top-ten list.

2) Genoa Port Authority, in collaboration with the Province of Genoa, is elaborating the Energetic Port Plan, which in an analysis of the energetic needs of the port. The plan contains an estimation of the potential of energy saving and an estimation of the potential of energy production from renewable sources in the port area. The document will be ready within the end of 2010.

3) The Ministry of Economic Development, Liguria Region and Port Authority will fund the electrification of the quays of the industrial sector of the port. The final design of the project is ready, and its implementation is foreseen in 2014.

4) Trialing in the use of "white diesel" in the vehicles in the port area and in the ships. Some companies operating in the port of Genoa are using this fuel, mainly due to its economic convenience.

4. MONITORING NETWORKS

4.1 AIR QUALITY NETWORK

The air monitoring network of the Province of Genoa dates back to 1993, but since the middle of 80's, campaigns for air pollution's monitoring had been carried out.

In the present configuration, the network consists of:

- 12 fixed stations in the municipality of Genoa
- 7 fixed stations in the remaining part of the Province

In addition, 3 mobile stations are used for yearly monitoring campaigns.

STATIONS

Table 1 is presenting the composition of the monitoring network, with the classification of each fixed station and the relevant pollutants measured, according to the definitions of Ministerial Decree 60/2002.

Figure 1 is showing the position of the fixed stations respectively in the Municipalities of Genoa and in the rest of the Province.

Table 1: List of the fixed stations of the air monitoring network of Genoa: the classification ("type of station") follows the definitions of the Ministerial Decree 60/2002. The yellow-highlighted stations are taken as reference for the evaluation of the compliance to air quality standards.

	STATION NAME	POSITION	TYPE OF STATION	MONITORED POLLUTANTS	NOTES
MUNICIPALITY OF GENOA	GE - Acquasola	Genoa - City centre	Background – Urban – Park/Sports complex/School	SO_2, CO, O_3, NO_X	Ozone network
	GE - Corso Buenos Aires	Genoa - City centre	Traffic – Urban – Residential/Commercial	CO, NO_X, C_6H_6, PM_{10} Teom	
	GE - Corso Firenze	Genoa - City centre	Background - Urban – Residential/Commercial	SO2, CO, O3, NO_X, PM_{10} grav., Metals	Ozone network
	GE - Quarto SE.Di.	Genoa - City centre	Background – Urban – Park/Sports complex/School	SO_2, CO, O_3, NO_X, C_6H_6, PM_{10} grav, $PM_{2.5}$ grav Metals, Meteo, B(a)P	Ozone network
	GE - Via Buozzi	Genoa - City centre	Traffic – Urban – Residential/Commercial	SO_2, CO, NO_X, C_6H_6, $PM_{2.5}$ grav.	
	GE - Corso Europa	Genoa - East part	Traffic – Urban – Residential/Commercial	CO, NO_X, C_6H_6, PM_{10} grav., Metals	
	GE - Gavette	Genoa - East part	Background - Urban – Residential/Commercial	CO, NO_X, PM_{10} Teom.	

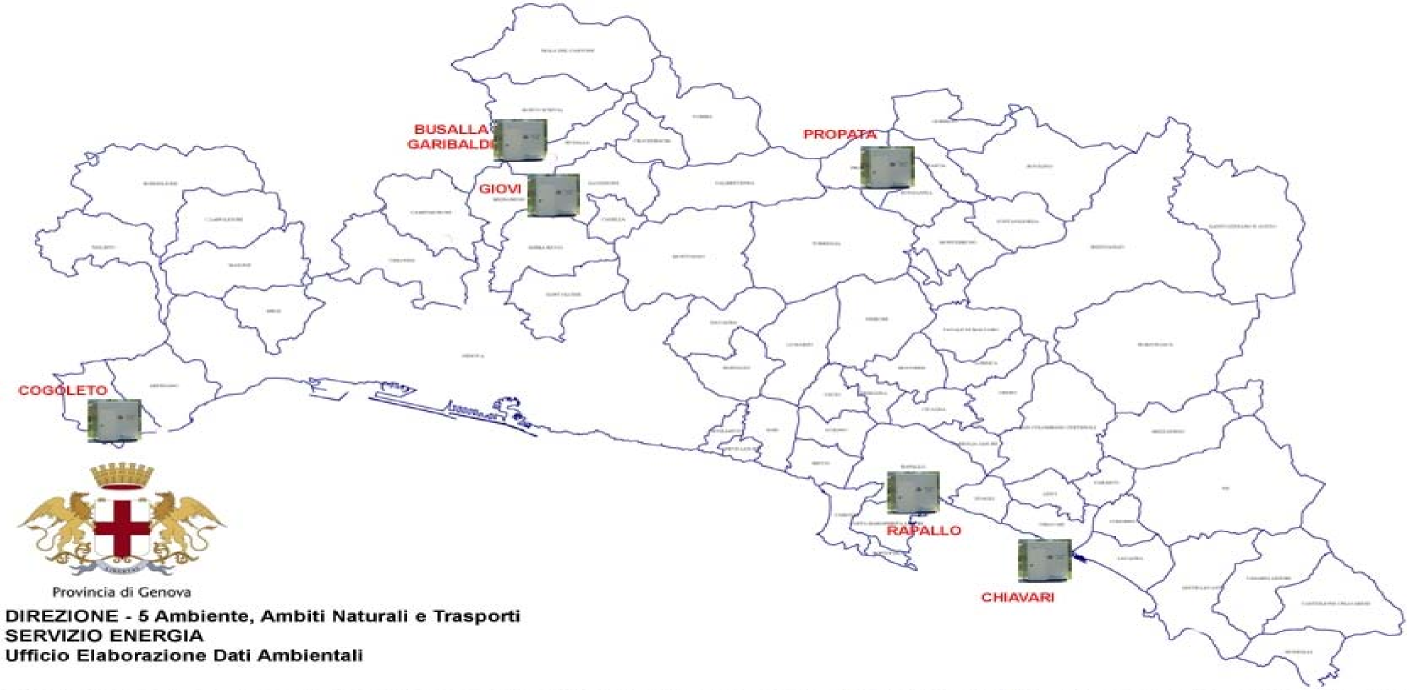
Projet confinancé par le Fonds Européen de Développement Régional
Project co-financed by the European Regional Development Fund

	STATION NAME	POSITION	TYPE OF STATION	MONITORED POLLUTANTS	NOTES
	GE - Multedo	Genoa – West part	Traffic – Urban – Residential/Commercial	SO_2, CO, NO_X, Meteo	
	GE - Pegli	Genoa – West part	Background – Urban – Park/Sports complex/School	SO_2, CO, O_3, NO_X	Ozone network Operative in 2011
	GE - Piazza Masnata	Genoa – West part	Traffic – Urban – Residential/Commercial	CO, NO_X	
	GE - Via Pastorino	Genoa – West part	Traffic – Urban – Residential/Commercial	CO, NO_X	
	GE – Via Puccini	Genoa – West part	Traffic – Urban – Residential/Commercial	CO, NOx	

L'Europe en Méditerranée / Europe in the Mediterranean
Project confinancé par le Fonds Européen de Développement Régional
Project co-financed by the European Regional Development Fund

OTHER MUNICIPALITIES	Chiavari - Assarotti	City of Chiavari	Traffic - Suburban – Residential/Commercial	CO, NO_X, PM_{10} Teom	
	Cogoleto - Gioventù	City of Cogoleto	Traffic - Suburban – Residential/Commercial	CO, NO_X, C_6H_6, PM_{10} Teom	
	Rapallo – Macera	City of Rapallo	Traffic - Suburban – Residential/Commercial	CO, NO_X, C_6H_6	
	Rossiglione	City of Rossiglione	Traffic - Suburban – Residential/Commercial	CO, NO_X, PM_{10} Teom	Operative in 2011
	Busalla - Garibaldi	City of Busalla	Traffic - Suburban – Residential/Commercial	SO_2, CO, NO_X, C_6H_6, B(a)P, Meteo	
	Mignanego - Giovi	City of Mignanego	Background – Ecosystem Protection	O_3, NO_X, PM_{10} grav., Meteo	Ozone network
	Propata	City of Propata	Rural	SO2, CO, O3, NO_X, PM_{10} grav., PM2,5	Ozone network

www.apice-project.eu



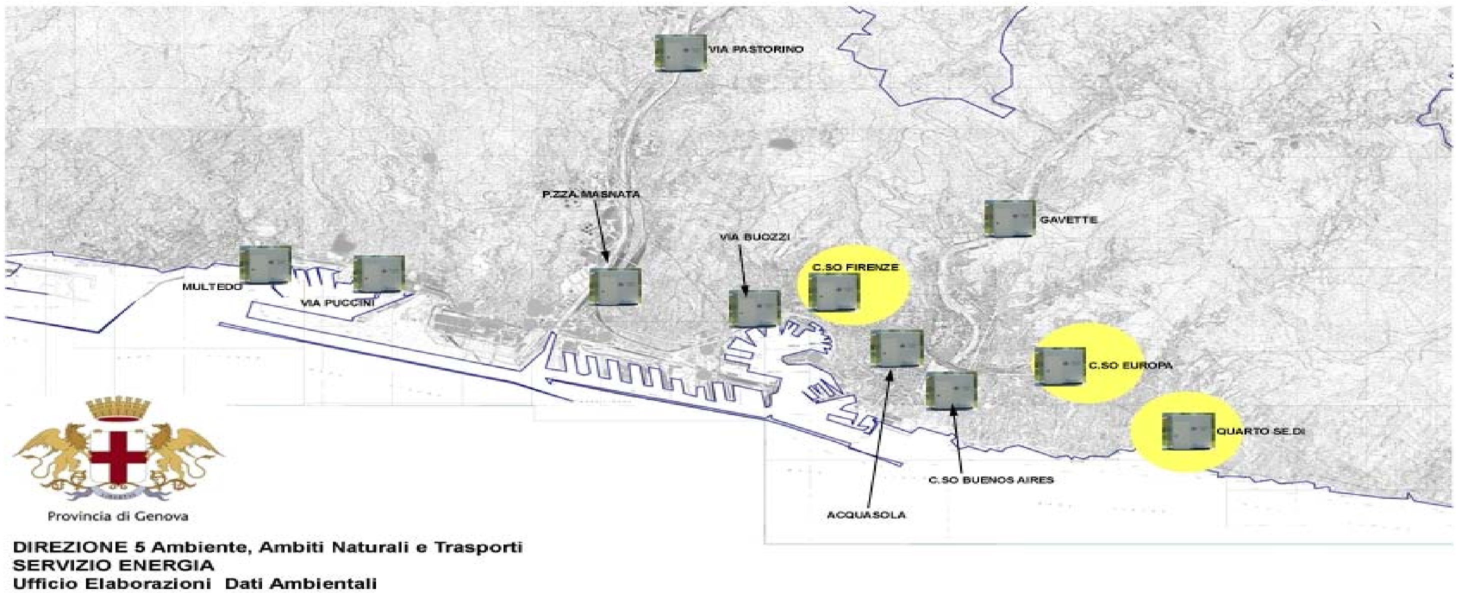


Figure 1: Position of the stations outside the Municipality of Genoa -

Position of the stations inside the Municipality of Genoa

L'Europe en Méditerranée
Europe in the Mediterranean
Project confinancé par le Fonds Européen de Développement Régional
Project co-financed by the European Regional Development Fund

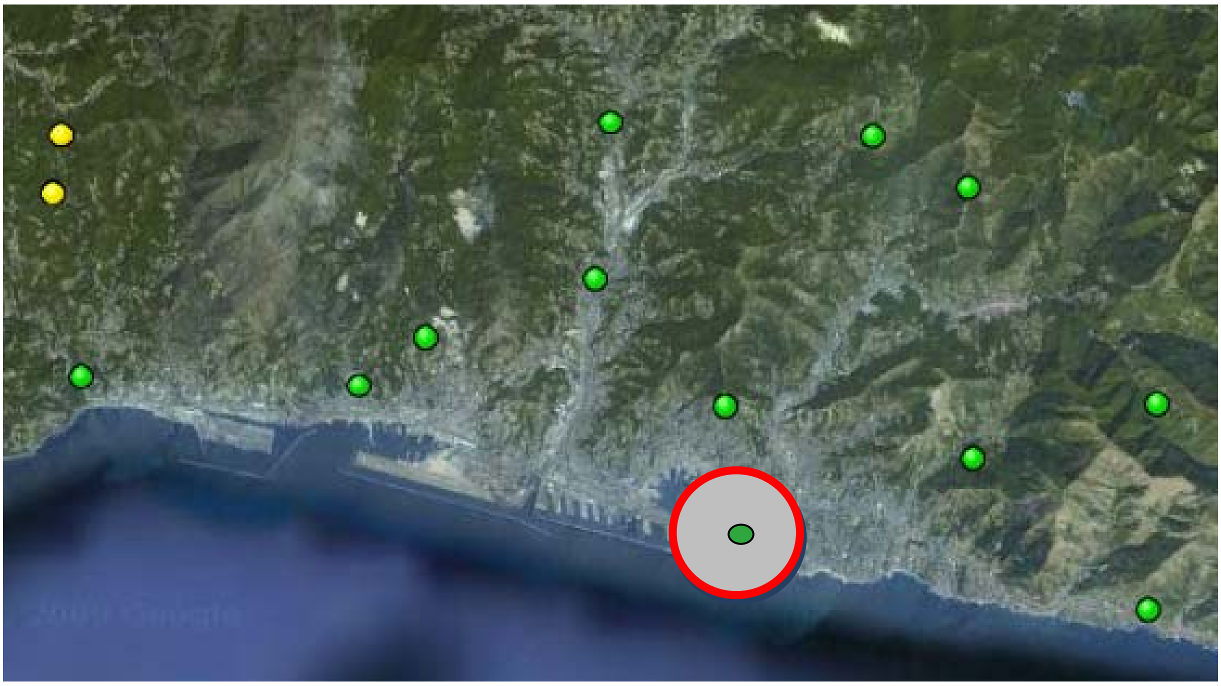


Figure 2: Satellite image of the city of Genoa and its surroundings. Green dots present locations where the meteorological stations are situated

Project confinancé parle Fonds Européen de Développement Régional
Project co-financed by the European Regional Development Fund

4.2 METEOROLOGY NETWORK

The observed meteorological data available for the area of Genoa are provided by the network of the Meteo-Hydrological Observatory of Liguria (OMIRL), consisting of more than 200 stations throughout the territory of Liguria Region and managed by the Regional Agency for Environmental Protection (ARPAL). On the stations belonging to this network, sensors are currently installed for the measurement of the following parameters:

- temperature
- total precipitation
- wind intensity
- wind direction
- relative humidity
- pressure
- Solar radiation.

STATIONS

The variety of the sensors that the stations are equipped with depends on the interest of a particular site. Most of the stations are thermo-pluviometric ones, while complete stations constitute a small subset. Data are recorded at the maximum possible temporal resolution, depending on the station type and the parameter: from a minimum of 5 min for precipitation and wind to a maximum of 30 min for temperature, humidity, pressure and radiation.

In Figure 2 we report a satellite image of the city of Genoa and its surroundings where we have marked the position of the meteorological stations.

Project cofinancé par le Fonds Européen de Développement Régional
Project co-financed by the European Regional Development Fund

MEASUREMENTS

5.1 POLLUTANTS

Temporal trends for PM, NO_x, SO_2, O_3, CO and some other pollutants are available for most of the stations on an hourly basis. Here the yearly records of NO_2 (*Figure 3*), CO (*Figure 4*), SO_2 *(Figure 5*) O_3 (*Figure 6*) and PM10 (*Figure 7*) in the three reference stations (see *Table 1*) stations are reported:

- Quarto (example of Background – Urban – Park)
- Corso Europa (example of Traffic – Urban – Residential)
- Corso Firenze. (example of Background - Urban – Residential/Commercial)

For the period 1993-2009, the annual NO_2 levels exceeded the legal limit value in both Firenze and Europe stations. At Quarto station, the limit was exceeded only in 1999 and 2008. For the same period, annual CO levels exceeded the limit value of 10mg/m^3 at Europa station in years 1993-2000, 2004-2005. Concerning SO_2, the limit value of 125mg/m^3 was not exceeded during the period 1993-2009 (data available from Firenze and Quarto stations). For the same stations, O_3 limit value for citizens' information (180µg/m^3) was exceeded during almost all years (Figures 3-6).

Regarding PM10 concentration, the annual limit of 40µg/m3 was exceeded during 2006 at Europa station. During all the other years, the annual levels remained lower than the limit at the three stations (Figure 7). Figure 8 presents the daily variation of PM2.5 and PM10 during the period *from May 2009 to May 2010*. PM composition has been measured since 1997 in several sites, mainly in collaboration with the Department of Physics of the University of Genoa. Some examples are given in *Figures 8-10* for the years 2009-2010. *V and Ni elements are usually considered as tracers of heavy oil combustion and therefore of ship emissions. The annual series show higher values during summer when the passenger traffic in the harbor of Genoa has a relevant increase.*

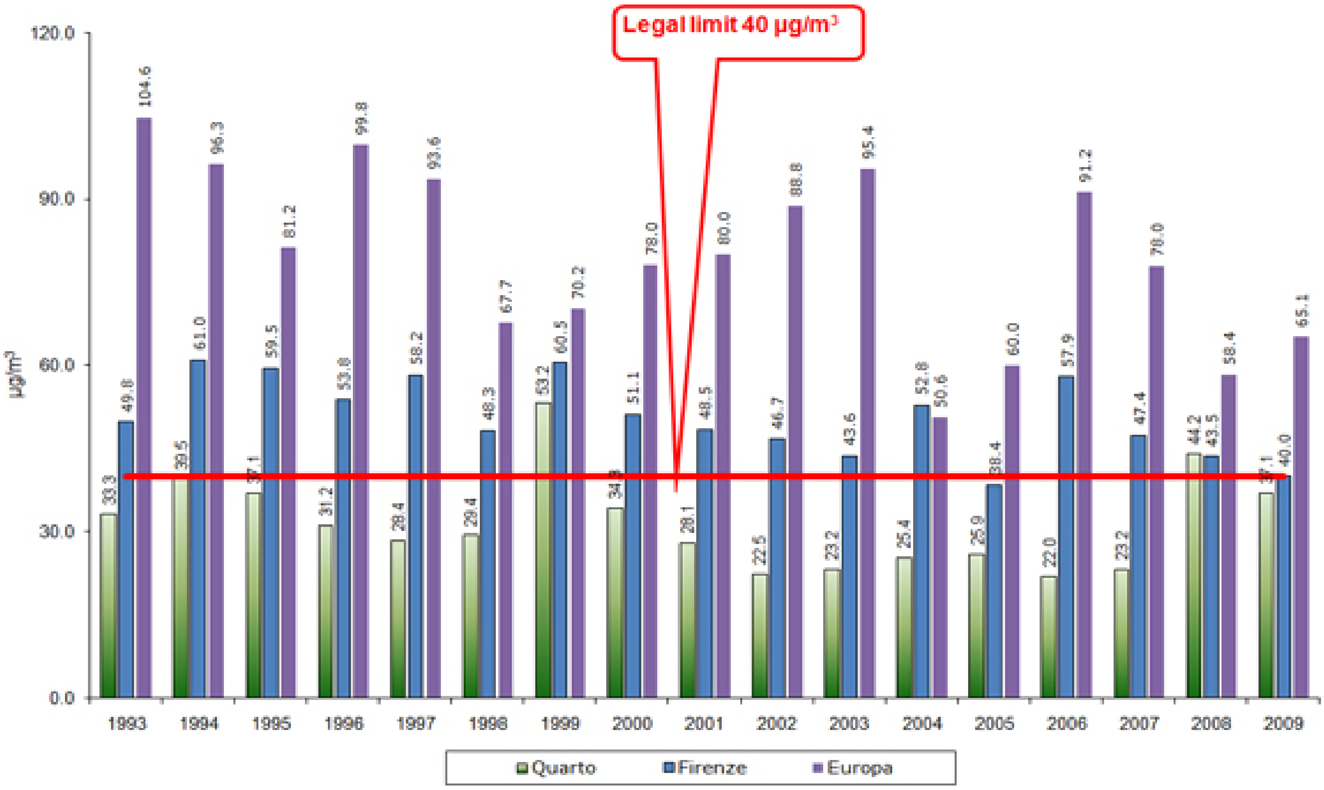


Figure 3: Trend of NO_2 concentration (annual average) measured at the stations of Quarto, Corso Europa and Corso Firenze.

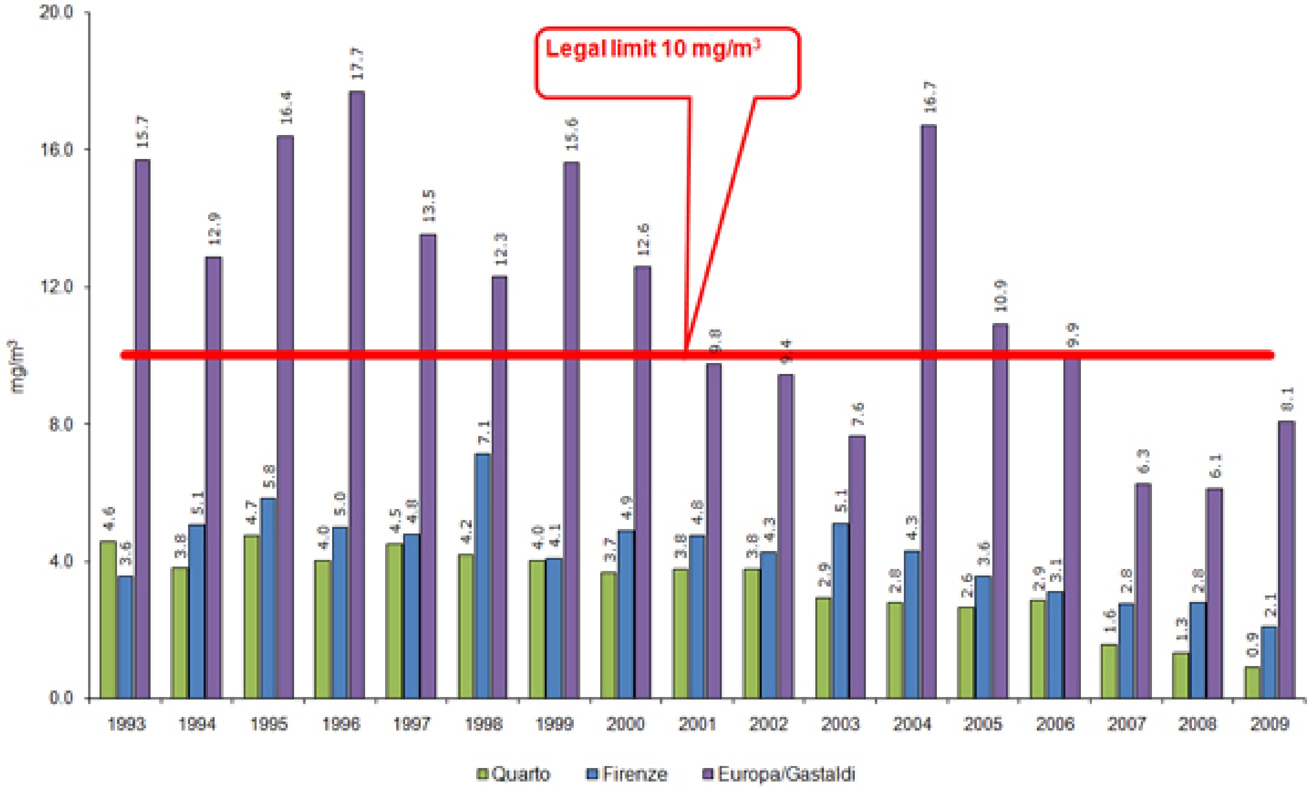


Figure 4: Trend of CO concentration (maximum of 8-hour mean value) measured at the stations of Quarto, Corso Europa and Corso Firenze.

Project cofinancé parle Fonds Européen de Développement Régional
Project co-financed by the European Regional Development Fund

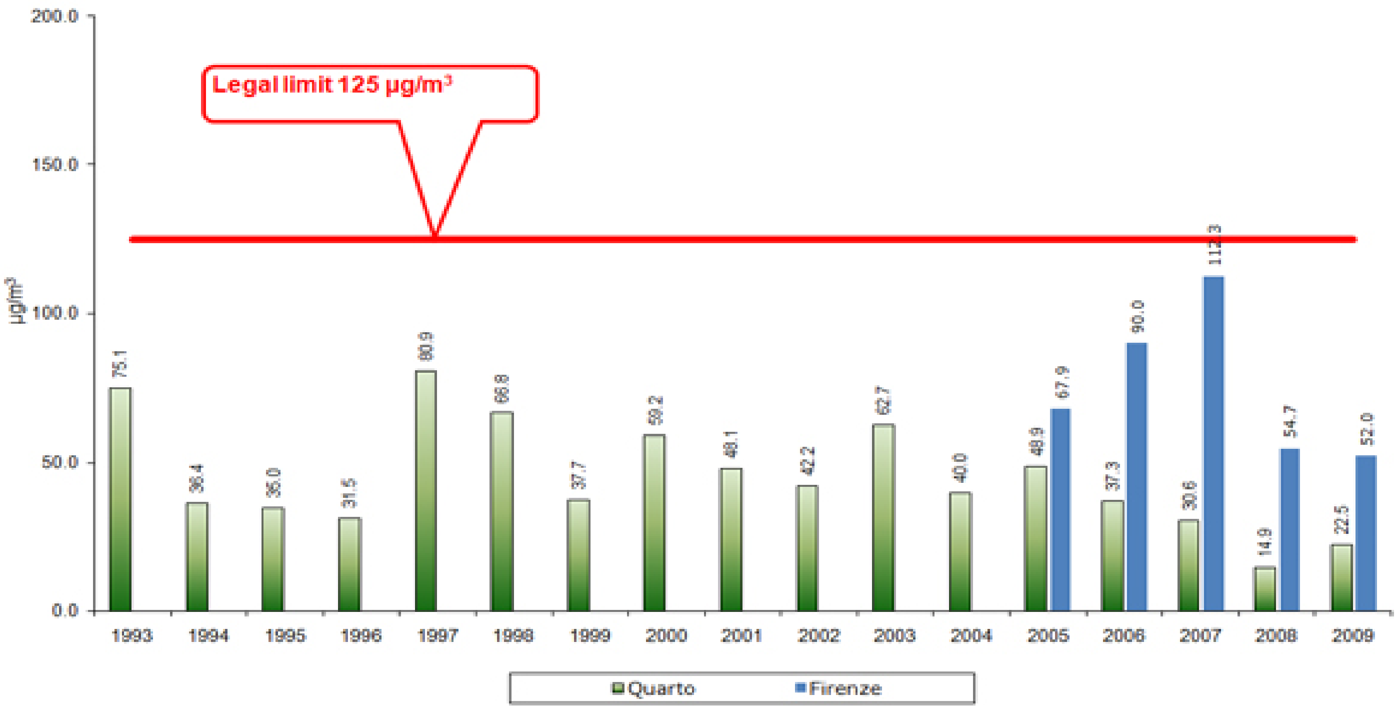


Figure 5: Trend of SO_2 concentration (daily maximum) measured at the stations of Quarto and Corso Firenze.

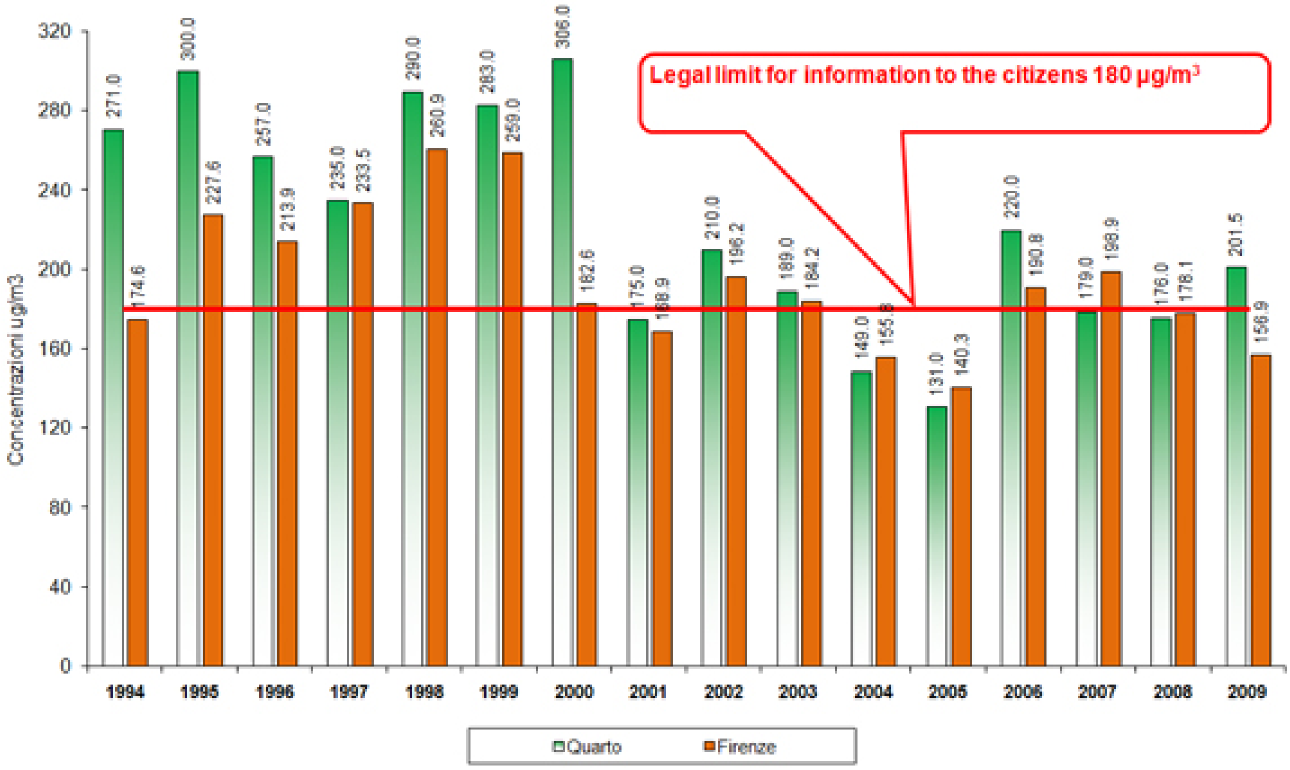


Figure 6: Trend of O_3 concentration (annual maximum) measured at the stations of Quarto and Corso Firenze

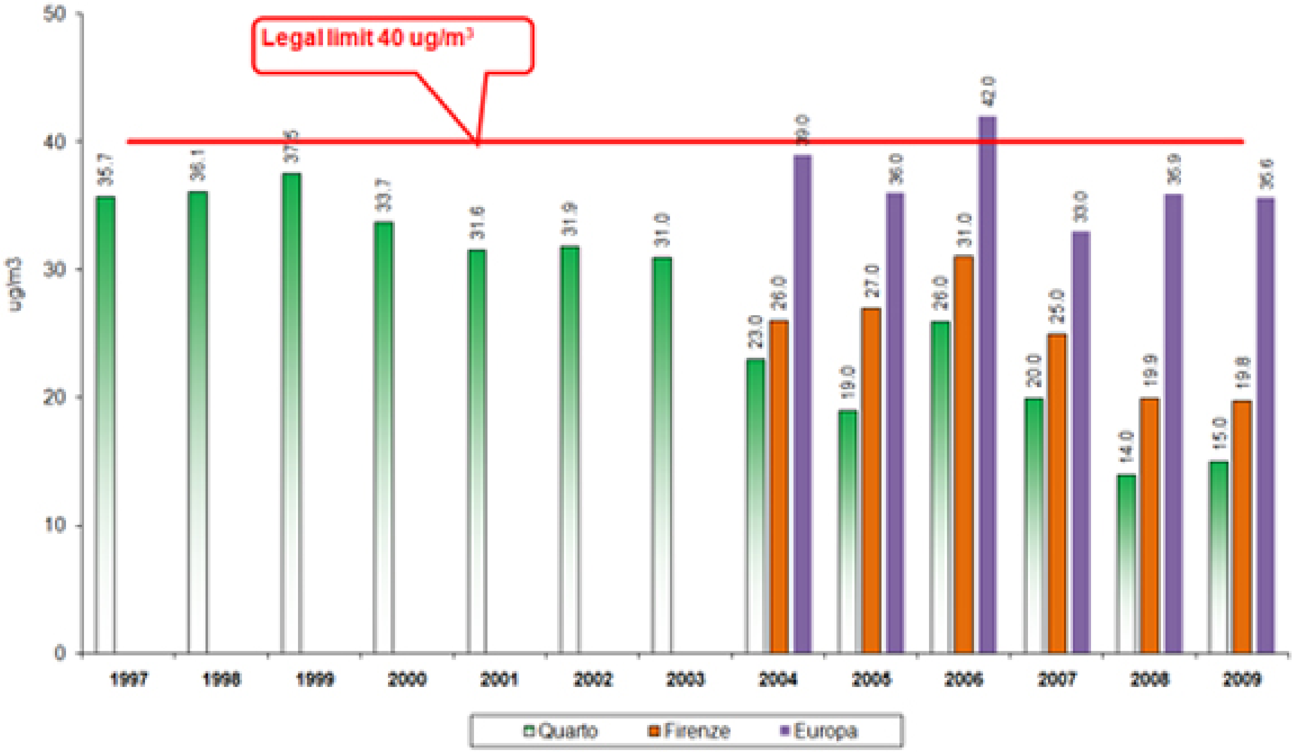


Figure 7: Trend of PM_{10} concentration (annual average) measured at the stations of Quarto, Corso Europa and Corso Firenze

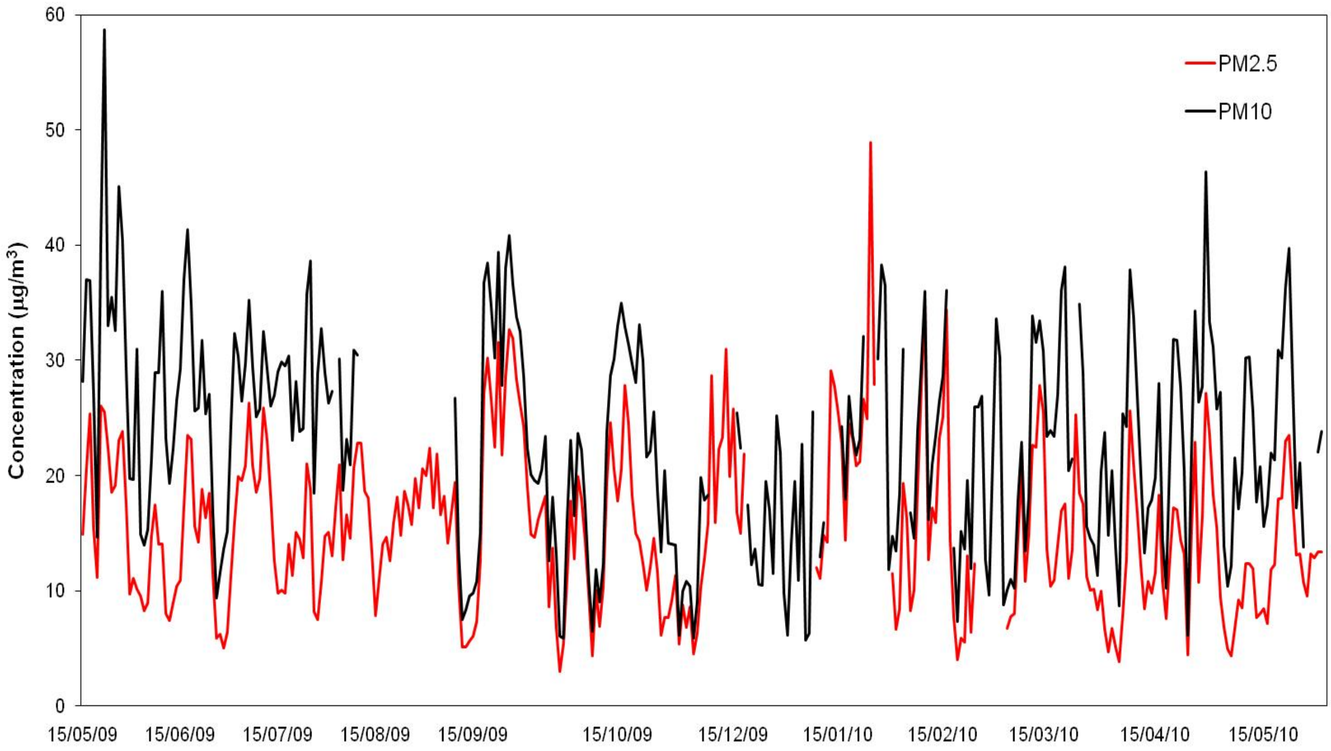


Figure 8: Trend of $PM_{2.5}$ and PM_{10} levels measured from May 2009 to May 2010 in the urban background site of Corso Firenze – Genoa. The $PM_{2.5}$ to PM_{10} mean ratio is about 0.65.

L'Europe en Méditerranée
Europe in the Mediterranean
Projet confinancé par le Fonds Européen de Développement Régional
Project co-financed by the European Regional Development Fund

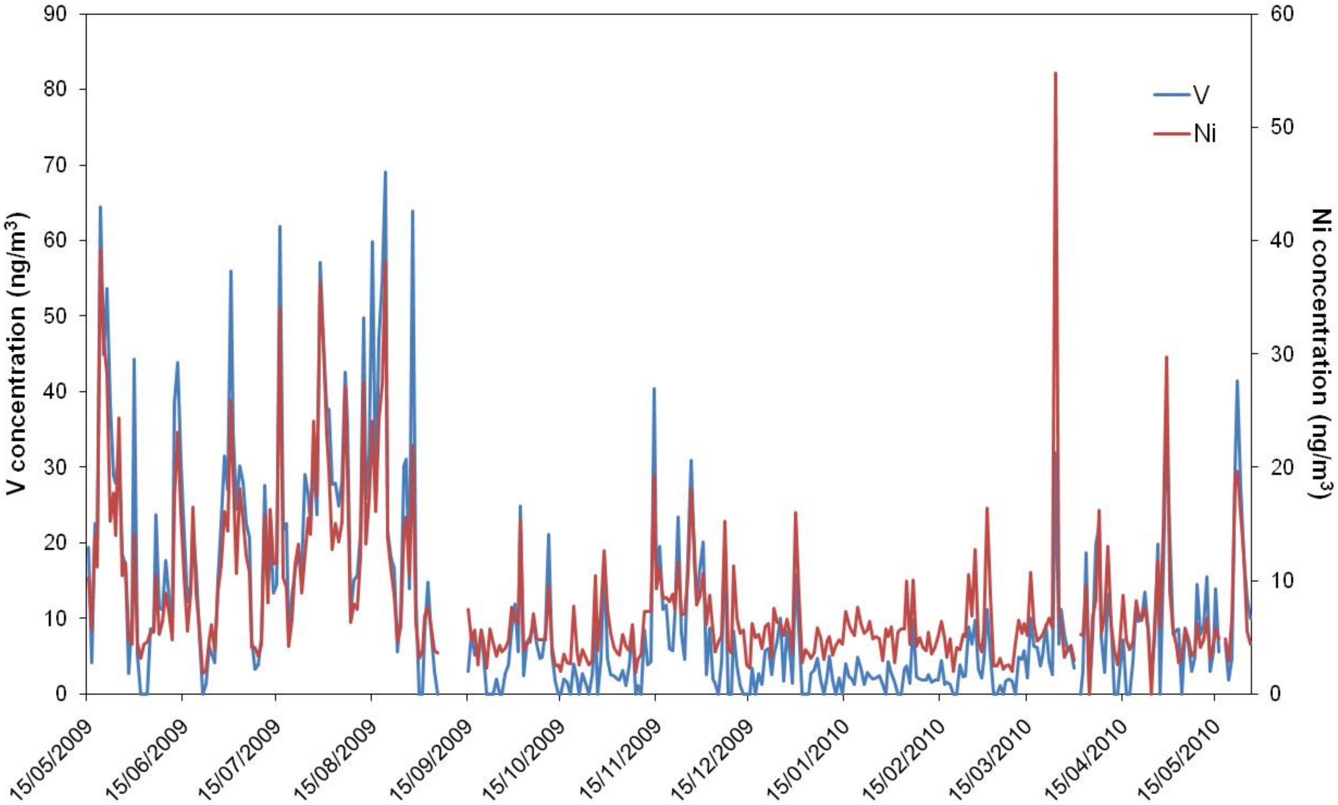


Figure 9: Trend of V and Ni concentration in $PM_{2.5}$ measured from May 2009 to May 2010 in the urban background site of Corso Firenze – Genoa. The two elements are usually considered as tracers of heavy oil combustion and therefore of ship emissions. The annual series show higher values during summer when the passenger traffic in the harbour of Genoa has a relevant increase.

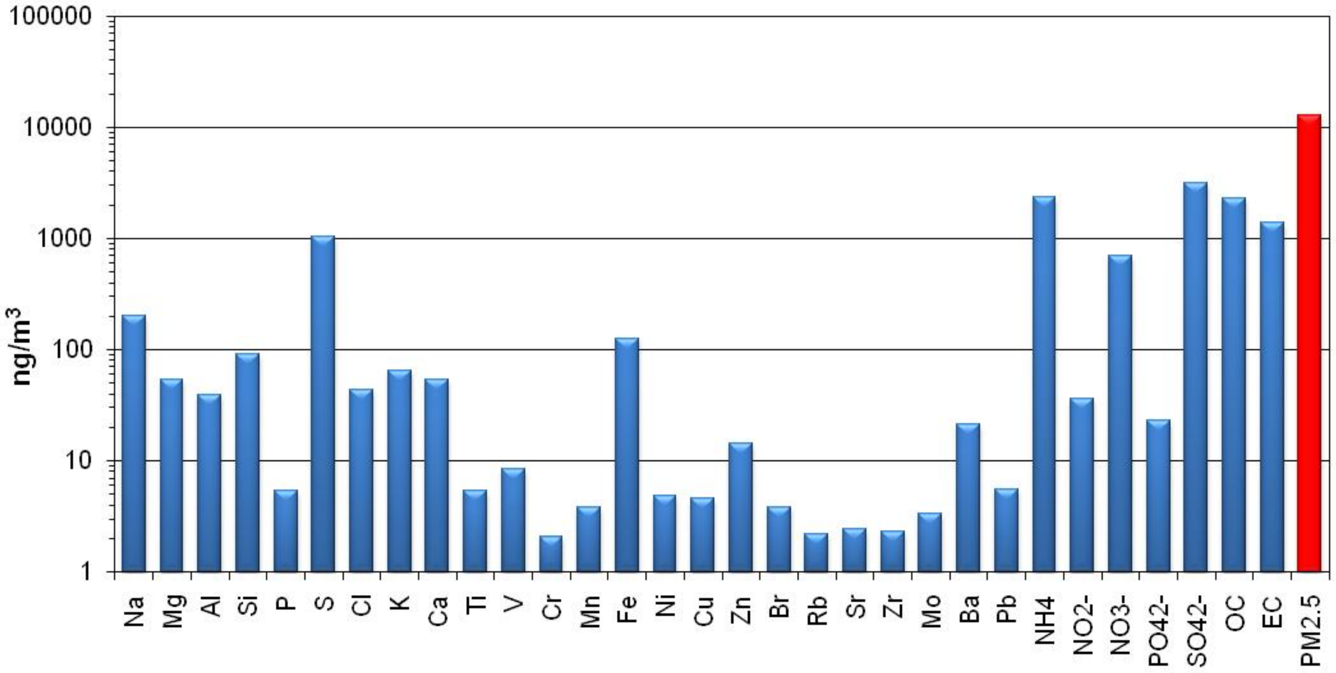


Figure 10: Average composition of $PM_{2.5}$ measured in spring 2010 in the urban background site of Corso Firenze -Genoa

5.2 METEOROLOGICAL PARAMETERS

In Figures 11-17 there is a report of the time series for the aforementioned variables relative to the year 2009 recorded by the station placed on the top of the building of the Meteo-Hydrological Centre of Liguria Region (CFUNZ station), which is pointed with the red circle in Figure2. The data extracted by all the stations are actually available, we have chosen to report here only the time series of the data of the station which is nearest to the harbor area and then gives the more accurate information on the study area of the APICE project.

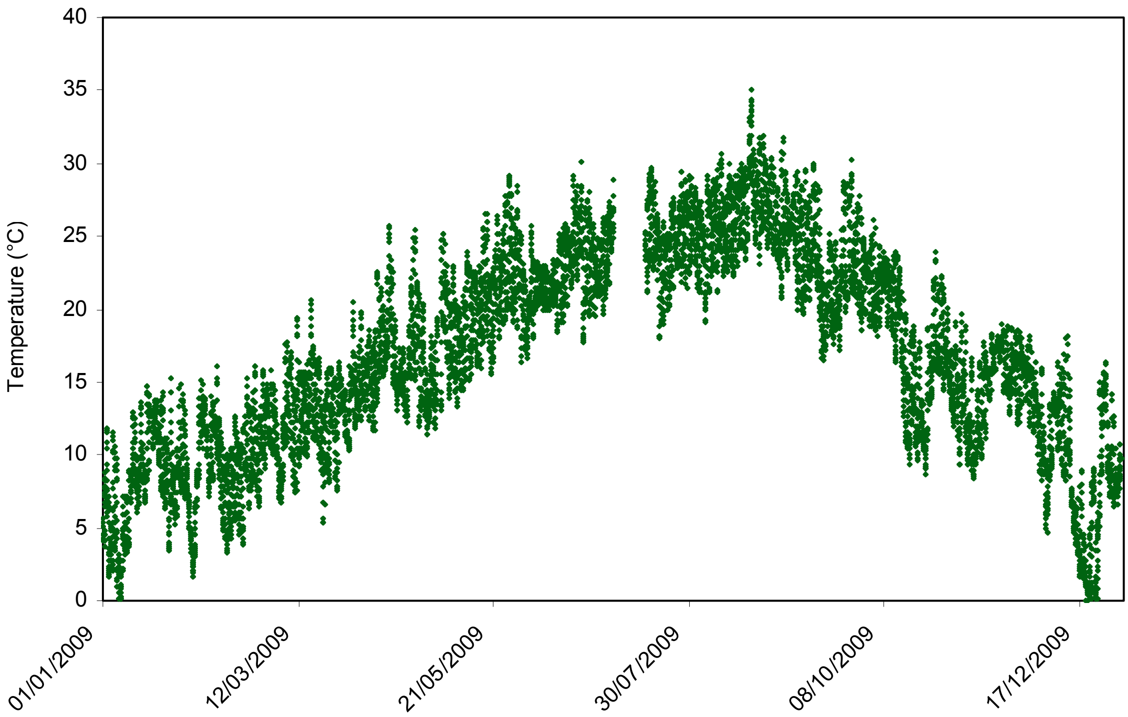


Figure 11: Time series of the temperature values observed at the CFUNZ station, year 2009

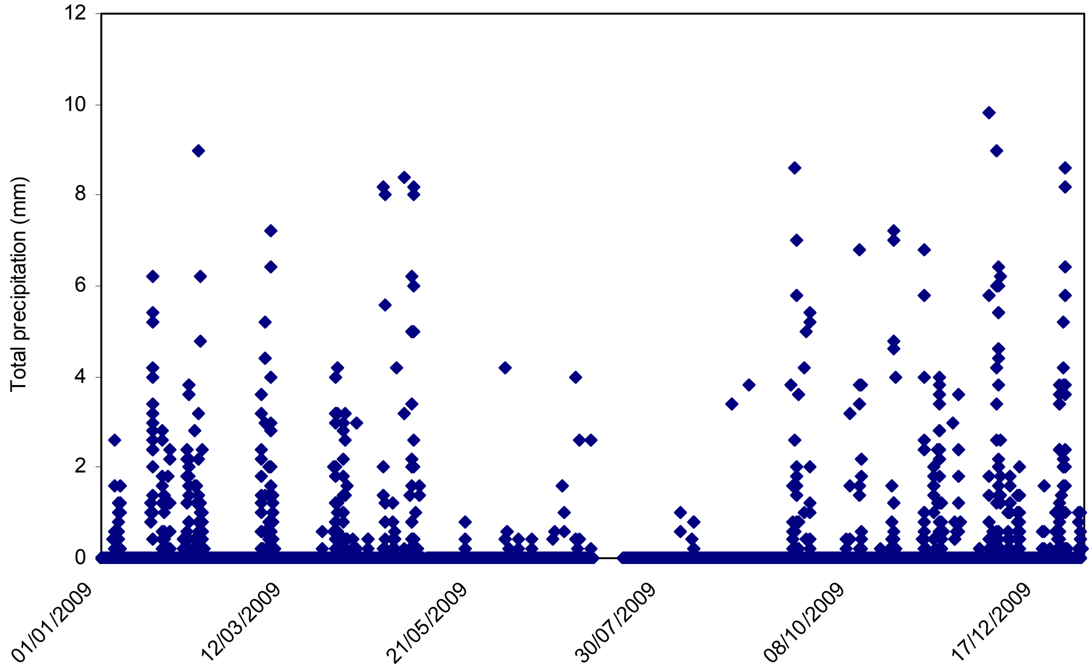


Figure 12: Time series of the total precipitation values observed at the CFUNZ station, year 2009

Project confinancé parle Fonds Européen de Développement Régional
Project co-finnaced by the European Regional Development Fund

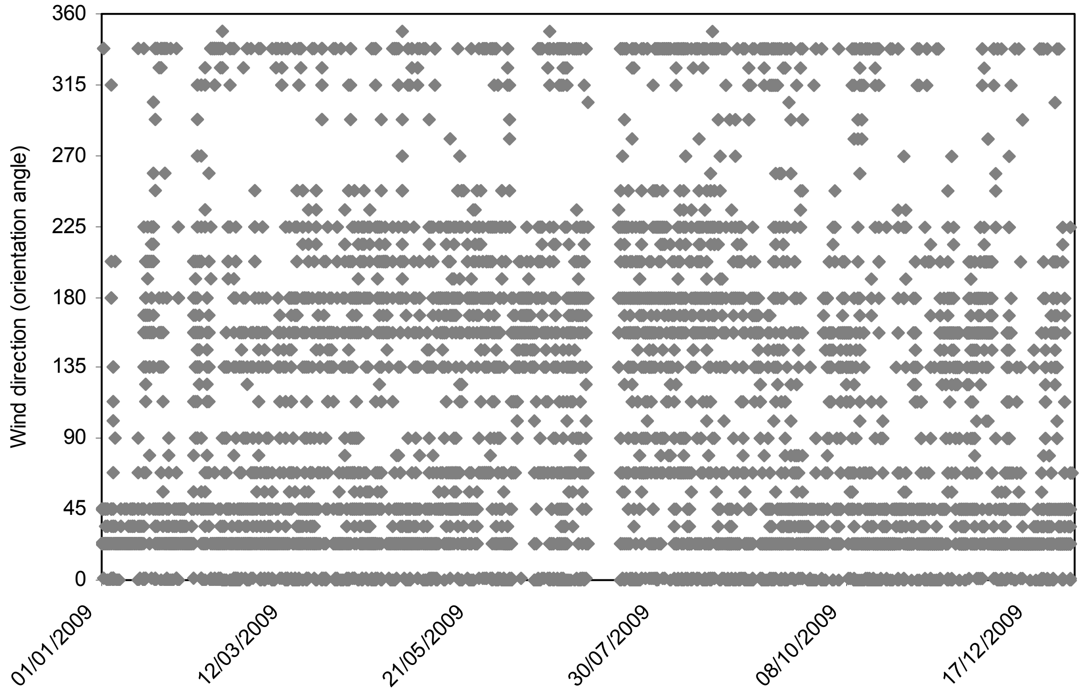


Figure 13: Time series of the wind direction values observed at the CFUNZ station, year 2009

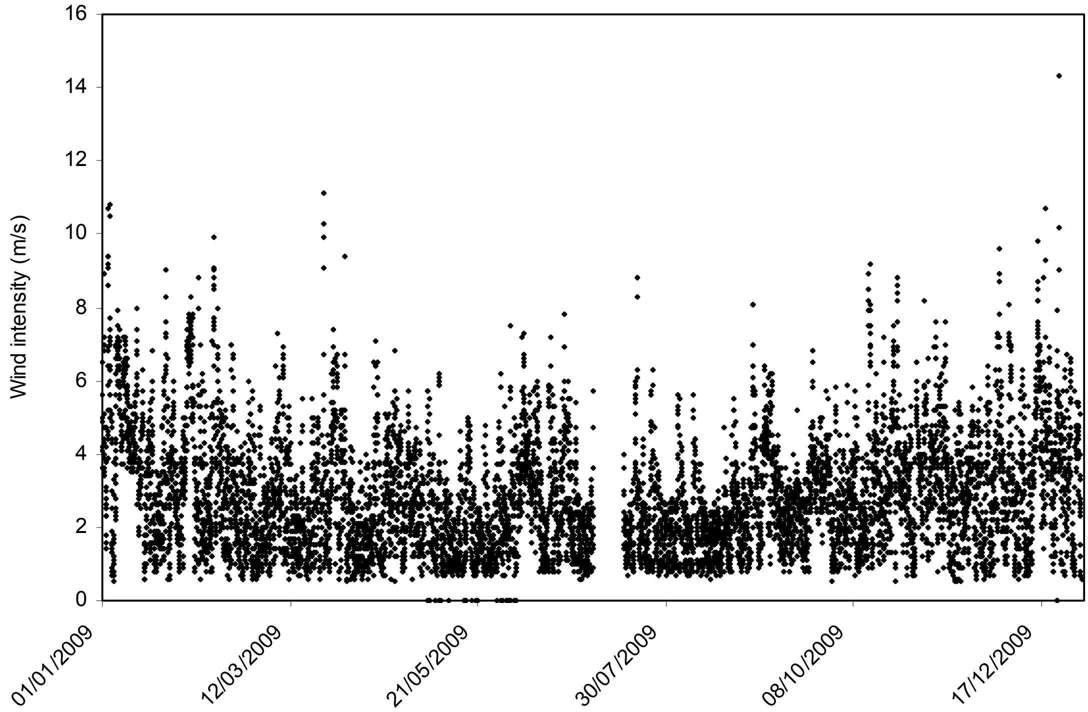


Figure 14: Time series of the wind intensity values observed at the CFUNZ station, year 2009

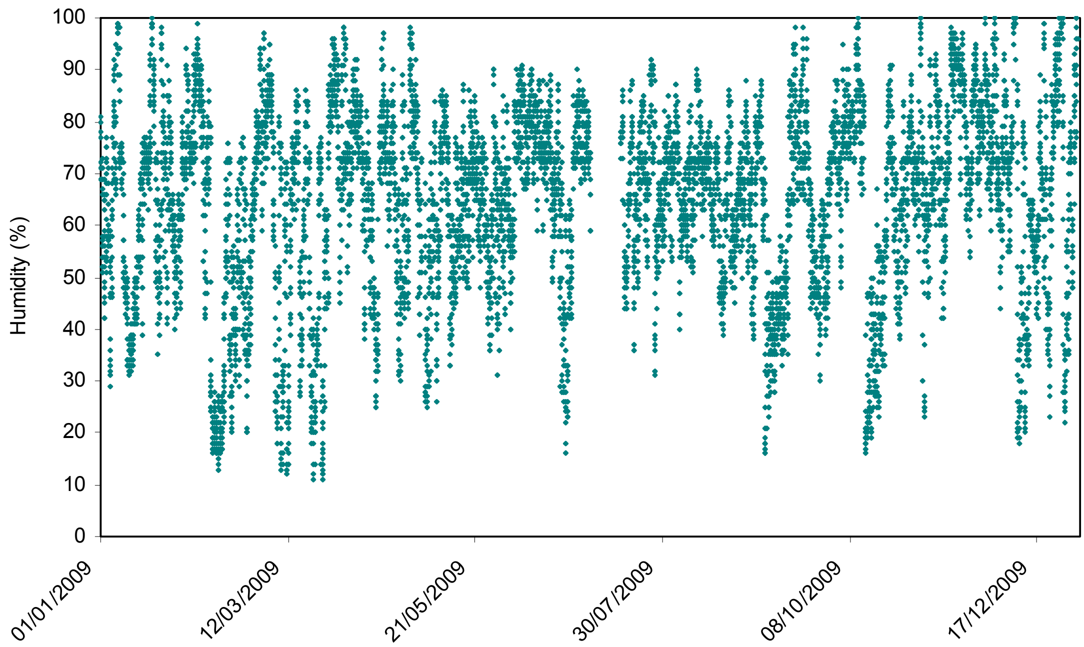


Figure 15: Time series of the relative humidity values observed at the CFUNZ station, year 2009

Project confinancé parle Fonds Européen de Développement Régional
Project co-finnaced by the European Regional Development Fund

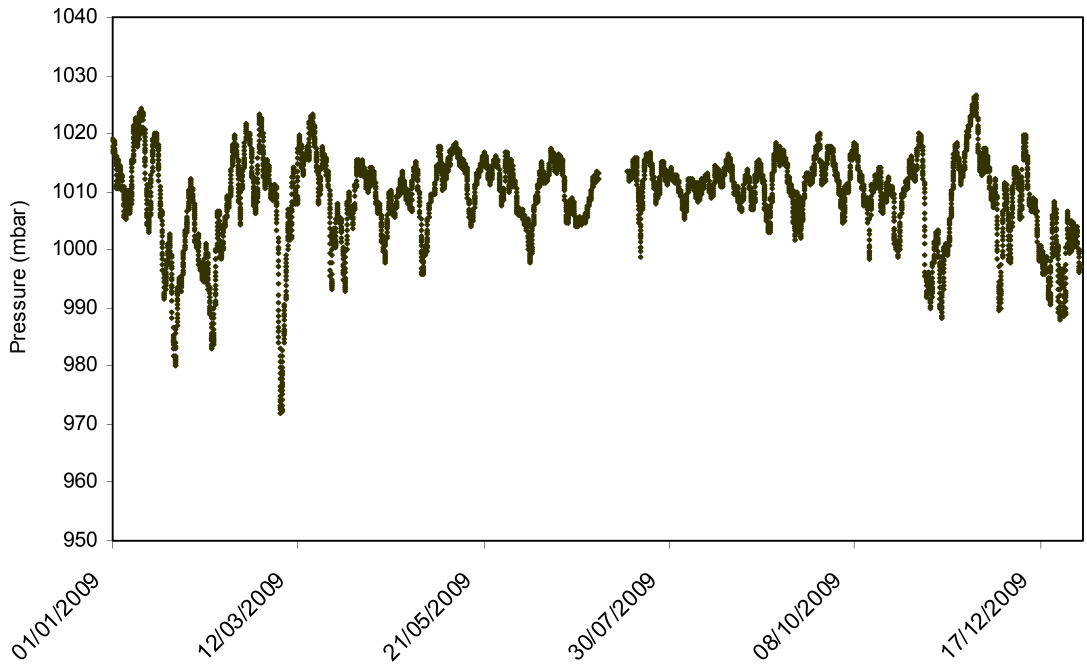


Figure 16: Time series of the pressure values observed at the CFUNZ station, year 2009

Project confinancé parle Fonds Européen de Développement Régional
Project co-financed by the European Regional Development Fund

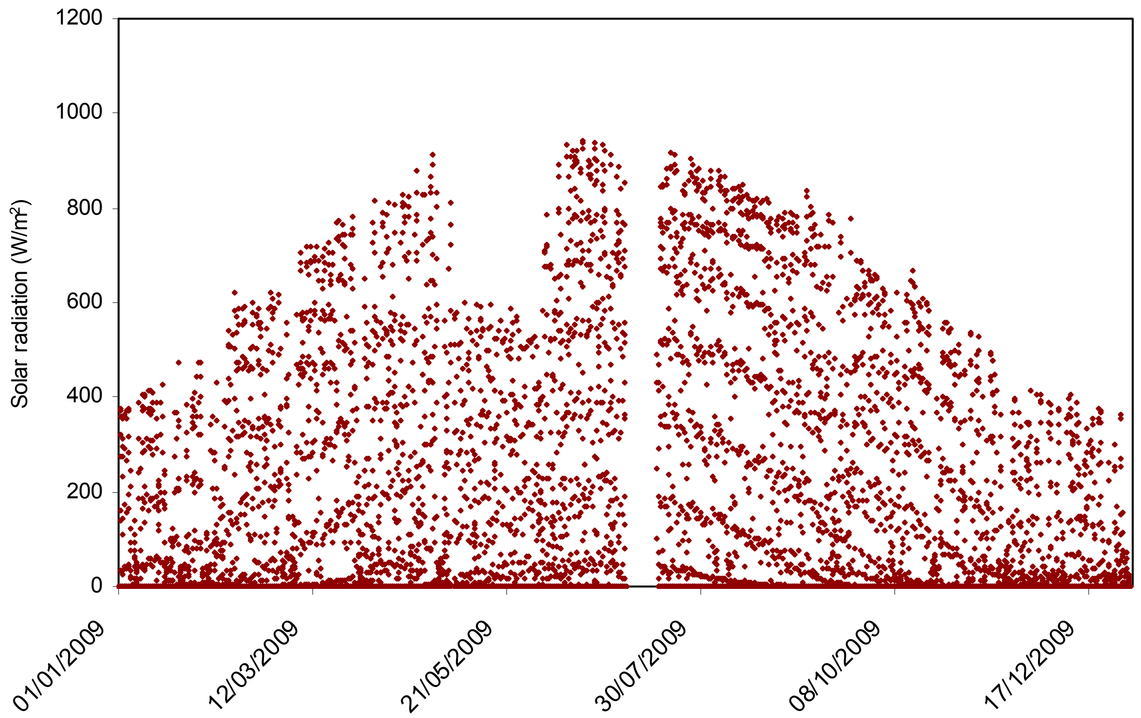


Figure 17: Time series of the solar radiation values observed at the CFUNZ station, year 2009

5. ANALYSIS OF PM10 FOR YEAR 2009 FOR NEAR THE PORT STATION

In this section there is an analysis of “**Corso Buenos Aires**” air quality station, which is located in the city centre and is characterized as Traffic – Urban – Residential/Commercial. The location of the sampling site is pointed with a blue arrow on the map. This station was selected because a complete data set with hourly resolution was available for several pollutants including PM10.

The available data from this station are shown in table 1 in paragraph 4.1.The analysis is focused on PM10 particles which is one of the major pollutants that attract the scientific interest, as there is a proven connection with adverse health problems.

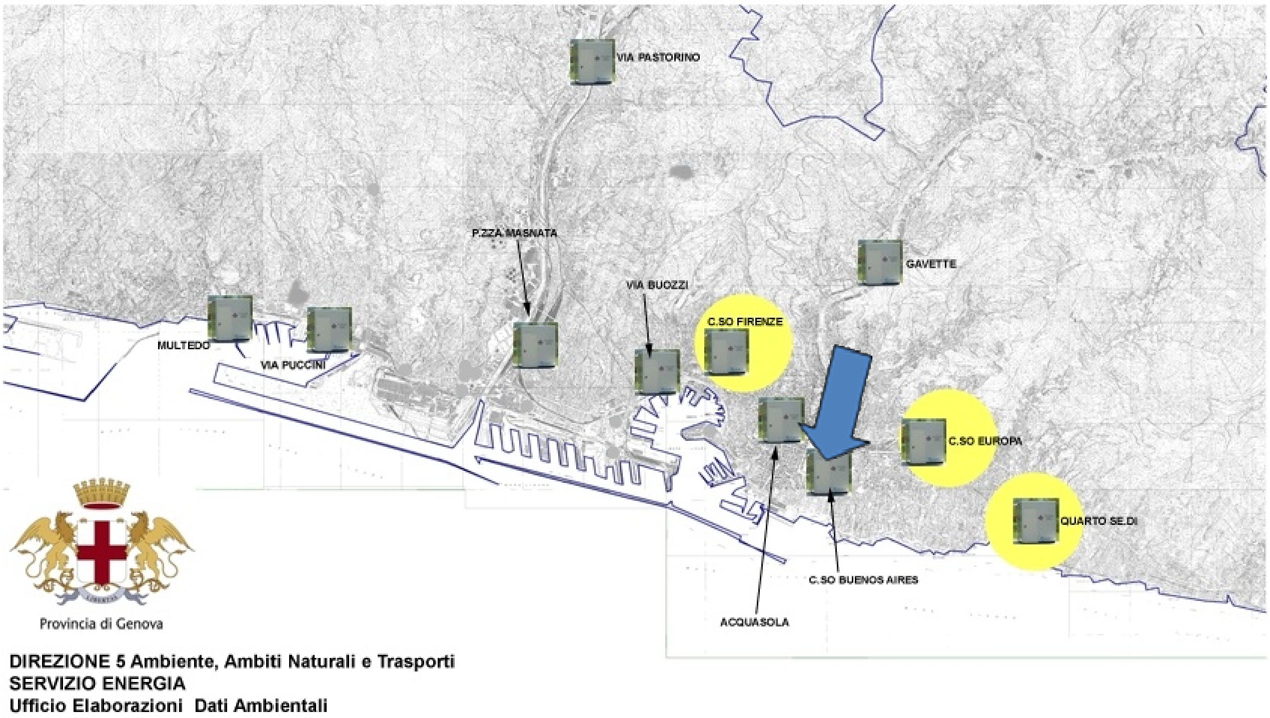


Figure 18:** **The location of **GE - Corso Buenos Aires Genoa** ***station which is marked with blue arrow***

Projet cofinancé par le Fonds Européen de Développement Régional
Project co-financed by the European Regional Development Fund

PM10 ANALYSIS

A discussion for the monthly, daily, hourly variation of PM10 during 2009 follows. Furthermore, the correlation between meteorological conditions and PM10 levels is examined as well as the contribution of port activities to the air quality of Genoa.

MONTHLY AVERAGES

The monthly variation of PM10 concentration for the year 2009 is presented in figure 19. The maximum values correspond to May, June and July. On the other side, the lowest values correspond to January, February and December. It is important to note that the factors that contribute to particles levels include permanent or seasonal sources. The meteorological pattern of each season plays a crucial role too, as a low dispersive atmosphere, generally occurring in Genoa during summertime, leads to particles levels increase.

Figure 19: Monthly averages for year 2009 PM10 µg/m³

Projet cofinancé par le Fonds Européen de Développement Régional
Project co-financed by the European Regional Development Fund

EXCEEDED DAYS

The new Directive 2008/50/EC highlights that the limit of 50μg/m^3 should not be exceeded for more than 35 times per calendar year. From 01/01/2010, the limit is restricted to be 7 days per year. As noticed in the following figure, the measured concentration exceeded the limit *once*.

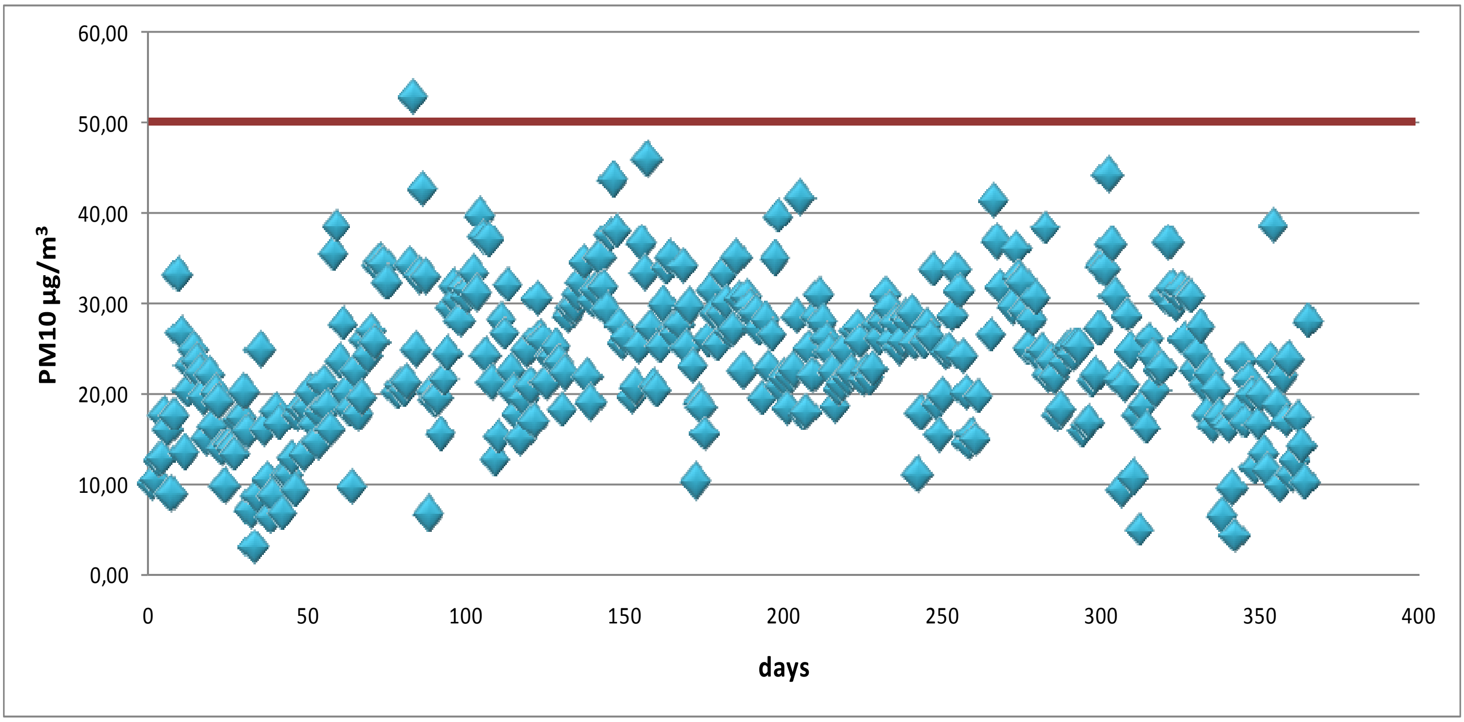


Figure 20: Exceeded days for year 2009 for PM10 μg/m^3

DAILY CHANGE

The daily variation of PM10 concentration during 2009 is presented in figure 21. Peaks are observed during the year, possibly because of their connection to pollution episodes under prevailing meteorological conditions.

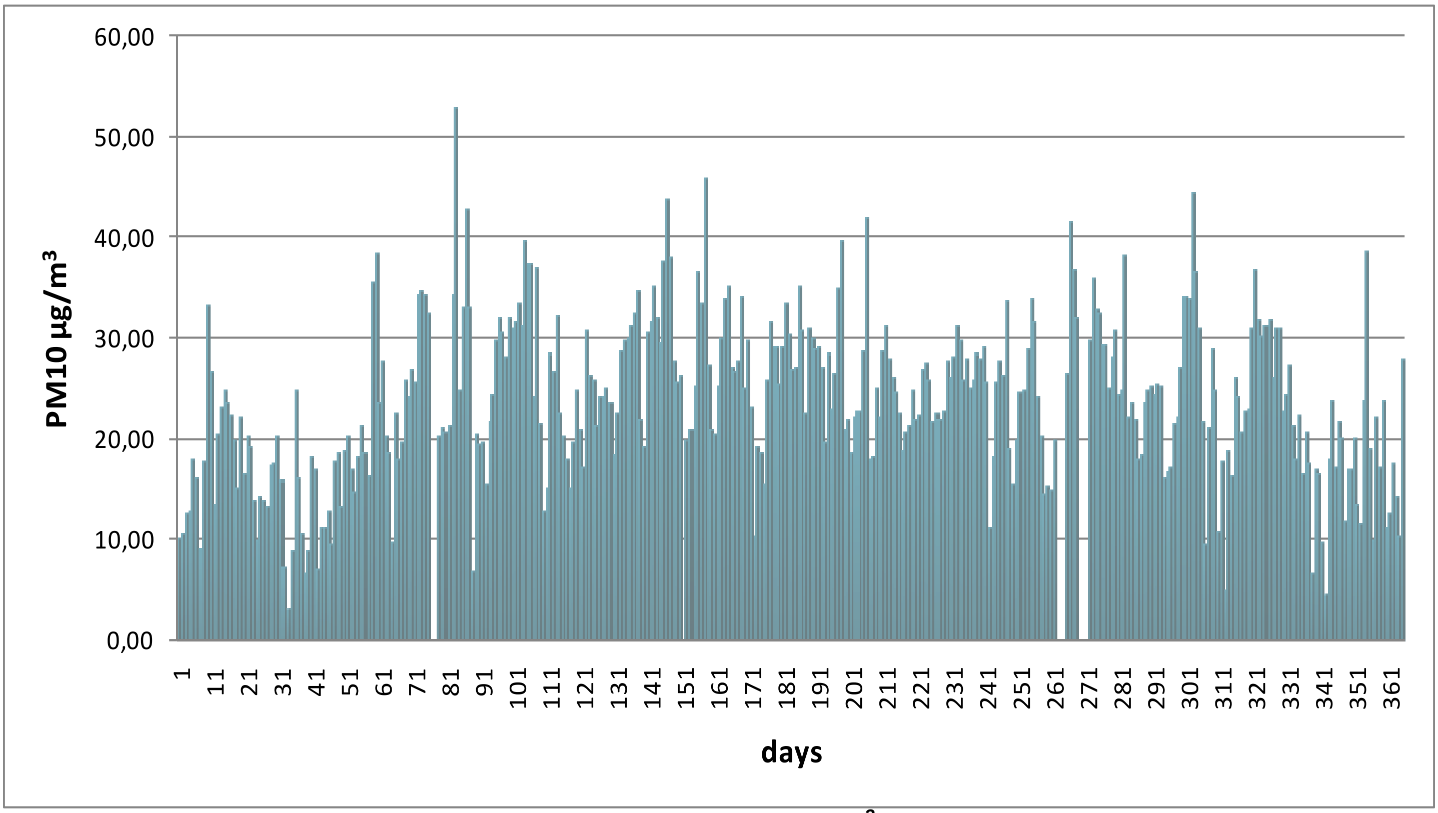


Figure 21: Daily averages for year 2009 PM10 µg/m^3

AVERAGES PER DAY

The average PM10 concentration for each day of the week for the year 2009 is shown in figure 22. As it can be noticed, although there are not significant differences, concentration on Sundays is lower, very likely because of the reduction of vehicles circulation. Friday was the day with the maximum daily PM10 average concentration.

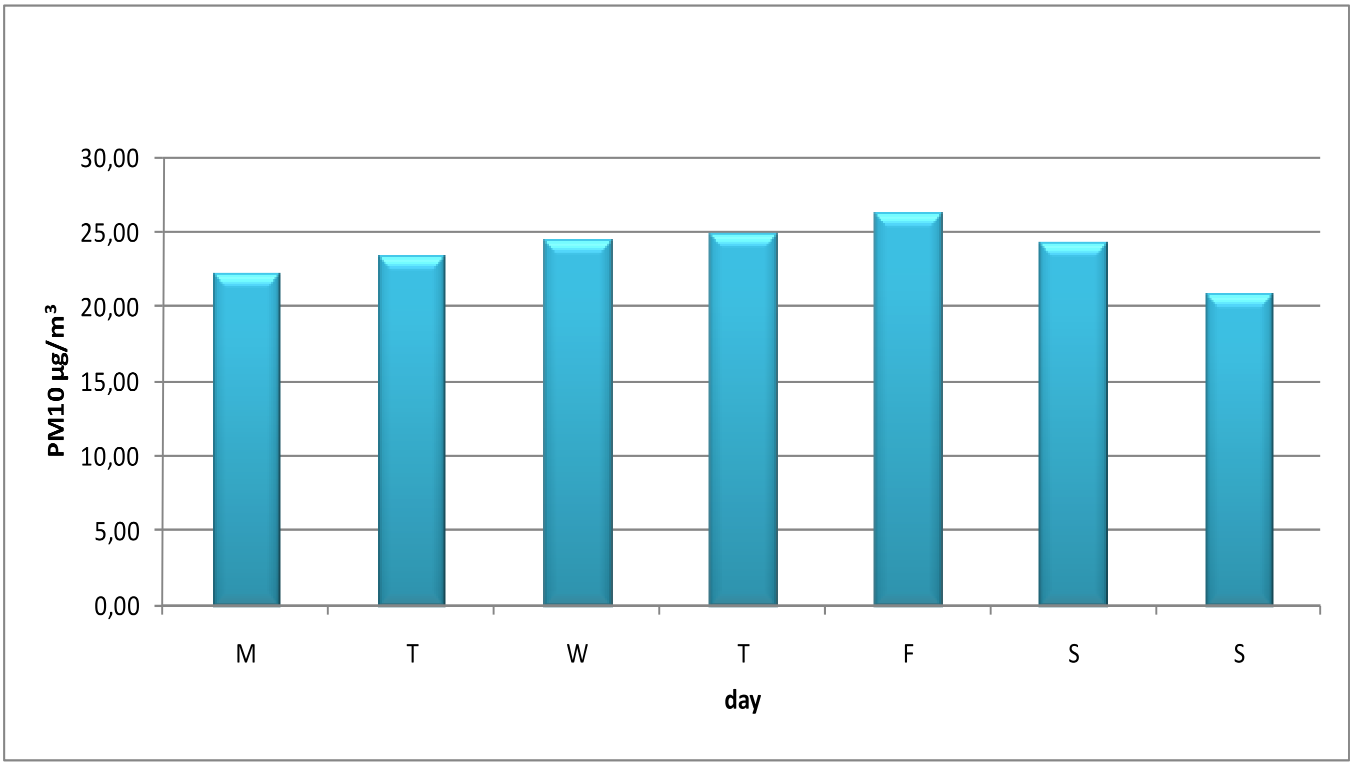


Figure 22: Averages per day for year 2009 PM10 µg/m³

HOURLY CHANGE

Figure 23 presents the mean hourly (from 01:00 to 24:00) variation of PM10, for the year 2009. As it can be noticed, concentration levels increase during early morning hours, presenting a peak at 9-10am, the rush hours of vehicles circulation. A second -lower- increase is observed during early evening hours (17-21pm). Concentration levels during night remain elevated.

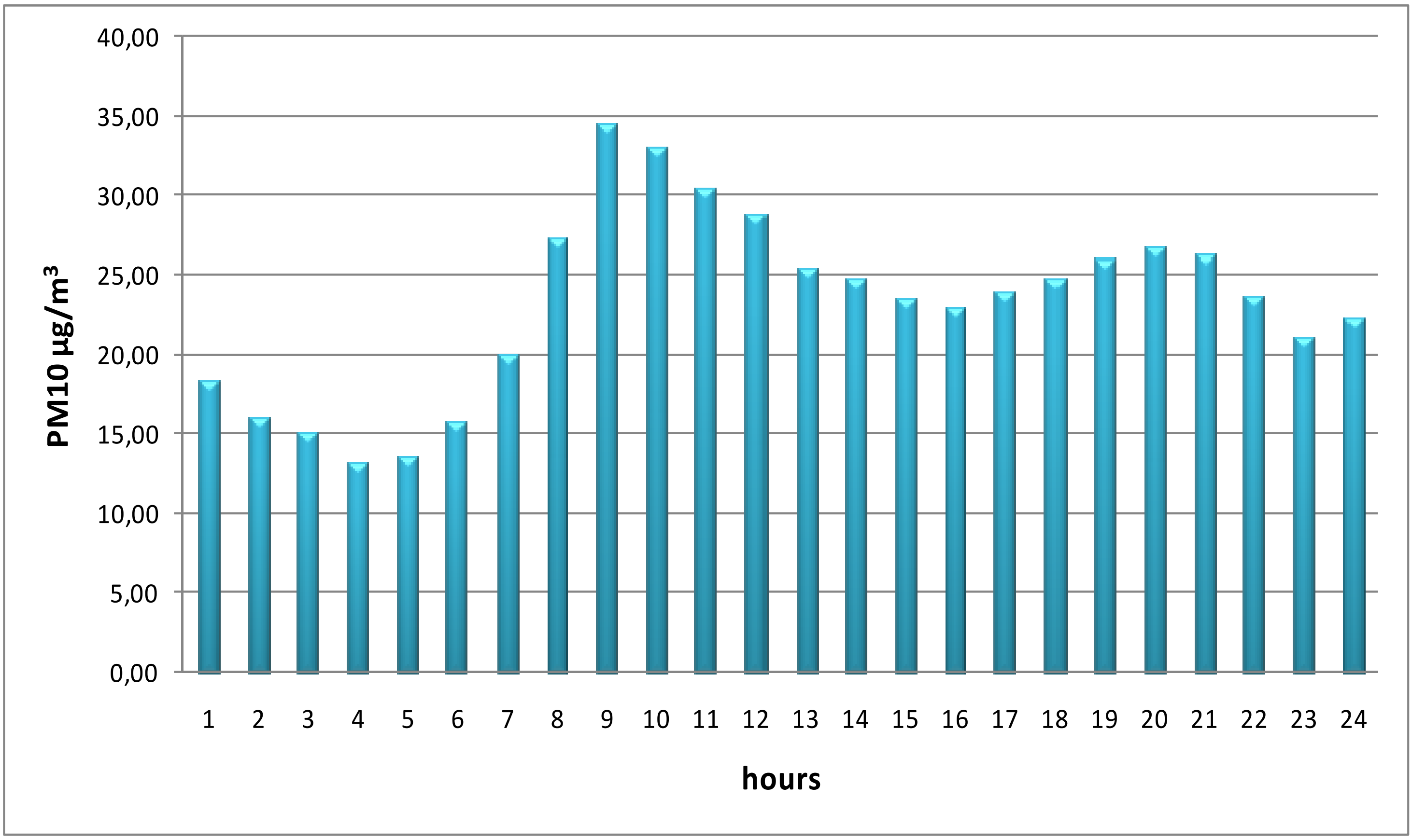


Figure 23: Hourly averages for year 2009 PM10 µg/m³

5.2 WIND ROSES

The meteorological parameters which can affect pollutants' levels in atmosphere are:

- Wind speed
- Wind direction
- Atmospheric stability
- Solar radiation
- Precipitation
- Humidity
- Temperature

WIND SPEED ROSE

Figure 24 presents the *wind speed-wind direction* rose-diagram for the year 2009. The diagram axis presents the frequency of the observed values of wind speed in % values. Hourly data (in m/s and degrees respectively) were provided by **''CORSO BUENOS AIRES''** station.

As shown, the maximum values for wind speed ranged between 11-17m/s and were mainly observed during periods with prevailing north-northeastern wind (and less often with prevailing northeastern and south-eastern winds). Western winds were rarely observed. "Calms" reach 0.05 m/s.

Project cofinancé par le Fonds Européen de Développement Régional
Project co-financed by the European Regional Development Fund

www.apice-project.eu

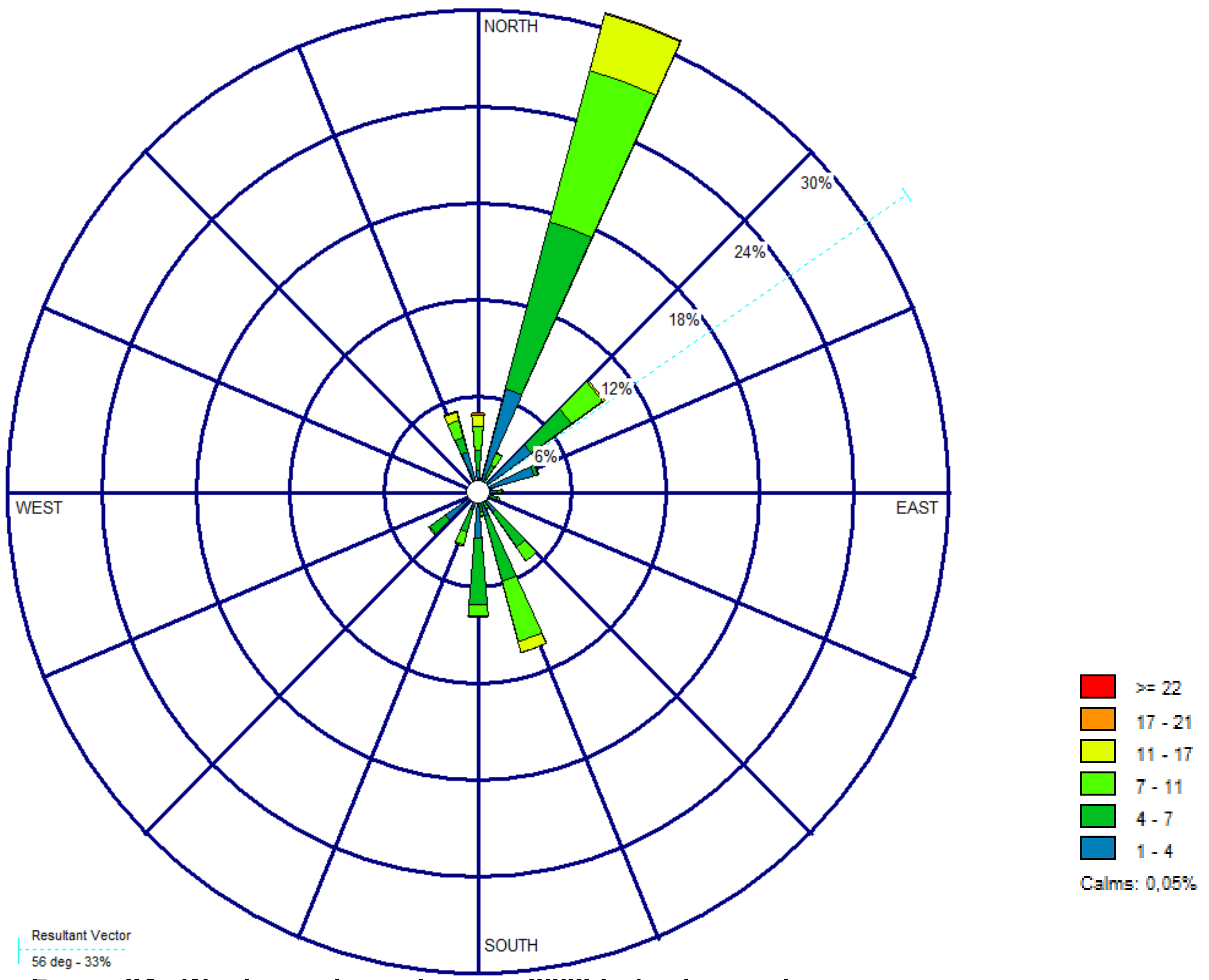


Figure 24: Wind speed rose for year 2009 (m/s, degrees)

Note: “calms” is wind speed lower than 0.5 m/s

PM10 ROSE

Figure 25 presents the PM10 concentration (in μg/m^3) -*wind direction* (in degrees) rose-diagram for the year 2009 for **''GE – CORSO BUENOS AIRES''** station. The diagram axis presents the frequency of the observed values of PM10 concentration in %values.

As it can be noticed, maximum PM10 levels were more often recorded during days with prevailing north-northeastern wind. High PM10 levels also corresponded to winds with Northeast, Southeast direction and other directions (less often).

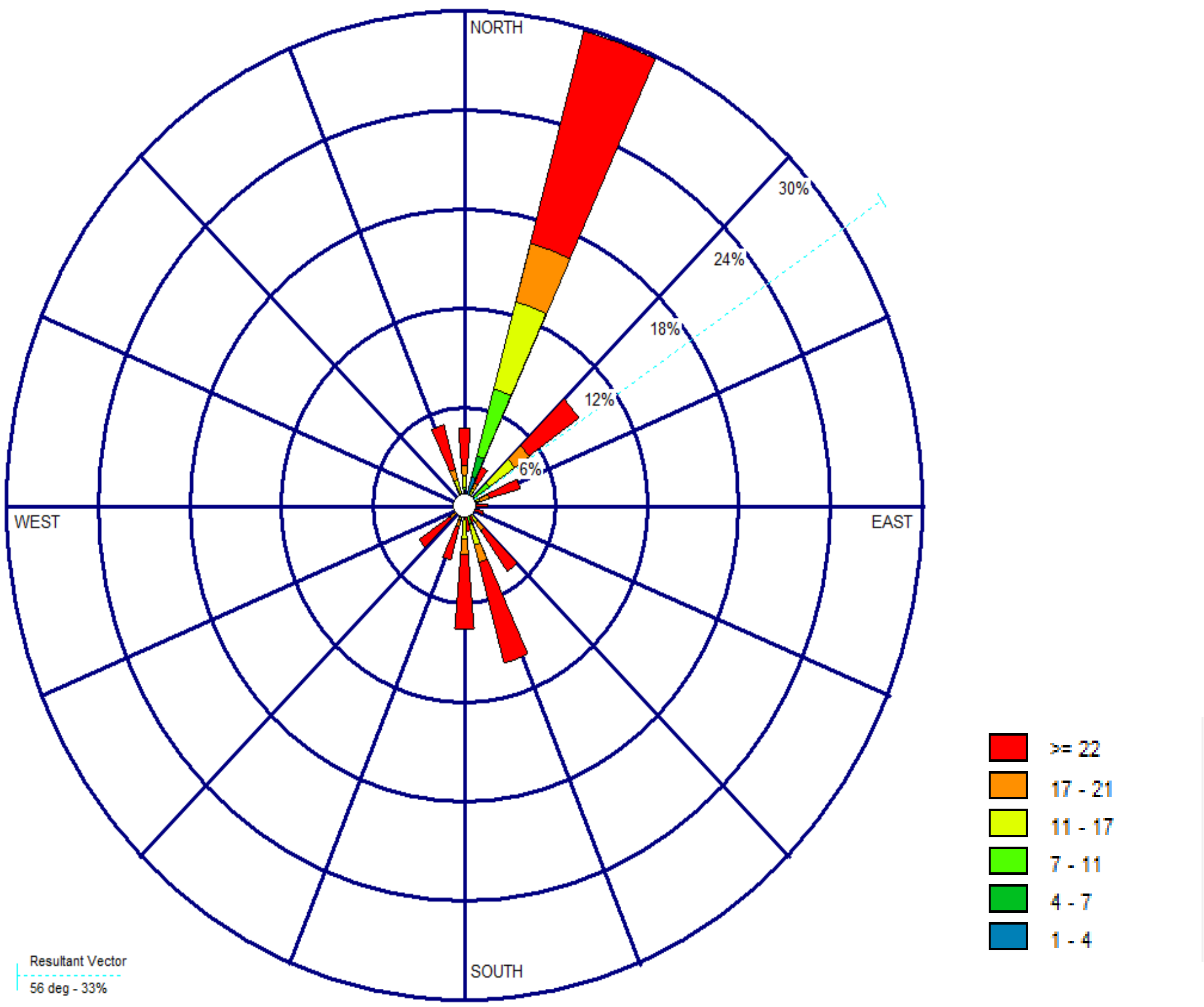
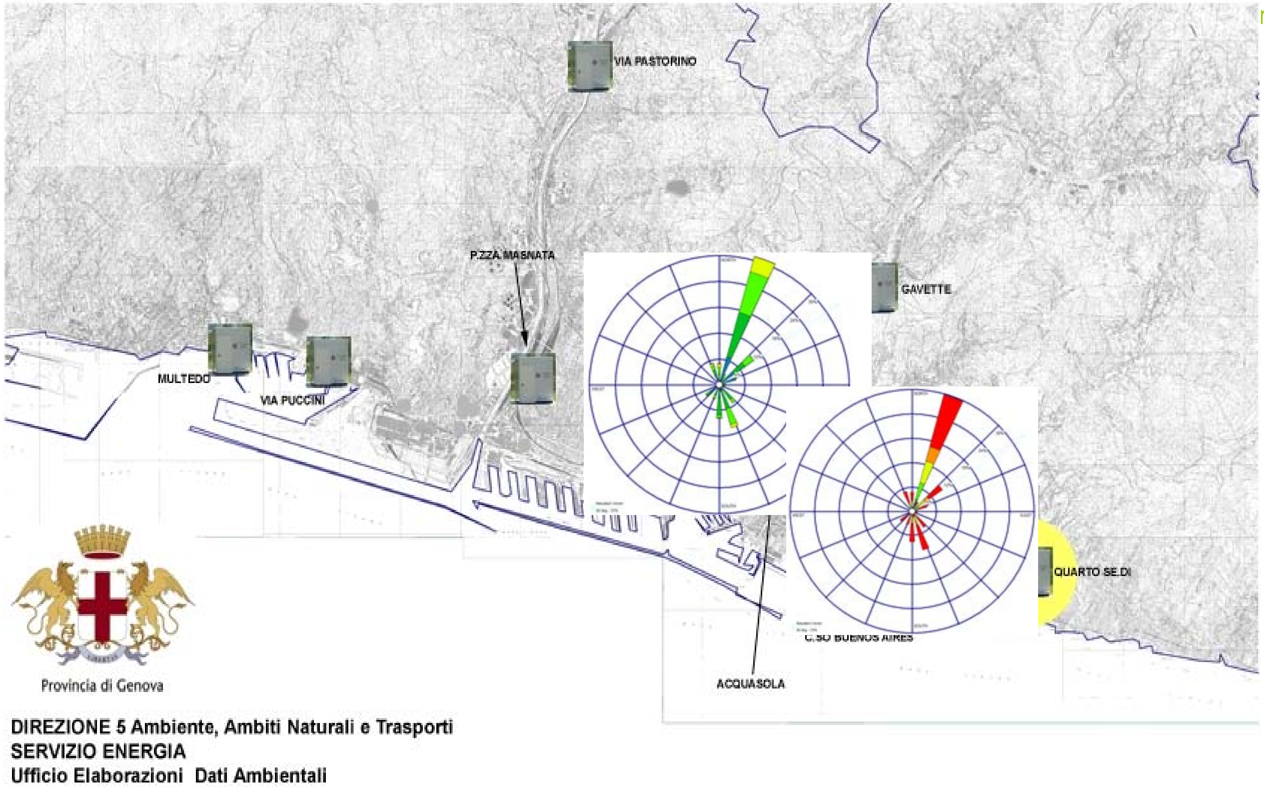
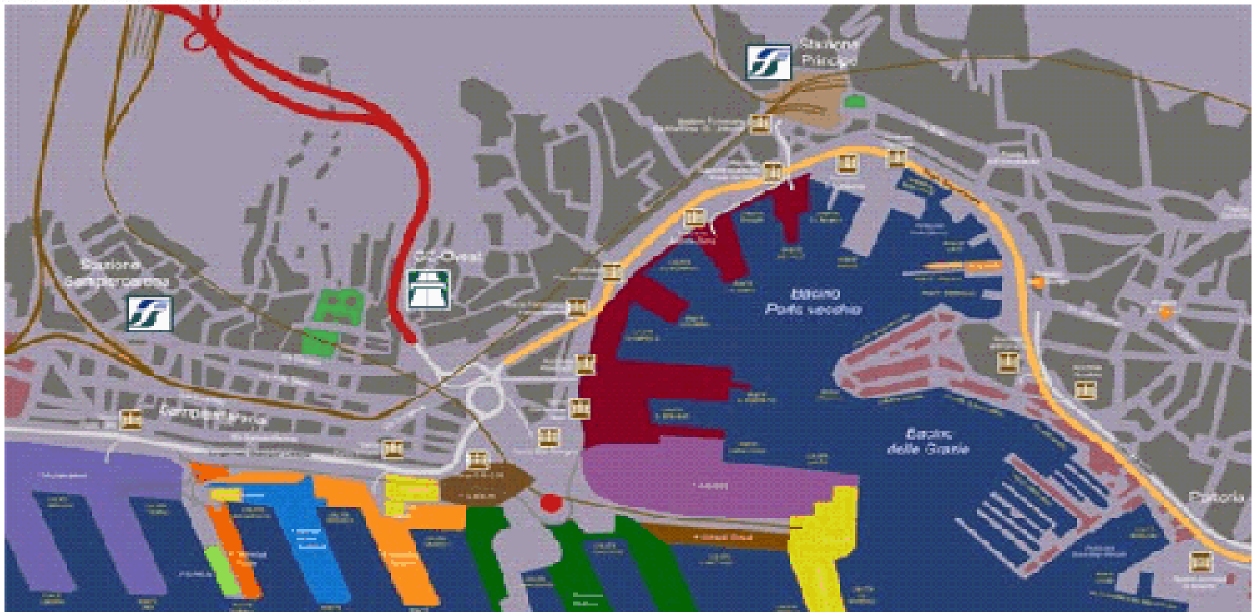


Figure 25: PM10 concentration rose for year 2009 (μg/m^3, degrees)

Projet confinancé parle Fonds Européen de Développement Régional
Project co-financed by the European Regional Development Fund





INTERCOMPARISON OF ROSES

In an effort to identify the sources contributing to PM10 concentration, preliminary conclusions can be drawn by examining the PM10-wind rose-diagrams (figure 26). In the reported case, maximum PM10 levels are often connected with the frequent north-northeastern winds, implying an inland to sea transportation. On the other hand, contribution from the all other sectors (basically from the sea) are also observed corresponding to high PM10 levels.

Figure 26: PM10 concentration rose (μg/m^3, degrees) and wind speed rose (m/s, degrees) for year 2009 – Industrial activities in Genoa

6. FRAMEWORK ANALYSIS

7.1 INTRODUCTION

By itself, technology is as likely to harm the environment as to help it. That's why laws and regulations have been such an important part of tackling the problem of pollution. Many once-polluted cities now have relatively clean air and water, largely thanks to anti-pollution laws introduced during the mid-20th century. In England, following the 1952 smog tragedy that killed thousands of people in the capital city of London, the government introduced its Clean Air Act of 1956, which restricted how and where coal could be burned and where furnaces could be sited and forced people to build smokestacks higher to disperse pollution. In the United States, a series of Clean Air Acts were passed between the 1960s and 1990s. The 1990 Pollution Prevention Act went even further, shifting the emphasis from cleaning up pollution to preventing it ever happening in the first place.

National laws are of little help in tackling trans-boundary pollution (when air pollution from one country affects neighboring countries or continents), but that doesn't mean the law is useless in such cases. The creation of the European Union (now comprising around 30 different countries) has led to many Europe-wide environmental acts, called directives. These force the member countries to introduce their own, broadly similar, national environmental laws that ultimately cover the entire European region. For example, the 1976 European Bathing Water Directive tried to enforce minimum standards of water quality for beaches and coastal areas across Europe to reduce pollution from sewage disposal, while the 1996 European Directive on Integrated Pollution Prevention and Control (IPPC) attempted to limit air and water pollution from industry. Other successful international laws include the Convention on Long-Range Trans-boundary Air Pollution (1979), which has helped to reduce sulfur dioxide emissions from power plants and, of course, the Montreal Protocol, which successfully brought 196 countries together to target ozone depletion. Unfortunately, attempts to control global warming through international laws and agreements have so far proved less successful.

Any effective program regulating maritime emissions will need to take account of the legal circumstances that govern maritime activity. Indeed, the international nature of shipping means that international regulations need to be accounted for in considering the legal context. To that end, the following section provides a very brief discussion of the existing international legal framework and its relevance for shipping.

Project confinancé parle Fonds Européen de Développement Régional
Project co-finnaced by the European Regional Development Fund

7.2 INTERNATIONAL FRAMEWORK

INTRODUCTION

Exhaust emissions from ships are considered to be a significant source of air pollution, with 18-30% of all nitrogen oxide and 9% of sulphur oxide pollution. The 15 biggest ships emit about as much sulphur oxide pollution as all cars combined. Sulfur in the air creates acid rain which damages crops and buildings. When inhaled the sulfur is known to cause respiratory problems and even increase the risk of a heart attack. According to Irene Blooming, a spokeswoman for the European environmental coalition Seas at Risk, the fuel used in oil tankers and container ships is high in sulfur and cheaper to buy compared to the fuel used for domestic land use. "A ship lets out around 50 times more sulfur than a lorry per metric ton of cargo carried." Cities in the U.S. like Long Beach, Los Angeles, Houston, Galveston, and Pittsburgh see some of the heaviest shipping traffic in the nation and have left local officials desperately trying to clean up the air. The increasing trade between the U.S. and China is helping to increase the number of vessels navigating the Pacific and exacerbating many of the environmental problems. To maintain the level of growth China is currently experiencing, large amounts of grain are being shipped to China by the boat load. The number of voyages is expected to continue increasing. 3.5% to 4% of all climate change emissions are caused by shipping.

Although international regulation in other environmental areas is long standing, international efforts to reduce air emissions from ships are relatively new. The need for measures to reduce air pollutant emissions from international shipping has been on the agenda since the late 1980s. After years of negotiation, a first agreement – the Annex VI1 to the IMO's MARPOL Convention – was adopted in 1997. But even at the time of adoption it was widely recognized as being insufficient.

L'Europe en Méditerranée
Europe in the Mediterranean
Projet cofinancé par le Fonds Européen de Développement Régional
Project co-financed by the European Regional Development Fund

LEGISLATION AUTHORITIES

There are some common elements that an emissions policy for ships must include; one of them is an appropriate legal basis, which is also related to an effective monitoring and enforcement regime. Any new policy to control emissions would have to be in conformity with international and EU law. The United Nations Convention on the Law of the Sea ("UNCLOS") sets out the basic legal framework that governs international shipping. The Convention gives some support for the control of air emissions (Article 212), but this is balanced against the right of ships to innocent passage without being subject to any charges, except for services received. Relevant are also the current international environmental regulations, notably the International Maritime Organization's ("IMO's"), International Convention on the Prevention of Pollution from Ships ("MARPOL"), which sets a global limit on fuel sulphur content, and also designates Sulphur Oxide Emission Control Areas ("SECAs") in the North Sea and the Baltic Sea. MARPOL also sets NOx emissions standards via the IMO "NOx curve". (The 2005 EU Sulphur Directive imposes additional requirements to limit fuel sulphur content in SECAs, imposes restrictions on passenger vessels throughout the EU, and requires ships at berth to use 0.1 percent sulphur fuel or better from 2010 onward. The considered policies must be consistent with the existing legal framework for addressing emissions from shipping, although it is likely that certain details need to be worked out for each one.

The mentioned authorities are based on studies of emissions from ships. This is complicated by the fact that fuel consumption and emission factors are highly variable, depending on engine size, age, and load, on existing emission control technologies, on fuel composition, and on ambient conditions. In general, monitoring can be divided into periodic and continuous monitoring (periodic monitoring is cheaper but less accurate than continuous monitoring) and into monitoring of the fuel used or direct measurement of exhaust emissions (fuel-based is cheaper but less accurate than the monitoring of exhaust emissions). The appropriate trade-off between cost and accuracy is likely to depend on the instrument used, as requirements differ between different approaches. Additional considerations include the ability to keep track of emissions within a specific geographical area, which poses significant challenges without continuous monitoring.

L'Europe en Méditerranée
Europe in the Mediterranean
Project cofinancé par le Fonds Européen de Développement Régional
Project co-financed by the European Regional Development Fund

UNITED NATIONS CONVENTION ON THE LAW OF SEA (UNCLOS)

The United Nations Convention on the Law of the Sea ("UNCLOS"), formally codified in 1982, is the basic legal framework that governs international shipping. As noted in Davies et al. (BMT 2000), states operate in three capacities: as flag, port, and coastal states. UNCLOS gives flag states the primary authority to impose environmental regulations (including those related to air emissions) on marine sources through their responsibility to enforce international laws. The roles of other jurisdictions—i.e., port and coastal states— "have traditionally been more limited" (BMT 2000). However, the language in UNCLOS suggests that non-flag states do have some authority to regulate marine emissions.

UNCLOS guarantees port states the right to "establish particular requirements for the prevention, reduction and control of pollution of the marine environment as a condition for the entry of foreign vessels into their ports or internal waters" (Article 211, paragraph 2). In addition, UNCLOS gives each coastal state the authority to control in-port emissions through its right to "exclude vessels from its ports or place conditions upon their entry" (BMT 2000). Although coastal states have limited authority to regulate general pollution under UNCLOS, they appear to have greater power in the regulation of air emissions. Articles 212 and 222 of UNCLOS, which govern air emissions from marine vessels, are somewhat vague with respect to the jurisdictional limits of coastal states. Indeed, when it comes to air emissions, a state's jurisdiction is defined with respect to infringement upon its airspace. Article 212 allows states to "adopt laws and regulations to prevent, reduce and control pollution of the marine environment from or through the atmosphere, applicable to the air space under their sovereignty." While UNCLOS gives some jurisdiction to port and coastal states in the control of marine air emissions, the Convention professes a clear preference for international regulations wherever possible. IMO would manage any such international regulations. Though IMO is explicitly mentioned only once in UNCLOS (Article 2 of Annex VIII), UNCLOS frequently refers to the "competent international organization" in connection with the adoption of international shipping safety and pollution standards; in most cases, this phrasing (i.e., "the competent international organization") has been interpreted to refer exclusively to IMO. IMO is generally responsible for the oversight of international shipping activity. In particular, IMO's charter explicitly charges it with the oversight of safety and antipollution efforts in international shipping. Since its creation in 1948, IMO has established a variety of measures to enforce increased safety and reduced pollution from international shipping. A major limitation affecting any jurisdictional authority relates to the right of innocent passage, which is also codified in UNCLOS. UNCLOS Part 2, Section 3 guarantees innocent right of passage for foreign-flag vessels in the territorial sea without being subject to any charges, except for services received. This restriction is clearly relevant to the control of emissions from shipping, since under a strict reading of this requirement, payments or charges related to reducing emissions from foreign-flag vessels would have to be embodied in a framework of providing services to those vessels. In addition, one aspect of the right of innocent passage, articulated in Article 21 of UNCLOS, precludes coastal states from enforcing any regulations that apply to the design, construction, manning or equipment of foreign vessels. This could be interpreted as restricting the ability of coastal states to require pollution abatement equipment or engine modifications on foreign vessels. A reason for considering market-based approaches to emissions regulations is that they offer a flexible means of complying with environmental regulations, and therefore may make it easier to promote the use of low-emissions technologies in certain sea areas, without impinging upon ships' right of innocent passage.

INTERNATIONAL MARITIME ORGANIZATION (IMO)

International Maritime Organization (IMO) is an agency of the United Nations which has been formed to promote maritime safety. It was formally established by an international conference in Geneva in 1948, and became active in 1958 when the IMO Convention entered into force (the original name was the Inter-Governmental Maritime Consultative Organization, or IMCO, but the name was changed in 1982 to IMO). IMO currently groups 167 Member States and 3 Associate Members.

IMO ship pollution rules are contained in the "International Convention on the Prevention of Pollution from Ships", known as MARPOL 73/78. On 27 September 1997, the MARPOL Convention has been amended by the "1997 Protocol", which includes Annex VI titled "Regulations for the Prevention of Air Pollution from Ships". MARPOL Annex VI sets limits on NOx and SOx emissions from ship exhausts, and prohibits deliberate emissions of ozone depleting substances.

The IMO emission standards are commonly referred to as Tier I...III standards. The Tier I standards were defined in the 1997 version of Annex VI, while the Tier II/III standards were introduced by Annex VI amendments adopted in 2008, as follows:

1997 Protocol (Tier I)—The "1997 Protocol" to MARPOL, which includes Annex VI, becomes effective 12 months after being accepted by 15 States with not less than 50% of world merchant shipping tonnage. On 18 May 2004, Samoa deposited its ratification as the 15th State (joining Bahamas, Bangladesh, Barbados, Denmark, Germany, Greece, Liberia, Marshal Islands, Norway, Panama, Singapore, Spain, Sweden, and Vanuatu). At that date, Annex VI was ratified by States with 54.57% of world merchant shipping tonnage.

Accordingly, Annex VI entered into force on 19 May 2005. It applies retroactively to new engines greater than 130 kW installed on vessels constructed on or after January 1, 2000, or which undergo a major conversion after that date. The regulation also applies to fixed and floating rigs and to drilling platforms (except for emissions associated directly with exploration and/or handling of sea-bed minerals). In anticipation of the Annex VI ratification, most marine engine manufacturers have been building engines compliant with the above standards since 2000.

2008 Amendments (Tier II/III)—Annex VI amendments adopted in October 2008 introduced (1) new fuel quality requirements beginning from July 2010, (2) Tier II and III NOx emission standards for new engines, and (3) Tier I NOx requirements for existing pre-2000 engines.

The revised Annex VI enters into force on 1 July 2010. By October 2008, Annex VI was ratified by 53 countries (including the Unites States), representing 81.88% of tonnage.

EMISSION CONTROL AREAS

Two sets of emission and fuel quality requirements are defined by Annex VI: (1) global requirements, and (2) more stringent requirements applicable to ships in Emission Control Areas (ECA). An Emission Control Area can be designated for SOx and PM, or NOx, or all three types of emissions from ships, subject to a proposal from a Party to Annex VI.

Existing Emission Control Areas include:

- Baltic Sea (SOx, adopted: 1997 / entered into force: 2005)
- North Sea (SOx, 2005/2006)
- North American ECA, including most of US and Canadian coast (NOx & SOx, 2010/2012).

EMISSION STANDARTS

NOx

NOx emission limits are set for diesel engines depending on the engine maximum operating speed (n, rpm), as shown in Table 2 and presented graphically in Figure 27. Tier I and Tier II limits are global, while the Tier III standards apply only in NOx Emission Control Areas.

Table 2: MARPOL Annex VI NOx Emission Limits

Tier	Date	NOx Limit, g/kWh		
		n < 130	130 ≤ n < 2000	n ≥ 2000
Tier I	2000	17.0	$45 \cdot n^{-0.2}$	9.8
Tier II	2011	14.4	$44 \cdot n^{-0.23}$	7.7
Tier III	2016†	3.4	$9 \cdot n^{-0.2}$	1.96

† In NOx Emission Control Areas (Tier II standards apply outside ECAs).

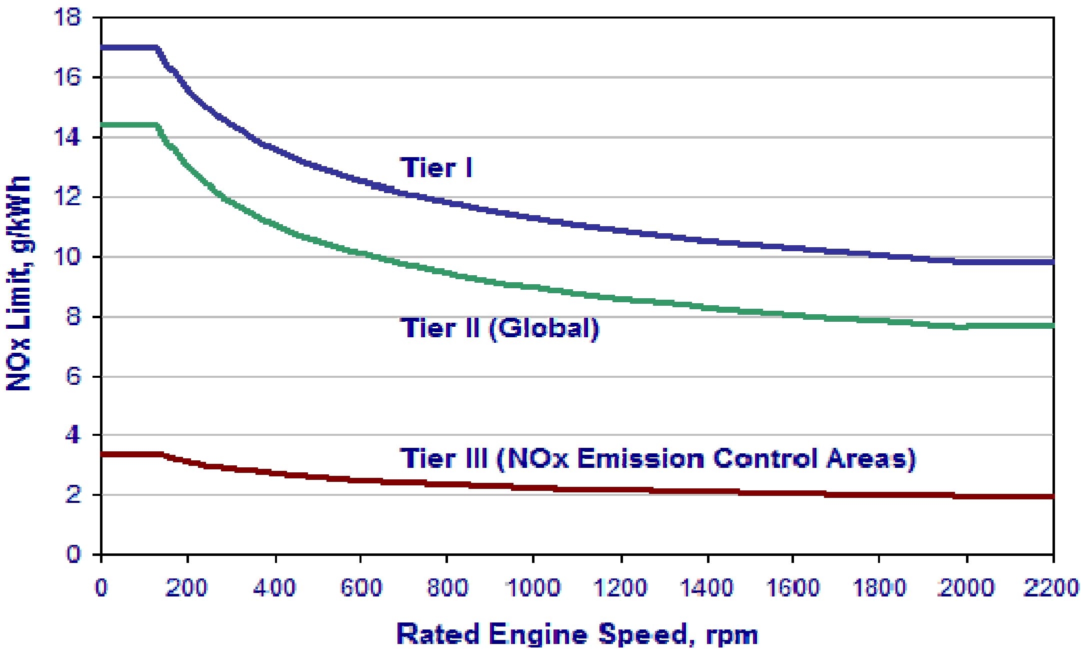


Figure 27: MARPOL Annex VI NOx Emission Limits

Tier II standards are expected to be met by combustion process optimization. The parameters examined by engine manufacturers include fuel injection timing, pressure, and rate (rate shaping), fuel nozzle flow area; exhaust valve timing, and cylinder compression volume.

Tier III standards are expected to require dedicated NOx emission control technologies such as various forms of water induction into the combustion process (with fuel, scavenging air, or in-cylinder), exhaust gas recirculation, or selective catalytic reduction.

Pre-2000 Engines. Under the 2008 Annex VI amendments, Tier I standards become applicable to existing engines installed on ships built from 1st January 1990 to 31st December 1999, with a displacement ≥ 90 liters per cylinder and rated output ≥ 5000 kW, subject to availability of approved engine upgrade kit.

Testing. Engine emissions are tested on various ISO 8178 cycles (E2, E3 cycles for various types of propulsion engines, D2 for constant speed auxiliary engines, C1 for variable speed and load auxiliary engines). Addition of not-to-exceed (NTE) testing requirements to the Tier III standards is being debated. NTE limits with a multiplier of 1.5 would be applicable to NOx emissions at any individual load point in the E2/E3 cycle. Engines are tested using distillate diesel fuels, even though residual fuels are usually used in real life operation.

Further technical details pertaining to NOx emissions, such as emission control methods, are included in the mandatory “NOx Technical Code”, which has been adopted under the cover of “Resolution 2”.

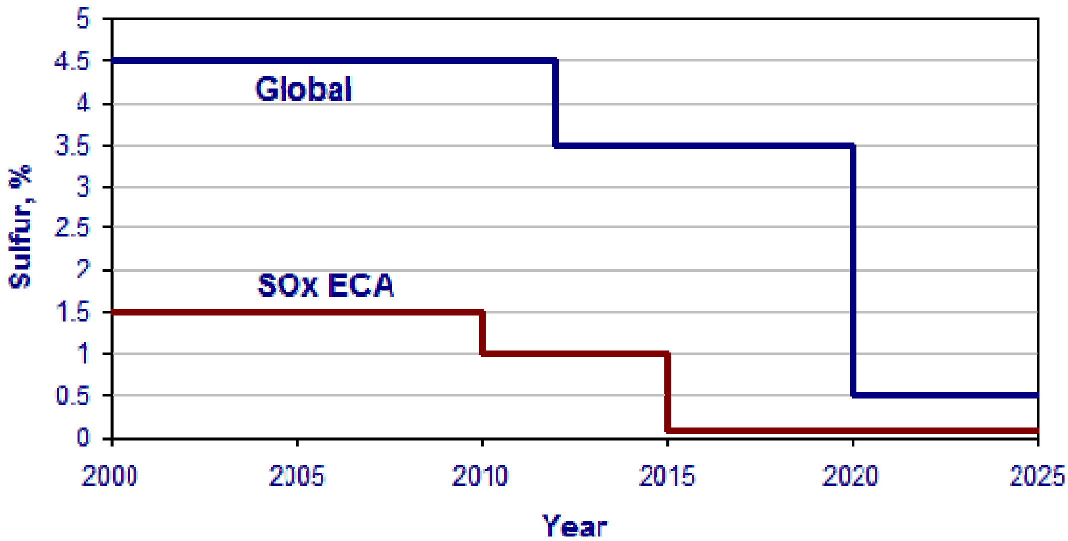
SULFUR

Annex VI regulations include caps on sulfur content of fuel oil as a measure to control SOx emissions and, indirectly, PM emissions (there are no explicit PM emission limits). Special fuel quality provisions exist for SOx Emission Control Areas (SOx ECA or SECA). The sulfur limits and implementation dates are listed in Table 3 and illustrated in Figure 28.

Table 3: MARPOL Annex VI Fuel Sulfur Limits

<table>
<tr><th rowspan="2">Date</th><th colspan="2">Sulfur Limit in Fuel (% m/m)</th></tr>
<tr><th>SOx ECA</th><th>Global</th></tr>
<tr><td>2000</td><td>1.5%</td><td rowspan="2">4.5%</td></tr>
<tr><td>2010.07</td><td rowspan="2">1.0%</td></tr>
<tr><td>2012</td><td rowspan="2">3.5%</td></tr>
<tr><td>2015</td><td rowspan="2">0.1%</td></tr>
<tr><td>2020[a]</td><td>0.5%</td></tr>
</table>

a - alternative date is 2025, to be decided by a review in 2018



Project cofinancé par le Fonds Européen de Développement Régional
Project co-financed by the European Regional Development Fund

Figure 28: MARPOL Annex VI Fuel Sulfur Limits

Heavy fuel oil (HFO) is allowed provided that it meets the applicable sulfur limit (i.e., there is no mandate to use distillate fuels).

Alternative measures are also allowed (in the SOx ECAs and globally) to reduce sulfur emissions, such as through the use of scrubbers. For example, in lieu of using the 1.5% S fuel in SOx ECAs, ships can fit an exhaust gas cleaning system or use any other technological method to limit SOx emissions to ≤ 6 g/kWh (as SO_2).

OTHER PROVISIONS

Ozone Depleting Substances. Annex VI prohibits deliberate emissions of ozone depleting substances, which include halons and chlorofluorocarbons (CFCs). New installations containing ozone-depleting substances are prohibited on all ships. But new installations containing hydro-chlorofluorocarbons (HCFCs) are permitted until 1 January 2020.

Annex VI also prohibits the incineration on board ships of certain products, such as contaminated packaging materials and polychlorinated biphenyls (PCBs).

Compliance. Compliance with the provisions of Annex VI is determined by periodic inspections and surveys. Upon passing the surveys, the ship is issued an "International Air Pollution Prevention Certificate", which is valid for up to 5 years. Under the "NOx Technical Code", the ship operator (not the engine manufacturer) is responsible for in-use compliance.

Greenhouse Gas Emissions. Annex VI does not cover the emission of greenhouse gases from ships. In November 2003, the IMO adopted resolution A.963(23) on IMO Policies and Practices related to the Reduction of Greenhouse Gas Emissions from Ships.

L'Europe en Méditerranée
Europe in the Mediterranean
Projet cofinancé par le Fonds Européen de Développement Régional
Project co-financed by the European Regional Development Fund

7.3 EUROPEAN

INTRODUCTION

Most European ports are free to determine their own dues and therefore also free to introduce dues differentiation. Indeed, dues are already commonly differentiated according to vessel class or particular vessel characteristics. The addition of environmental criteria is not likely to require new institutions, provided that ports can easily verify the status of ships with respect to the differentiation criteria it has in place. In the absence of existing institutions to carry out certification of ships according to the desired criteria, this may require that procedures be put in place.

AIR QUALITY STANDARTS

Humans can be adversely affected by exposure to air pollutants in ambient air. In response, the European Union has developed an extensive body of legislation which establishes health based standards and objectives for a number of pollutants in air. These standards and objectives are summarized in the table below. These apply over differing periods of time because the observed health impacts associated with the various pollutants occur over different exposure times.

Table 4: Air quality standards per pollutant

Pollutant	Concentration	Averaging period	Legal nature	Permitted exceedences each year
Fine articles (PM2.5)	25 µg/m3***	1 year	Target value enters into force 1.1.2010 Limit value enters into force 1.1.2015	n/a
PM10	50 µg/m3	24 hours	Limit value enters into force 1.1.2005**	35
	40 µg/m3	1 year	Limit value enters into force 1.1.2005**	n/a
Sulphur dioxide (SO2)	350 µg/m3	1 hour	Limit value enters into force 1.1.2005	24
	125 µg/m3	24 hours	Limit value enters into force 1.1.2005	3
Nitrogen dioxide (NO2)	200 µg/m3	1 hour	Limit value enters into force 1.1.2010	18
	40 µg/m3	1 year	Limit value enters into force 1.1.2010*	n/a
Lead (Pb)	0.5 µg/m3	1 year	Limit value enters into force 1.1.2005 (or 1.1.2010 in the immediate vicinity of specific, notified industrial sources; and a 1.0 µg/m3 limit value applies from 1.1.2005 to 31.12.2009)	n/a

Carbon monoxide (CO)	10 mg/m3	Maximum daily 8 hour mean	Limit value enters into force 1.1.2005	n/a
Benzene	5 µg/m3	1 year	Limit value enters into force 1.1.2010**	n/a
Ozone	120 µg/m3	Maximum daily 8 hour mean	Target value enters into force 1.1.2010	25 days averaged over 3 years
Arsenic (As)	6 ng/m3	1 year	Target value enters into force 1.1.2012	n/a
Cadmium (Cd)	5 ng/m3	1 year	Target value enters into force 1.1.2012	n/a
Nickel (Ni)	20 ng/m3	1 year	Target value enters into force 1.1.2012	n/a
Polycyclic Aromatic Hydrocarbons	1 ng/m3 (expressed as concentration of Benzo(a)pyrene)	1 year	Target value enters into force 1.1.2012	n/a

**Under the new Directive the Member State can apply for an extension of up to five years (i.e. maximum up to 2015) in a specific zone. Request is subject to assessment by the Commission. In such cases within the time extension period the limit value applies at the level of the limit value + maximum margin of tolerance (48µg/m3 for annual NO2 limit value).*

***Under the new Directive the Member State can apply for an extension until three years after the date of entry into force of the new Directive (i.e. May 20011) in a specific zone. Request is subject to assessment by the Commission. In such cases within the time extension period the limit value applies at the level of the limit value +*

L'Europe en Méditerranée
Europe in the Mediterranean
Projet cofinancé par le Fonds Européen de Développement Régional
Project co-financed by the European Regional Development Fund

maximum margin of tolerance (35 days at 75µg/m3 for daily PM10 limit value, 48µg/m3 for annual PM10 limit value).

****Standard introduced by the new Directive 2008/50/EC*

L'Europe en Méditerranée
Europe in the Mediterranean
Project confinancé parle Fonds Européen de Développement Régional
Project co-finnaced by the European Regional Development Fund

Under EU law a limit value is legally binding from the date it enters into force subject to any exceedences permitted by the legislation. A target value is to be attained as far as possible by the attainment date and so is less strict than a limit value.

The new Directive is introducing additional PM2.5 objectives targeting the **exposure** of the population to fine particles. These objectives are set at the national level and are based on the average exposure indicator (AEI).

AEI is determined as a 3-year running annual mean PM2.5 concentration averaged over the selected monitoring stations in agglomerations and larger urban areas, set in urban background locations to best assess the PM2.5 exposure to the general population.

Table 5: Air quality standards for PM2.5 in lines of AEI

Title	**Metric**	**Averaging period**	**Legal nature**	**Permitted exceedences each year**
PM2.5 Exposure concentration obligation	20 µg/m3 (AEI)	Based on 3 year average	Legally binding in 2015 (years 2013,2014,2015)	n/a
PM2.5 Exposure reduction target	Percentage reduction* + all measures to reach 18 µg/m3 (AEI)	Based on 3 year average	Reduction to be attained where possible in 2020, determined on the basis of the value of exposure indicator in 2010	n/a

** Depending on the value of AEI in 2010, a percentage reduction requirement (0, 10, 15, or 20%) is set in the Directive. If AEI in 2010 is assessed to be over 22 µg/m3, all appropriate measures need to be taken to achieve 18µg/m^3 by 2020.*

Projet cofinancé par le Fonds Européen de Développement Régional
Project co-financed by the European Regional Development Fund

PRINCIPLES

European legislation on air quality is built on certain principles. The first of these is that the Member States divide their territory into a number of zones and agglomerations. In these zones and agglomerations, the Member States should undertake assessments of air pollution levels using measurements and modeling and other empirical techniques. When levels are elevated, the Member States should prepare an air quality plan or program to ensure compliance with the limit value before the date when the limit value formally enters into force. In addition, information on air quality should be disseminated to the public.

CLEAN AIR FOR EUROPE (CAFE)

In May 2001, the European Commission formally adopted the Clean Air For Europe (CAFE) program. The program is aimed at integrating the various strands of air pollution policy under the 6th Environmental Action Program and includes the preparation of a thematic strategy on air pollution – one of seven covering various areas of EU environmental policy. The CAFE process has therefore effectively become the focal point for the EU's air quality work, providing a framework within which air pollution measures, such as the Auto Oil program, national emissions ceilings Directive and the air quality Daughter Directives can be coordinated.

In September 2005, the Commission published its Thematic Strategy on Air Pollution; its aim being to cut the annual number of premature deaths caused by air pollution by 40% by 2020 from the 2000 level and to reduce the continuing damage to Europe's ecosystems. To do this the Strategy says that emissions of sulphur dioxide will need to be reduced by 82%, nitrogen oxides by 60%, volatile organic compounds by 51%, ammonia by 27% and fine particulate matter by 59% (compared to their 2000 levels).

The Strategy proposes streamlining European air quality legislation and to this end includes a proposal for a Directive on Ambient Air Quality and Cleaner Air for Europe (COM (2005) 447) which will replace the Air Quality Framework Directive and three of its Daughter Directives (on sulphur dioxide, oxides of nitrogen, particulate matter and lead; on carbon monoxide & benzene; and that on monitoring & information on ozone).

The Strategy also outlines proposals for reviewing the National Emission Ceilings Directive, and for consideration to be given to the feasibility of tighter (Euro 5) emission limits for cars and Euro VI for heavy goods vehicles. Consideration is also to be given to extending the Integrated Pollution Prevention Control Directive to cover small combustion plant, a new Directive reducing VOC emissions from fuel stations, setting NOx emission limit values for ships, and reducing nitrogen use for animal feedstuffs and fertilizers.

L'Europe en Méditerranée
Europe in the Mediterranean
Projet cofinancé par le Fonds Européen de Développement Régional
Project co-financed by the European Regional Development Fund

EUROPEAN QUALITY LIMIT VALUES

European Limit Values are legally binding, and exceedences can result in the European Commission taking legal action against the country at fault. In 1996, the European Union adopted the Air Quality Framework Directive (96/62/EC), which in turn gave rise to a series of "Daughter" Directives containing Limit Values for seven pollutants. In June 2008, a new Air Quality Directive (2008/50/EC) came into force and must have been implemented by member states by 11 June 2010. This merges the former framework Directive and the first three Daughter Directives into a single Directive with no change to existing air quality objectives. It also introduces new air quality objectives for $PM_{2.5}$ (fine particles) including a limit value and exposure related objectives – exposure concentration obligation and exposure reduction target. The new Directive also introduced several new features that weaken the previous legislation, including the possibility to discount natural sources of particles (e.g. sea salt) when assessing compliance against limit values, and the possibility (with EU approval) of time extensions of three years (PM_{10}) or up to five years (NO_2, benzene) for complying with limit values.

EU MARINE SULPHUR DIRECTIVE

In 2002, the European Commission presented a proposal to amend Directive 1999/32 as regards the sulphur content of marine fuels (henceforth, the “marine fuel sulphur directive”) The European Parliament and Council finalized the marine fuel sulphur directive in April 2005 with a second reading agreement. At the time of writing, the directive had not yet been published in the EU Official Journal, but it had been formally signed and given the directive reference number 2005/33. The directive includes the following provisions: Ships in IMO Sulphur Emission Control Areas must use 1.5 percent sulphur fuel or better – starting with the Baltic Sea in May 2006, then extending to the North Sea and Channel in autumn 2007. All passenger vessels on regular services to or from Community ports must use 1.5 percent sulphur fuel or better from May 2006 onward. Ships at berth in ports must use 0.1 percent sulphur fuel or better from 2010 onward.

These provisions should apply to all marine fuels and replace the current regulations on marine gas oil, thereby establishing a similar regime for marine fuels as for heavy fuels and gas oils used by land-based sources, which are limited to 1.0 percent and 0.1 percent sulphur content, respectively. The Directive also allows ships to use other technical abatement technologies that achieve the same or greater levels of emission reductions, provided it can be demonstrated that these technologies do not adversely affect the marine environment. (The most often mentioned acceptable abatement technology is the desulphurization of exhaust gases via “seawater scrubbing.”)

EU CONTEXT- SUBSIDIES AND STATE AID RULES

Project cofinancé par le Fonds Européen de Développement Régional
Project co-financed by the European Regional Development Fund

The Commission has adopted the following three sets of state aid guidelines that define the context with regard to possible state subsidies for ship emissions reductions.

1. Community guidelines on state aid for environmental protection (2001/C37/03) allow aid where it serves as an incentive to firms to achieve levels of protection that are higher than those required by Community standards, or where no Community standards exist—as is the case for NOX emissions from seagoing ships. Investment aid can be given for plant and equipment intended to reduce or eliminate pollution, but may not exceed 30 percent gross of the eligible investment costs.

2. Community guidelines on state aid to maritime transport (1997/C205/05) allow investment aid in certain circumstances to promote the use of clean ships, such as providing incentives to upgrade Community registered ships to standards which exceed mandatory environmental standards laid down in international conventions.

3. Finally, the most recent Commission framework on state aid to shipbuilding (2003/C317/O6) allows aid for research and development and allows aid up to 20 percent of gross expenditure for innovation, i.e. technologically new or substantially improved products and processes compared to the state of the art referring to industry. Thus, it appears to be legally possible for Member States to provide subsidies for emissions reductions generated through the development and use of emissions abatement technologies for ships, either for new vessels or for retrofits.

MARKET BASED APPROACHES TO AIR EMISSIONS POLICY

Once a primarily theoretical approach to environmental policy, economic instruments have gained wide acceptance over the last three decades. Indeed, virtually all environmental policy initiatives that have been developed recently in the US include a market-based component. Market-based approaches have recently gained wider acceptance in Europe as well. The EU Emissions Trading Scheme (the “EU ETS”) represents perhaps the most prominent example of Europe’s use of market-based approaches. Under the EU ETS, Member States are permitted to trade CO2 emissions reduction credits among one another, as part of an EU-wide initiative to meet anticipated obligations under the Kyoto Protocol. The Commission has recognized that market-based instruments might be used to deal with various environmental issues. Experience suggests that well-designed market based approaches can reduce the costs and increase the likelihood of achieving environmental targets (see, e.g., Ellerman, Joskow and Harrison 2003). This experience also indicates, however, that the market-based approaches need to be carefully thought out in order to achieve these and other objectives. Moreover, it is important to include all interested parties in this process, particularly since the approach is relatively new for shipping.

Project cofinancé par le Fonds Européen de Développement Régional
Project co-financed by the European Regional Development Fund

7.4 NATIONAL FRAMEWORK

GENOA

Province of Genoa is one of the 4 provinces of the Liguria Region. In Italy, authorizations, controls and environmental issues are under the responsibility of Provinces while plans and programs are in charge to Regions.

Concerning air quality, the most relevant laws in Italy are:

- Legislative Decree number 351 of 4.08.1999 that has defined the rules to realize plans for air quality protection.
- Ministerial Decree number 60 of 02.04.2002 (transposition of EU dir. 1999/30/CE and 2000/69/CE) has redefined and updated the reference methods and new threshold numerical values for SO_2, NOx, particulate matter, Pb, benzene and CO).
- Legislative Decree number 183 of 21.05.2004 (transposition of EU dir. 2002/3/CE) concerning O_3.
- Legislative Decree. Number 152 of 03.08.2007 (transposition of EU directive 2002/3/CE) concerning As, Cd, Hg, Ni and Aromatic Polycyclic Hydrocarbons (PAH).

Mainly based on these laws, Liguria Region adopted so far the “Regional plan for rehabilitation and protection of air quality and reduction of greenhouse gases” (date of adoption 21.02.2006). This is the reference document to design the air quality monitoring network in Province of Genoa.

The Province of Genoa -according to Italian regional laws- is responsible for the air quality monitoring network, and for this purpose Province of Genoa controls air quality through the “Centro Operativo Provinciale”, by sampling and analyzing the pollutants present in urban area of the city of Genoa and its surroundings. Recently, the above mentioned national laws was repealed and replaced by the new Legislative Decree number 155 of 13.08.2010 (transposition of EU directive 2008/50/CE), which is the new comprehensive Italian framework law on air quality. In implementing the new Act, the Liguria region should revise its “Regional plan for rehabilitation and protection of air quality and reduction of greenhouse gases”, and consequently the provincial network will be updated. For the specific purposes of APICE, it is important to note that D.Lgs. 155/10 has defined legal limits for PM2.5 that was not fixed by the previous Italian laws.

7. EVALUATION OF AIR QUALITY IN REGION OF GENOA

L'Europe en Méditerranée
Europe in the Mediterranean
Project cofinancé par le Fonds Européen de Développement Régional
Project co-finnaced by the European Regional Development Fund

The current report has been redacted in lines of APICE program (Common Mediterranean strategy and local practical Actions for the mitigation of Port, Industries and Cities Emissions). The report includes a brief analysis of the air quality of the area during the last years. The interest is focused on the Port of Genoa, the first harbor in Italy and in Mediterranean Basin.

With 12 fixed stations in the municipality of Genoa, 7 fixed stations in the remaining part of the Province and 3 mobile stations, the air quality network supplies with PM, NO_x, SO_2, O_3, CO and some other pollutants' measurements. Data of meteorological parameters (wind speed, wind direction, precipitation, pressure, solar radiation, temperature and relative humidity) are also available from the network of the Meteo-Hydrological Observatory of Liguria (OMIRL), consisting of more than 200 stations throughout the territory of Liguria Region and managed by the Regional Agency for Environmental Protection (ARPAL).

The main conclusions of the analysis of the air quality in Genoa's region are:

- For the period 1993-2009, the annual NO_2 levels exceeded the legal limit value in both Firenze and Europa stations. At Quarto station, the limit was exceeded only in 1999 and 2008. *NO_2 is mainly associated with high traffic emissions which in combination with stable meteorological conditions, frequently during winter, without wind and thermal inversion, led to concentration's increase.*
- For the same period, annual CO levels exceeded the limit value of 10mg/m^3 at Europa station in years 1993-2000, 2004-2005.
- Concerning SO_2, the limit value of 125mg/m^3 was not exceeded during the period 1993-2009 (data available from Firenze and Quarto stations).
- For the same stations, O_3 limit value for citizens' information (180μg/m^3) was exceeded during almost all years. *As reactions between ozone and nitrogen oxides from traffic are very quick, ozone concentrations are expected to be lower at the city centre and higher in surrounding areas through pollutants transportation (in combination with prevailing meteorological patterns)*
- Regarding PM10 concentration, the annual limit of 40μg/m3 was exceeded during 2006 at Europa station. During all the other years, the annual levels remained lower than the limit at the three stations. *It is important to note that the factors that contribute to particles levels include permanent or seasonal sources*
  - PM composition has been measured since 1997 in several sites, mainly in collaboration with the Department of Physics of the University of Genoa. *V and Ni elements are usually considered as tracers of heavy oil combustion and therefore of ship emissions. The annual series show higher values during*

summer when the passenger traffic in the harbor of Genoa has a relevant increase.

The present report has focused on the study of PM10 levels during 2009. Thus,

- The maximum values of PM10 concentration correspond to May, June and July. On the other side, the lowest values correspond to January, February and December. *It is important to note that the factors that contribute to particles levels include permanent or seasonal sources.* The new Directive 2008/50/EC highlights that the limit of 50μg/m^3 should not be exceeded for more than 35 times per calendar year. From 01/01/2010, the limit is restricted to be 7 days per year. As noticed in the following figure, the measured concentration exceeded the limit *once*.

- Regarding average PM10 concentration for each day of the week, it can be noticed that although there are not significant differences, concentration on Sundays is lower, which could an impact of the reduction of vehicles circulation. Friday was the day with the maximum daily PM10 concentration average reported.

- Regarding the mean hourly (from 01:00 to 24:00) variation of PM10, concentration levels increase during early morning hours, presenting a peak at 9-10am, possibly because of the intense vehicles circulation. A second -lower- increase is observed during early evening hours (17-21pm). Concentration levels during night remain elevated.

- The maximum values for wind speed ranged between 11-17m/s and were mainly observed during periods with prevailing north-northeastern wind (and less often with prevailing northeastern and south-eastern winds). Western winds were rarely observed. Maximum PM10 levels (> 22μg/m^3) were more often recorded during days with prevailing north-northeastern wind. High PM10 levels also corresponded to winds with Northeast, Southeast direction and other directions (less often).

L'Europe en Méditerranée
Europe in the Mediterranean
Projet cofinancé par le Fonds Européen de Développement Régional
Project co-financed by the European Regional Development Fund

In conclusion, as mentioned previously, the aim of the present report was to briefly describe the air quality conditions in the region of Genoa, based on the data collected from the air quality and meteorological networks. A source apportionment study which will follow in the frame of APICE project will lead to focused conclusions on the main sources contributing to PM levels. The role of the ports emissions, in combination with the meteorological pattern of each area will be extensively examined.

SOURCES

- *Annual reports on Air Quality in the Province of Genoa – Edited by Amministrazione Provinciale di Genova – Settore Ambiente – Ref. person. M.T. Zannetti*
- *Scientific publication by University of Genoa: see list in annex 2*
- *Meteorological records of Agenzia Regionale per la Protezione dell'Ambiente Ligure (ARPAL): Ref. person. Elisabetta Trovatore*
- *United Nations Convention on the Law of the Sea*
- *World Shipping Council*
- *International Shipping Federation*
- *Port State Control*
- *International Association of Ports and Harbors*
- *International Marine time Organizations*
- *International Convention on the prevention of Pollution from Ships*
- *Sulphur Oxide Emission Control Areas*
- *Protocol 1978 Relating Thereto*
- *MEPC 176(58)*
- *2008/50/EK Directive*
- *MARPOL (ANNEX VI)*
- *Directive 2005/35/EU*
- *Marine Strategy Framework Directive 11/12/2007*
- *ICZM*
- *COM446/2005*
- *Directive 1999/32/CE*
- *DM60/2002*
- *www.shippingandco2.org*

- www.cleanairatsea.com
- www.dnv.com
- www.aircm.org
- www.maricopa.gov
- http://eur-lex.europa.eu

L'Europe en Méditerranée
Europe in the Mediterranean
Projet cofinancé par le Fonds Européen de Développement Régional
Project co-financed by the European Regional Development Fund

ANNEX I

OLFACTORY POLLUTION

Over MPM area, olfactory pollution leads to frequent complaints for the quality of life. Olfactory survey is a regional mission given to AIRFOBEP (driver) and ATMOPACA. It is a part of the global approach, incited by the Permanent Secretary for Industrial Pollution, to decrease olfactory pollution. The objectives of the regional olfactory survey are:

- To manage and to develop olfactory pollution survey tools
- To determine areas with a high inconvenience and to help for olfactory source identification
- To inform public and partners about olfactory inconveniences

SURVEY TOOLS

VOLUNTARY NOSE INJURY

Composed of inhabitants, nose jury is involved in observation campaigns. During these campaigns, each "nose" notes, at a precise time, its olfactory observations: Is there an odor? Is it irritating? How to characterize it?

A permanent jury is located over Berre pond area since 2001. Over the eastern part of Bouches-du-Rhône department (Aix-en-Provence and Marseille), a jury has run from 2001 to 2004. Some juries of specific noses are frequently mobilized into carrying out these observation campaigns over areas where several complaints have been recorded.

COMPLAINT COLLECTION

Spontaneous observations or complaints are recorded during irritating odor events into a database. A free telephone number is available to signal all irritating olfactory.

2009 OSERVATIONS

More than 10 000 olfactory observations have been carried out by the permanent jury in 2009.

Between 600 and 1 100 observations are monthly recorded. The highest nose participation has been recorded during May, the lowest during July. Observations are carried out close to Berre pond border and over the North-western part of Bouches-du-Rhône department.

Project cofinancé par le Fonds Européen de Développement Régional
Project co-financed by the European Regional Development Fund

PERSEPTION RATE

Permanent jury observations show that the mean olfactory perception rate, over Berre pond area, stays stable in 2009 in comparison to the two last years (between 12% and 13%). The monthly perception rate is recorded during July with 20%.

In 2009, 1 observation for 10 has lead to an irritating olfactory perception over Berre pond area. The olfactory perception rate varies between and inside cities.

OLFACTORY COMPLAINTS

During 2009, about 2 070 complaints have been recorded for Provence-Alpes-Côte d'Azur (PACA) region. 86% of complaints come from Bouches-du-Rhône department. Complaint number has increased of 15% between 2008 and 2009.

ANNEX II

PUBLICATIONS

- The Mt. Cimone 2004 summer campaign: characterization of PM10 and PM1 F. Marenco, P. Bonasoni, F. Calzolari, M. Ceriani, M. Chiari, P. Cristofanelli, A. D'Alessandro, F. Mazzei, S. Nava, P. Prati, G. Valli, R. Vecchi *Journal of Geophysical Research, 2006 vol. 111, n. D24, D24202*

- Elemental composition and source apportionment of particulate matter near a steel plant in Genoa (Italy) F. Mazzei, A. D'Alessandro, F. Lucarelli, S. Nava, P. Prati, G. Valli, R. Vecchi *Nucl. Instr. And Method. B249, issues 1-2, (2006) 548-551*

- Aerosol advection and sea salt events in Genoa (Italy) during the second half of 2005. F. Marenco, F. Mazzei, P. Prati, M. Gatti. *The Science of the Total Environment 377,411 (2007)*

- Characterization of particulate matter sources in an urban environment F. Mazzei, A. D'Alessandro, F. Lucarelli, S. Nava, P. Prati, G. Valli, R. Vecchi *The Science of the Total Environment Volume 401, Issues 1-3*, *15 August 2008*, *81-89*

- A comprehensive characterisation of the sub-micron sized aerosol fraction at urban sites in Italy: a mass closure and source apportionment study R. Vecchi, G. Valli, F. Silvani, A. D'Alessandro, F. Mazzei, P. Prati, F. Lucarelli, S. Nava, P. Fermo, A. Piazzalunga. *Atmospheric Environment42 (2008) 2240 - 2253*

- A new methodological approach: the combined use of two-stage streaker samplers and optical particle counters for the characterization of airborne particulate matter" F. Mazzei, A. D'Alessandro, F. Lucarelli, S. Nava, P. Prati, G. Valli, R. Vecchi *Atmospheric Environment, 41, issue 26 (2007)5525,5535*

- PIXE and XRF analysis of particulate matter samples: an inter-laboratory comparison G. Calzolai, M. Chiari, , F. Lucarelli, F. Mazzei, S.Nava, P. Prati, G. Valli, R. Vecchi *Nucl. Instr. And Meth. B266 (2008) 2401-2404*

- 4-hours resolution data to study PM10 in a "hot spot" area in Europe R. Vecchi, V. Bernardoni, P. Fermo, F. Lucarelli, F. Mazzei, S. Nava, P. Prati, A. Piazzalunga, G. Valli Environ. Monit. Assess.DOI 10.1007/s10661-008-0396-1

- PM10 apportionment around a steel smelter plant F. Mazzei, P. Prati *J. Air & Waste Manage. Assoc.* 59:514–519, 2009, DOI:10.3155/1047-3289.59.5.514

- Nuclear techniques and the particulate matter pollution in big harbours. V. Ariola, V. Bernardoni, G. Calzolai, M. Chiari, E. Cuccia, F. Lucarelli, F.

Mazzei, S. Nava, P. Prati, G. Valli, R. Vecchi *Il Nuovo Cimento C, 2009, DOI 10.1393/ncc/i2008-10306-5*

- Self-attenuation artifacts and correction factors of measurements of light element concentrations by X-Ray Analysis: implication for mineral dust composition studies P. Formenti, S. Nava, P. Prati, S. Chevaillier, A. Klaver, F. Mazzei, S. Lafon, G. Calzolai, M. Chiari *J. Geophys. Res., 115, D01203, doi:10.1029/2009JD012701*

- Black Carbon determination in particulate matter deposited on standard Teflon filters" E. Cuccia, D. Massabò, P. Prati *Il Nuovo Cimento C DOI 10.1393/ncb/i2010-10869-3*

- An alternative way to determine the size distribution of airborne particulate matter E. Cuccia, V. Bernardoni, D. Massabò, P. Prati, G. Valli, R. Vecchi *Atmospheric Environment 44 (2010) 3304 -3313*

- ED-XRF set-up for size-segregated aerosol samples analysis V. Bernardoni, E. Cuccia, G. Calzolai, M. Chiari, F. Lucarelli, D. Massabò, S. Nava, P. Prati, G. Valli, R. Vecchi. *In press on X Ray Spectrometry*

- Large Eddy Simulation of the Onset of the Sea Breeze M. Antonelli, R.Rotunno *J. of the Atmos. Sci., 64 (2007), 4445–4457* Anisotropies and Universality of Buoyancy-Dominated Turbulent Fluctuations: A Large-Eddy Simulation Study M. Antonelli, A. Lanotte, A. Mazzino *J. Atmos. Sci. 64 (2007), 2642-2656*

- Editorial: Harbours and Air Quality E. Georgieva, E. Canepa, P. Builtjes *Atmospheric Environment,41,Issue 30, (2007),6319-6321, for Harbours and Air Quality Special Issue, Atmospheric Environment, Edited by Emilia Georgieva, Elisa Canepa, Peter Builtjes*

- A simple and efficent procedure for the numerical simulation of wind fields in complex terrain M. Burlando, L. Carassale, E. Georgieva, C. F. Ratto, G. Solari *Boundary-Layer Meteorol 125 (2007), 417-439.*

- The GIS-based SafeAirView software for the concentration assessment of radioactive pollutants after an accidental releases E. Canepa, F. D'Alberti, F. D'Amati, G. Triacchini *Science of the Total Environment. Volume/Issue 373/1 (2007), 32-42*

- The SAFE_AIR II dispersion model: description and statistical evaluation of its dispersion module against wind tunnel data from area sources M. Cavallaro, E. Canepa, E. Georgieva *Ecological Modelling, Volume/Issue 202/3-4 (2007), 547-558 http://dx.doi.org/10.1016/j.ecolmodel.2006.11.018*

- Parameterisation of the planetary boundary layer for diagnostic wind models M. Burlando, E. Georgieva, C.F.Ratto *Boundary-Layer Meteorol , 125, (2007), 389-397*

- Optimisation of the regional spatial distribution of wind power plants to minimise the variability of wind energy input into power supply systems F. Cassola, M. Burlando, M. Antonelli, C:F. Ratto *J. Appl. Meteorol. Climatol., 47 (2008), 3099–3116*

- Mesoscale wind climate analysis: identification of anemological regions and wind regimes M. Burlando, M. Antonelli, C. F. Ratto *Int. Int. J. Climatol., 28 (2007): 629-641*

- A new mass conservation approach to the study of CO2 advection in an alpine forest L. Montagnani, G. Manca, E. Canepa, E. Georgieva, M. Acosta, C. Feigenwinter, D. Janous, G. Kerschbaumer, A. Lindroth, L. Minach, S. Minerbi, M. Mölder, M. Pavelka, G. Seufert, M. Zeri, W. Ziegler *Journal of Geophysical Research, 114 (2009), D07306, doi:10.1029/2008JD010650*

- The synoptic-scale surface wind climate regimes of the Mediterranean Sea according to the cluster analysis of ERA-40 wind fields M. Burlando *Theor. Appl. Climatol., 96, 2009, 69–83*

- Preliminary estimate of the large-scale wind energy resource with few measurements available: the case of Montenegro M. Burlando, A. Podestà, L. Villa, C. F. Ratto, G. Cassulo *Journal of Wind Engineering and Industrial Aerodynamics 97 (2009), 497–511*

- A pilot study of the wind speed along the Rome-Naples HS/HC railway line. Part 1 – Numerical modelling and wind simulations M. Burlando, A. Freda, C. F. Ratto, G. Solari *Journal of Wind Engineering and Industrial Aerodynamics, 98 (2010), 392-403*

- Numerical simulation of turbulent wind fields at airports in complex terrains M. Burlando, L. Carassale, C. F. Ratto, G. Solari, F. Tubino *Journal of Wind Engineering and Industrial Aerodynamics, 2010, submitted*

Other Relevant Publications

In the last five years the Researchers of the Department of Physics of the University of Genoa have given more than 30 talks at major international conferences as:

- *European Aerosol Conference (EAC)*
- *International Aerosol Conference (IAC)*
- *Air Quality (AQ former UAQ)*
- *International Conference on Ion Beam Analysis (IBA)*
- *International Conference on X-Ray Spectrometry*
- *European Wind Energy Conference*

L'Europe en Méditerranée
Europe in the Mediterranean
Project cofinancé par le Fonds Européen de Développement Régional
Project co-financed by the European Regional Development Fund

- *International Conference on Wind Engineering*

ANNEX II

PROJECTS

The Physics Department (DIFI in the following) of the University of Genoa was an active member in several research projects funded in the last five (and more) years and devoted to the developments of new instruments and methods for atmospheric aerosol researches. The research at DIFI was also addressed to the development, tuning and application of numerical models relative to weather forecasting and simulation and/or prediction of the behavior of the atmosphere with particular regard to weather modeling, evaluation of potential offshore and onshore wind on complex topography, simulation of atmospheric dispersion. The major DIFI research projects in the quoted fields (last five years) are:

- the WERMED (Weatherrouting dans la Méditerranée Occidentale) project aiming at analyzing the potential of modern weather routing techniques applied to navigation in the Mediterranean and funded on Interreg IIIB MEDOCC Programme (2006-2007);
- the realization of the Wind Atlas of Italy, in collaboration with CESI RICERCA, financed by the Ministry of Economic Development with the Research Fund for the Italian Electric System (2006-2007);
- the realization of the wind atlases of Montenegro (2007) and Albania (2008);
- the analysis of the impact of the coal power plant of Genoa, in collaboration with CESI by means of numerical simulations of the dispersion of the emitted pollutants compared with measured data (2006-2008);
- the MITA project, in collaboration with the Municipality of Genoa, devoted to study the effects of the traffic emissions on the urban air quality in Genoa (2009-2011).
- The characterization, since 2003, the Particulate Matter (PM) sources acting in the urban area of the city of Genoa and in its surroundings (grant Province of Genoa).
- Italian Ministry of Research, research project of National Relevance; 2007-2008: The Development of new physical methods for the characterization of the carbonaceous components of the atmospheric aerosol.
- Italian National Institute for Nuclear Physics (INFN): 2006-2008: “NUTELLA” (NUclear TEchniques for poLLution Analysis) grant ; 2009-2011: “NUMEN” (Nuclear Methods for Environment) grant
- Galileo Program (bilateral France and Italy), 2007: Etude de la composition elementaire et mineralogique de poussières saharienne/sahelienne par methodes physiques
- 2006, grant with the Tribunal of Genoa for the evaluation of the pollution produce by the steel smelter located in the Genoa-Cornigliano area
- 2007, grant with the Tribunal of Massa Carrara for the evaluation of the particulate matter pollution linked to the marble transportation through the town of Carrara

- 2009-2010, collaboration with the EU-JRC-Ispra in the study of the atmospheric pollution in the western Mediterranean through sampling and monitoring activities on board of a cruise ship.